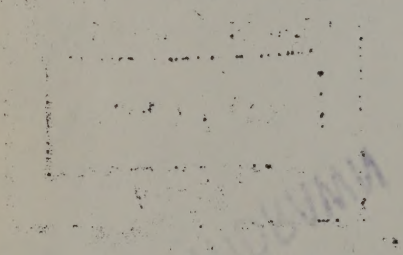
STANDARD SPECIFICATIONS

for

ROAD AND BRIDGE CONSTRUCTION

STATE OF NEVADA
DEPARTMENT OF HIGHWAYS
CARSON CITY

1976



STATE OF NEVADA
DEPARTMENT OF HIGHWAYS

Standard Specifications for Road and Bridge Construction

GRANT BASTIAN
State Highway Engineer

DIRECTORS

MIKE O'CALLAGHAN, *Governor,* Chairman
ROBERT LIST, *Attorney General*
WILSON MCGOWAN, *State Controller*

CARSON CITY, NEVADA
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TABLE OF CONTENTS

DIVISION I—GENERAL REQUIREMENTS

SECTION 101—DEFINITIONS AND TERMS

CONTENTS

GENERAL REQUIREMENTS—*Continued*

SECTION 102—BIDDING REQUIREMENTS AND CONDITIONS

GENERAL REQUIREMENTS—*Continued*

SECTION 103—AWARD AND EXECUTION OF CONTRACT

SECTION 104—SCOPE OF THE WORK

SECTION 105—CONTROL OF WORK

SECTION 106—CONTROL OF MATERIAL

CONTENTS

GENERAL REQUIREMENTS—*Continued*

SECTION 107—LEGAL RELATIONS AND RESPONSIBILITY TO THE PUBLIC

SECTION 108—PROSECUTION AND PROGRESS

GENERAL REQUIREMENTS—*Continued*

CONSTRUCTION DETAILS—*Continued*

CONSTRUCTION DETAILS—*Continued*

SECTION 204—ROUNDED AND TRANSITION SLOPES

SECTION 205—OVERHAUL

SECTION 206—STRUCTURE EXCAVATION

SECTION 207—BACKFILL

CONTENTS

CONSTRUCTION DETAILS—*Continued*

CONSTRUCTION DETAILS—*Continued*

SECTION 211—EROSION CONTROL

SECTION 212—LANDSCAPING

CONSTRUCTION DETAILS—*Continued*

CONSTRUCTION DETAILS—*Continued*

CONSTRUCTION DETAILS—*Continued*

CONSTRUCTION DETAILS—*Continued*

CONTENTS

CONSTRUCTION DETAILS—*Continued*

CONSTRUCTION DETAILS—*Continued*

CONTENTS

CONSTRUCTION DETAILS—*Continued*

CONSTRUCTION DETAILS—*Continued*

CONSTRUCTION DETAILS—*Continued*

CONSTRUCTION DETAILS—*Continued*

CONTENTS

CONSTRUCTION DETAILS—*Continued*

SECTION 504—LIGHTWEIGHT CONCRETE FOR STRUCTURES

SECTION 505—REINFORCING STEEL

SECTION 506—STEEL STRUCTURES

CONSTRUCTION DETAILS—*Continued*

SECTION 507—TIMBER STRUCTURES

CONSTRUCTION DETAILS—*Continued*

CONSTRUCTION DETAILS—*Continued*

CONSTRUCTION DETAILS—*Continued*

CONSTRUCTION DETAILS—*Continued*

SECTION 607—UNDERDRAINS

SECTION 608—DOWNDRAINS

CONSTRUCTION DETAILS—*Continued*

CONSTRUCTION DETAILS—*Continued*

CONTENTS

CONSTRUCTION DETAILS—*Continued*

CONSTRUCTION DETAILS—*Continued*

SECTION 617—CATTLE GUARDS

SECTION 618—GUARDRAIL

CONSTRUCTION DETAILS—*Continued*

SECTION 619—OBJECT MARKERS AND GUIDE POSTS

SECTION 620—RIGHT OF WAY MARKERS

SECTION 621—MONUMENTS

CONSTRUCTION DETAILS—*Continued*

SECTION 622—RAISED TRAFFIC BARS

SECTION 623—SIGNALS AND LIGHTING

CONSTRUCTION DETAILS—*Continued*

CONSTRUCTION DETAILS—*Continued*

CONTENTS

CONSTRUCTION DETAILS—*Continued*

SECTION 626—TEMPORARY SIGNS

SECTION 627—PERMANENT SIGNS

SECTION 628—MOBILIZATION

CONSTRUCTION DETAILS—*Continued*

SECTION 632—HEADLIGHT GLARE SCREEN

SECTION 633—PAVEMENT MARKERS

SECTION 634—ASBESTOS–CEMENT PIPE

CONTENTS

CONSTRUCTION DETAILS—*Continued*

CONSTRUCTION DETAILS—*Continued*

DIVISION III—MATERIALS DETAILS

SECTION 701—PORTLAND CEMENT

SECTION 702—CONCRETE CURING MATERIALS AND ADMIXTURES

SECTION 703—BITUMINOUS MATERIALS

CONTENTS

MATERIALS DETAILS—*Continued*

MATERIALS DETAILS—*Continued*

CONTENTS

MATERIALS DETAILS—*Continued*

MATERIALS DETAILS—*Continued*

SECTION 713—REINFORCEMENT

SECTION 714—PAINT

SECTION 715—GALVANIZING

SECTION 716—SIGN MATERIALS

CONTENTS

MATERIALS DETAILS—*Continued*

MATERIALS DETAILS—*Continued*

SECTION 721—OBJECT MARKERS AND GUIDE POSTS

SECTION 722—WATER

SECTION 723—HARDWARE

SECTION 724—FENCE MATERIALS

CONTENTS

MATERIALS DETAILS—*Continued*

SECTION 725—ELASTOMERIC BEARING PADS

SECTION 726—ROADSIDE MATERIALS

SECTION 727—CONCRETE SURFACE FINISHING MATERIAL

SECTION 728—EPOXY

MATERIALS DETAILS—*Continued*

DIVISION I

GENERAL REQUIREMENTS

SECTION 101

DEFINITIONS AND TERMS

Wherever in these specifications or in other contract documents the following terms or pronouns in place of them are used, the intent and meaning shall be interpreted as follows:

101.01 Abbreviations. Wherever the following abbreviations are used in these specifications or on the plans, they are to be construed the same as the respective expressions represented:

AAN—American Association of Nurserymen
AAR—Association of American Railroads
AASHTO—American Association of State Highway and Transportation Officials
ACI—American Concrete Institute
AGC—Associated General Contractors of America
AIA—American Institute of Architects
AISC—American Institute of Steel Construction
ARA—American Railway Association
AREA—American Railway Engineering Association
ASA—American Standards Association
ASCE—American Society of Civil Engineers
ASLA—American Society of Landscape Architects
ASME—American Society of Mechanical Engineers
ASTM—American Society for Testing and Materials
AWG—American Wire Gauge
AWPI—American Wood Preservers Institute
AWS—American Welding Society
AWWA—American Water Works Association

Code—National Electric
EIA—Electronic Industries Association
FHWA—Federal Highway Administration—Department of Transportation
FSS—Federal Specifications and Standards, General Services Administration
IEEE—Institute of Electrical and Electronics Engineers
MUTCD—Manual on Uniform Traffic Control Devices for Streets and Highways. Published by the Federal Highway Administration
NEMA—National Electrical Manufacturers Association
SAE—Society of Automotive Engineers
UL—Underwriters Laboratories, Incorporated
USASI—United States of America Standards Institute

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

101.03 Award. The acceptance by the Department of a bid.

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

101.05 Bidder. An individual, partnership, firm, corporation, or any acceptable combination thereof, or joint venture, submitting a bid for the advertised work.

101.06 Bridge. A structure, including supports, erected over a depression or an obstruction, as water, highway, or railway, and having a track or passageway for carrying traffic or other moving loads and having a length measured along the center of roadway of more than twenty (20) feet between undercopings of abutments or extreme ends of openings for multiple boxes.

Length. The length of a bridge structure is the overall

length measured along the line of survey stationing back to back of backwalls of abutments, if present, otherwise end to end of the bridge floor; but in no case less than the total clear opening of the structure.

Roadway width. The clear width measured at right angles to the longitudinal centerline of the bridge between the bottom of curbs or guard timbers or in the case of multiple height of curbs, between the bottoms of the lower risers and in the case of no curbs or guard timbers, between the inner faces of parapet or railing at the bottom.

101.07 Calendar Day. Every day shown on the calendar.

101.08 Contract Change Order. A written order issued by the Engineer to the Contractor, covering changes in the plans, specifications 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 change.

101.09 Channel. A natural or artificial water course.

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

The contract includes the invitation for bids, proposal, contract form and contract bond, Standard Specifications, supplemental specifications, special provisions, general and detailed plans, Notice to Proceed, and any change orders and supplemental agreements that are required to complete the construction of the work in an acceptable manner, including authorized extensions and basis of payment thereof, all of which constitute one instrument.

101.11 Contract Bond. The approved form of security, executed by the Contractor and his surety or sureties, guaranteeing complete execution of the contract and all

supplemental agreements pertaining thereto and the payment of all legal debts pertaining to the construction of the project.

101.12 Contract Item (Pay Item). An item of work specifically described and for which a price, either unit or lump sum, is provided. It includes the performance of all work and the furnishing of all labor, equipment, and materials described in the text of a specific item included in the contract or described in the Standard Specifications, supplemental specifications, or special provisions of the contract. Contract items are numbered so that the first three digits of the item number correspond to the section of the same number. Thus, in Item No. 203 0100, which is the item number for roadway excavation, the number 203 is the section number and corresponds to Section 203 of the Standard Specifications, supplemental specifications, and special provisions.

Each contract item shall be constructed under the specifications contained in the section of the same number, i.e., the number preceding aforementioned last four digits.

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

101.14 Contract Time. The number of work days or calendar days allowed for completion of the contract, including authorized time extensions.

In case a calendar date of completion is shown in the proposal in lieu of the number of working or calendar days, the contract shall be completed by that date.

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

101.16 Department. The party of the first part to a contract which shall be the State Highway Department as constituted under the laws of the State of Nevada, for the administration of highway work.

101.17 Detour. A temporary route for traffic around a closed portion of road.

101.18 Directors. The directors of the State Highway Department of the State of Nevada as established by the laws of the State of Nevada, acting directly or through their authorized representatives.

101.19 Divided Highway. A highway with separated roadways for traffic in opposite directions.

101.20 Employee. Any person working on the project mentioned in the contract of which these specifications are a part, and who is under the direction and control, or receives compensation from the Contractor or his subcontractor.

101.21 Engineer. The State Highway Engineer of the State of Nevada, acting either directly or through his duly authorized representatives, who is responsible for the engineering supervision of the construction.

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

101.23 Extra Work. An item of work not provided for in the contract as awarded but found essential to the satisfactory completion of the contract within its intended scope.

101.24 Frontage Road or Frontage Street. A local street or road auxiliary to and located generally on the side of an arterial highway for service to abutting property and adjacent areas and for control of access.

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

101.26 Holidays. In the State of Nevada, these occur on:

January 1 (New Year's Day)
Third Monday in February (Washington's Birthday)
Last Monday in May (Memorial Day)
July 4 (Independence Day)
First Monday in September (Labor Day)
October 31 (Nevada Day)
November 11 (Veterans' Day)
Fourth Thursday in November (Thanksgiving Day)
December 25 (Christmas Day)

or on any day that may be appointed by the President of the United States or by the Governor of Nevada for public fast, thanksgiving or as a legal holiday.

If January 1, July 4, October 31, November 11, or December 25 falls upon a Sunday, the Monday following shall be observed as a holiday.

If January 1, July 4, October 31, November 11, or December 25 falls upon a Saturday, the Friday preceding shall be observed as a holiday.

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

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

101.29 Major Contract Item. A "Major Item" shall be construed to be any individual bid item included in the proposal that has a total cost equal to or greater than $50,000 or 5 percent of the total contract cost, whichever is the lesser amount. The total contract cost shall be computed on the basis of the proposal quantities and contract unit prices.

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

101.31 Median. That portion of a divided highway separating the travel ways for traffic generally in opposite directions.

101.32 Notice to Contractors. The official notice inviting bids for the proposed work.

101.33 Notice to Proceed. A written notice to the Contractor to proceed with the contract work including, when applicable, the date of beginning of contract time.

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

101.35 Plans. The approved project plans and standard plans, profiles, 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 performed. All such documents are to be considered as a part of the plans whether or not noted in the special provisions.

In the above definition, the following terms are defined as follows:

(a) Standard Plans—The standard plans of the State Highway Department.

(b) Project Plans—The project plans are specific details and dimensions peculiar to the work and are supplemented by the standard plans insofar as the same may apply.

101.36 Profile Grade. The trace of a vertical plane intersecting the top surface of the proposed structural section as shown on the plans. Profile grade means either elevation or gradient of such trace according to the context.

101.37 Project. The specific section of the highway together with all appurtenances and construction to be performed thereon at the prices quoted.

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

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

101.40 Proposal Guaranty. The security furnished with a bid to guarantee that the bidder will enter into the contract if his bid is accepted.

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

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

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

101.44 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.

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

101.46 Roadway. The portion of a highway within limits of construction.

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

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

101.49 Special Provisions. Additions and revisions to the standard and supplemental specifications covering conditions peculiar to an individual project.

101.50 Specifications. The directions, provisions, and requirements contained in the Standard Specifications and supplemental specifications as modified by the special provisions. Whenever the term "these specifications" is used in this book, it means the provisions set forth in this book.

101.51 State. The State of Nevada acting through its authorized representatives.

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

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

101.54 Subcontractor. Any individual, firm, or corporation to whom the Contractor, with the consent of the Department, sublets any part of the contract.

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

101.56 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 backwall, wingwalls, and wing protection railings.

101.57 Superintendent. The Contractor's authorized representative in responsible charge of the work, present on the work at all times during the progress to supervise and direct the construction, to receive and fulfill instructions from the Engineer, and to accept orders for changed and extra work.

101.58 Superstructure. The entire structure except the substructure.

101.59 Supplemental Agreement. A written agreement made and entered into by and between the Contractor and the Department covering work not otherwise provided for, revisions in or amendments to the terms of the contract, or conditions specifically prescribed in the specifications as requiring supplemental agreements. Such supplemental agreements become a part of the contract when approved and properly executed.

101.60 Supplemental Specifications. Additions and revisions to the Standard Specifications that are adopted subsequent to the issuance of the printed book.

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

101.62 Surface Course. One or more layers of a pavement structure designed to accommodate the traffic load, the top layer of which resists skidding, traffic abrasion, and the disintegrating effects of climate. The top layer is sometimes called "Wearing Course."

101.63 Traffic Lane. The portion of a traveled way for the movement of a single line of vehicles.

101.64 Traveled Way. That portion of roadway for the movement of vehicles, exclusive of shoulders and auxiliary lanes.

101.65 Work. Work will mean furnishing all labor, materials, equipment, and other incidentals necessary or convenient to the successful completion of the project and the carrying out of all of the duties and obligations as imposed by the contract.

101.66 Working Day. A calendar day on which weather and other conditions not under the control of the Contractor will permit construction operations to proceed for the major part of the day (five (5) hours) with the normal working force engaged in performing the controlling item or items of work which would be in progress at that time, exclusive, however, of Saturdays, Sundays, State recognized holidays, and any day that is incumbent upon the Contractor, by means of a labor union, to observe as a holiday. However, if the Contractor elects to work on such days, those days will be considered as a working day.

Attention is directed to subsections 108.04, "Limitation of Operations," and 108.08, "Determination and Extension of Contract Time."

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

101.68 In order to avoid cumbersome and confusing repetition of expressions in these specifications, it is provided that whenever anything is, or is to be, done, if, as, or, when, or where "contemplated, required, determined, directed, specified, authorized, ordered, given, designated, indicated, considered necessary, deemed necessary,

permitted, 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 Notice to Contractors. After the date is fixed for the letting of the work, the Department will give notice of such letting to Contractors. The Notice to Contractors will contain a description of proposed work, together with information to the bidder regarding access to the proposal forms, plans, and specifications, the amount and nature of proposal guaranty, and the reservation of the right of the Department to reject any or all bids.

102.02 Prequalification of Bidders. All bidders shall be prequalified as required by law. To be qualified, a prospective bidder shall submit, under oath, on the standard form furnished by the Department, a statement of his financial ability and experience in the performance of contracts for public work. Financial statements shall be prepared and certified by a certified public accountant, or by an accountant who has been previously approved by the Department as being competent to prepare a Contractor's financial statement. After verifying the information contained in the statement, the Department shall notify the submitter of the maximum contract amount and class of work upon which he will be eligible to bid.

Statements of financial ability and experience shall be submitted as of the date upon which the fiscal year of the prospective bidder ends.

In order to remain on the qualified list, a prospective bidder shall submit a new statement at the close of his fiscal year. A prospective bidder not already qualified shall submit his statement of financial ability and experience at least five (5) full days prior to the date set for the opening of bids in which he is interested in order to have it considered, but qualification shall not be granted until such statement has been verified. Statements shall preferably be submitted at least thirty (30) days prior to bid opening.

Nothing contained in this section shall be construed as depriving the Department of its discretion in the matter of determining the lowest responsible bidder.

On Federal-aid projects, any Contractor otherwise qualified by the State of Nevada to perform such work is not required to be licensed nor to submit application for license in advance of submitting a bid or having such bid considered, provided, however, that such exception does not constitute a waiver of the State's right under its license laws to require a Contractor, determined to be a successful bidder, to be licensed to do business in the State of Nevada in connection with the award of a contract to him.

No bid will be accepted from, or contract awarded to, a Contractor to whom a proposal form has not been issued by the Department of Highways.

102.03 Contents of Proposal Forms. Upon request, the Department will furnish the prospective bidder with a proposal form. This form will state the location and description of the contemplated construction and will show the approximate 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 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 form will also include any 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, supplemental notices to contractors, and other documents designated in the proposal form will be considered a part of the proposal whether attached or not.

The prospective bidder or interested nonbidder will be required to pay the Department the sum stated in the advertisement and "Notice to Contractors" for each copy

of proposal form and each set of plans. The contract documents are nonreturnable and no refund will be made.

Checks in payment for plans and specifications will be made payable to the State of Nevada, Department of Highways.

102.04 Interpretation of Quantities in the Proposal. The quantities given in the Notice to Contractors and in the proposal and contract forms are approximate only, being given as a basis for the comparison of bids, and the Department does not, expressly or by implication, agree that the actual amount of work will correspond therewith, but reserves the right to increase or decrease the amount of any class or portion of the work, or to omit portions of the work, as may be deemed necessary or advisable by the Engineer.

102.05 Examination of Plans, Specifications, Contract Documents, and Site of Work. The Department will prepare plans and specifications giving such directions as will enable any competent mechanic or Contractor to carry them out. The bidder is expected to examine carefully the site of the proposed work, the proposal, plans, specifications, supplemental specifications, special provisions, and contract forms 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 the work and as to the requirements of the plans, specifications, supplemental specifications, special provisions, and contract documents.

When a pay item is shown on the plans and not in the proposal, and such pay item is not specifically excluded from payment either in these specifications or in the contract documents, the pay item shall then be considered an obvious omission in the proposal and payment will be made according to the provisions of subsection 104.03, "Extra Work."

Whenever the Department has obtained subsurface information for study and design, some of which may

constitute possible local materials sources, and which may be of interest to bidders, said information may be obtained upon request from the Department as "Materials Information." While such data will have been collected with reasonable care, there is no expressed or implied guaranty that conditions so indicated are exact or entirely representative of those actually existing and the Department will in no way be responsible for the accuracy therein contained. It is expressly understood and agreed that information obtained as "Materials Information" is not a part of the contract.

Information derived from such inspection of records of investigations made by the Department will not in any way relieve the Contractor from fulfilling the terms of the contract.

When a log of test borings, showing a record of the data obtained by the Department's investigation of subsurface conditions, is included with the contract plans, said record is the Department's opinion of such borings and there is no expressed or implied guaranty that conditions so indicated are exact or entirely representative of those actually existing. Such a log is included in the plans only for information and its use is subject to all of the conditions and limitations as set forth in this section.

If a mass diagram has been prepared for a project, it will be available to the bidders upon the following conditions: The swell or shrinkage of excavated material and the direction and quantities of haul or overhaul as shown on said mass diagram are for the purpose of design only, and as in the case of "Materials Information" the Department assumes no responsibility whatever in the interpretation or exactness of any of the information shown on the mass diagram, and does not, either expressed or implied, make any guaranty of the same.

102.06 Preparation of Proposal. The bidder shall submit his proposal upon the forms furnished by the Department. The bidder shall specify a unit price in figures and words for each pay item for which a quantity is given, and shall also show the products of the respective unit

prices and quantities, written in figures in the column provided for that purpose, and the total amount of the proposal obtained by adding the amount of the several items. All the words and figures shall be in ink or typed. In case of a discrepancy between the prices written in words and those written in figures, the prices written in words shall govern.

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

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

102.07 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 may tend to make the proposal incomplete, indefinite, or ambiguous as to its meaning.

(c) If the bidder adds any provisions reserving the right to accept or reject an award, or to enter into a contract pursuant to an award.

This does not exclude a bid limiting the maximum gross amount of awards acceptable to any one bidder or at any one bid letting, provided that the selection of any bid awards be made by the Department.

(d) If the unit prices contained in the proposal are obviously unbalanced, either in excess or below the reasonable cost analysis values.

(e) If the proposal does not contain a unit price for each pay item listed.

102.08 Proposal Guaranty. No proposal will be considered unless accompanied by a proposal guaranty, in the amount equal to five (5) percent of the Contractor's bid, made unconditionally payable to the State Highway Department, which guaranty, at the bidder's option, may be cash, cashier's check, certified check, postal money order, bank money order, express money order, bank draft, or any other guaranty that may be especially approved by the Department. Such proposal guaranty is to be forfeited to the Department should the bidder to whom the contract is awarded fail to enter into the contract within twenty (20) days after award.

102.09 Delivery of Proposals. Each proposal should be submitted in a special envelope furnished by the Department. The blank spaces on the envelope shall be filled in correctly to clearly indicate its contents. When an envelope other than the special one furnished by the Department is used, it shall be of the same general size and shape and be similarly marked to clearly indicate its contents. When sent by mail, the sealed proposal shall be addressed to the Department at the address and in care of the official in whose office the bids are to be received. All proposals shall be filed prior to the time and at the place specified in the advertisement and "Notice to Contractors." Proposals received after the time for opening of bids will be returned to the bidder unopened.

102.10 Withdrawal or Revision of Proposals. A bidder may withdraw or revise a proposal after it has been

deposited with the Department, provided the request for such withdrawal or revision is received by the Department, in writing or by telegram, before the time set for the opening of proposals. The withdrawal of a proposal shall not prejudice the right of the bidder to file a new proposal provided it is received prior to the time set for opening of proposals.

102.11 Public Opening of Proposals. Proposals will be opened and read publicly at the time and place indicated in the advertisement and "Notice to Contractors." Bidders, their authorized agents, and other interested parties are invited to be present.

102.12 Disqualification of Bidders. Any of the following reasons may be considered as sufficient for the disqualification of a bidder and the rejection of his proposal or proposals:

(a) More than one proposal for the same work from an individual, firm, or corporation under the same or different name.

(b) Evidence of collusion among bidders. Participants in such collusion will receive no recognition as bidders for any future work of the Department until any such participants shall have been reinstated as qualified bidders.

(c) Unsatisfactory performance record as shown by past work for the Department judged from the standpoint of workmanship and progress.

(d) Uncompleted work which in the judgment of the Department might hinder or prevent the prompt completion of additional work if awarded.

(e) Failure to pay or satisfactorily settle all bills due for labor or material on former contracts in force at the time of letting.

(f) Failure to hold a valid license of a class corresponding to the work to be done as required by the State Contractor's License Law. However, it is not required that a Contractor have a contractor's license in order to bid on Federal-aid projects.

(g) Failure to comply with any qualification regulations of the Department.

102.13 Material Guaranty. 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 samples may be subject to the tests provided for in these specifications to determine their quality and fitness for the work.

102.14 Combination or Conditional Bids. On certain projects a bidder may submit bids on more work than he desires to have awarded to him. He may indicate the total amount he desires to accept and the Department will determine which of his low bids on these projects, up to the final total indicated, will be accepted. This limitation will only apply to those projects on which the following statement has been included in the proposal and is properly filled in by the Contractor:

"We desire to disqualify all of our bids at this letting which exceed the total of $..... or ..... contracts and hereby authorize the Department to determine which bids shall be disqualified."

"A proposal guaranty, conforming to subsection 102.08, "Proposal Guaranty," in the amount of $..... accompanies the proposal for project number ..... or has been filed with the Department in advance."

.....

Contractor

102.15 Motor Fuel Tax Refund. It is understood and agreed that the price bid by the Contractor for the work to be done under the contract shall include the applicable tax on motor vehicle fuel and special fuel as required by Chapters 365 and 366 of the Nevada Revised Statutes.

It shall be the Contractor's responsibility to determine that subcontractors have reported fuel consumption to the State of Nevada, Department of Motor Vehicles, as required by law.

SECTION 103

AWARD AND EXECUTION OF CONTRACT

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

The right is reserved to reject any or all proposals, to waive technicalities, or to advertise for new proposals, if in the judgment of the awarding authority, the best interests of the Department will be promoted thereby.

103.02 Award of Contract. In order to meet the requirements prescribed under Section 112(c) of the Federal-aid Highway Act of 1958 (Title 23, United States Code) relative to the award of contracts, each bidder shall furnish with his proposal a sworn statement executed by or in behalf of the person, firm, association, or corporation submitting the bid. Such sworn statement shall be in the form appended to the special provisions and shall be sworn to before such persons as are authorized by the laws of the State to administer oaths.

The award of the contract, if it be awarded, will be to the lowest responsible bidder whose proposal complies with all the requirements prescribed. The award, if made, will be made within thirty (30) calendar days after the opening of the proposals. The successful bidder will be notified by letter, mailed to the address shown on his proposal, that his proposal has been accepted and that he has been awarded the contract.

The date of the award of the contract shall be the date of the "Notice of Award."

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.

Whenever a contract is awarded to an unlicensed Contractor, it shall be with the full understanding that such award shall become null and void should said Contractor fail to become licensed, in accordance with the provisions of NRS Chapter 624 for any reason within the control of said Contractor, within twenty (20) calendar days after award of said contract.

103.04 Return of Proposal Guaranty. All proposal guaranties, except those of the three lowest bidders, will be returned immediately following the opening and checking of the proposals. The retained proposal guaranty of the unsuccessful of the three lowest bidders will be returned within ten (10) days following the award of the contract and that of the successful bidder will be returned after a satisfactory bond has been furnished and the contract has been executed.

103.05 Requirement of Contract Bond. The successful bidder shall, at the time of the execution of the contract, furnish a surety bond or bonds in a sum equal to the full amount of the contract as a guaranty that he will complete the work in accordance with the terms of the contract. Such bond, or bonds, shall also provide and secure payment for all materials, labor and supplies, trucks, and other means of transportation, used in, or upon, or about, or for the performance of the work contracted to be done, and for any work or labor done thereupon or incidental thereto. The bond or bonds shall be on the form provided in the proposal and shall be written by a surety approved by the Insurance Commissioner of the State of Nevada. A power of attorney for an attorney in fact who executes bonds shall be registered with and approved by the Insurance Commissioner of the State of Nevada. The power of attorney shall show the limiting amount authorized for issuance of bonds. Written appointment of agent of bonding company in and for the State of Nevada shall

also be registered with, and approved by, the Insurance Commissioner.

103.06 Execution and Approval of Contract. The contract shall be signed by the successful bidder and returned, together with the contract bond, within twenty (20) calendar days after the contract has been mailed to the bidder. If the contract is not executed by the Department within thirty (30) calendar days following receipt from the bidder of the signed contract and bond, the bidder shall have the right to withdraw his bid without penalty. No contract shall be considered as effective until it has been fully executed by all the parties thereto.

103.07 Failure to Execute Contract. Failure to execute the contract and file acceptable bonds and/or failure to obtain a valid contractor's license within twenty (20) calendar days after the contract has been awarded shall be just cause for the annulment of the award and the forfeiture of the proposal guaranty which shall become the property of the Department, not as a penalty, but as liquidation of damages sustained. Award may then be made as provided in subsection 103.02, "Award of Contract," or the work may be readvertised and constructed under contract or otherwise, as the Department may decide.

SECTION 104

SCOPE OF THE WORK

104.01 Intent of the Contract. The intent of the contract is to provide for the construction and completion in every detail of the work described. The Contractor shall furnish all labor, materials, equipment, tools, transportation, and supplies required to complete the work in accordance with the plans, specifications, and terms of the contract.

104.02 Increased or Decreased Quantities and Change in Character of Work. The Engineer reserves the right to make by written order and without notice to surety, such alterations in the plans or character or quantity of the work which may be considered necessary or desirable from time to time during the progress of the work to complete satisfactorily the proposed construction. Such alterations shall not be considered as a waiver of any conditions of the contract or invalidate any of the provisions thereof.

Whenever an alteration in character of work involves a substantial change in the nature of the design or in the type or extent of construction which materially increases or decreases the cost of the performance, the work shall be performed in accordance with the specifications and as directed, provided however, that before such work is started, a contract change order acceptable to both parties to the contract shall be executed.

The right is reserved to increase or decrease any or all of the items in the estimate of approximate quantities as shown in the proposal. The length of the project may be increased or decreased by adding or omitting sections or by relocation. 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.

If it is found that the quantity of any major item required to complete the work underruns or overruns less

than twenty-five (25) percent of the proposed quantity, payment for the work performed will be made at the contract unit price for the quantity of work actually performed.

Whenever the termini of the project are changed and whenever any change or combination of changes results in increasing or decreasing the original contract amount as calculated from the bid quantities and contract unit prices by more than twenty-five (25) percent, a supplemental agreement acceptable to both parties to the contract shall be executed in advance of performing the affected work.

Whenever an overrun or underrun of more than twenty-five (25) percent of the original bid quantity for one or more major contract items occurs, either party to the contract may demand a supplemental agreement to be negotiated satisfactory to both parties.

Revision of any unit price requested by the Contractor shall be negotiated on the basis of actual cost plus a reasonable allowance for profit and overhead. Written request for supplemental agreement shall set forth in detail the particulars and character by which the work was changed and by what amount the unit price of the proposal item will be altered. Failure of the Contractor to file a request for a supplemental agreement within ten (10) calendar days after any of the above outlined conditions are encountered shall be considered as a waiver thereof on the part of the Contractor and payment shall be made at the contract unit price for the actual quantity of work performed.

If a supplemental agreement satisfactory to both parties cannot be agreed upon, the Engineer may order the work in dispute to be performed on a force account basis or he may cancel the work from the contract.

Changes not requiring negotiated agreements, except as to extra work involved, shall be ordered by means of a contract change order, and acceptance by the Contractor, as evidenced by his signature, shall constitute agreement that the change does not involve any adjustment of contract unit prices. Attention is directed to subsection 108.08, "Determination and Extension of Contract Time." Work

shall not be started on any such change until the change order has been delivered to the Contractor and accepted by him.

In case the Contractor refuses to accept a change order, the Engineer may order the work to proceed and defer settlement of the disputed points.

104.03 Extra Work. The Contractor shall perform unforeseen work, for which there is no price included in the contract, whenever it is deemed necessary or desirable in order to complete fully the work as contemplated. Such work shall be performed in accordance with the specifications and as directed, and will be paid for as agreed unit prices, force account, or a combination of the two. Agreed unit prices together with the estimated quantities of each unit shall be shown. Orders involving extra and force account work shall be as detailed in subsection 109.03, "Extra and Force Account Work," and conform to the requirements contained therein.

104.04 Maintenance of Traffic. While undergoing improvements, the road shall be kept open to all traffic by the Contractor unless otherwise provided for in the contract documents. If the usable roadway is not sufficient to safely accommodate two-way traffic, the Contractor shall adequately maintain one-way traffic. Wherever one-way traffic is in effect, the distance shall not be in excess of six thousand (6,000) feet or as otherwise set forth in writing by the Engineer. Where controlled traffic is necessary for protection of the work or for the safety of public travel, it shall be in accordance with the provisions of subsections 624.03.02, "Flagmen," and 624.03.03, "Pilot Cars" of these specifications. 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. Snow removal, however, will not be required of the Contractor. The Contractor shall bear all expense of maintaining the roadway over the section of road undergoing improvement and of constructing and maintaining such

approaches, crossings, intersections, and other features as may be necessary, without direct compensation, except as provided in subsection 107.15, "Relief from Maintenance and Responsibility," or in (a) or (b) below:

(a) Special detours and maintain base. When the proposal contains an item for "Special Detours" or "Maintain Base," the Contractor will be paid on a "Force Account" basis for the construction and maintenance of the detour(s) and the maintenance of the roadway base. Attention is directed to Section 624, "Accommodations for Public Traffic."

(b) Maintenance of traffic during suspension of work. The Contractor shall be responsible for the maintenance of the roadway during suspension of the work when such suspensions are due to the Contractor's negligence. Attention is directed to subsection 108.06, "Temporary Suspension of the Work." During any other suspension, the Contractor shall make passable and shall open to traffic such portions of the project and temporary roadways or portions thereof as may be agreed upon between the Contractor and the Engineer for the temporary accommodation of traffic during the anticipated period of suspension. Thereafter, and until an issuance of an order for the resumption of construction operations, the maintenance of the temporary route or line of travel agreed upon will be by and at the expense of the Department. Such maintenance and responsibility will include and be restricted to: The traveled roadway for the convenience of public travel; opening plugged pipes and roadway ditches and drains or correcting any other hazard which may be detrimental to adjacent property owners or the traveling public. When work is resumed, it shall be the Contractor's responsibility to replace, renew, and repair any work or materials lost or damaged because of such temporary use of the project regardless of the cause of such damage or loss, except as provided in subsection 107.15, "Relief of Maintenance and Responsibility." It is herewith expressed that the Department is in no way responsible to the Contractor to maintain the roadway and appurtenances in any certain

condition or state of repair. It is incumbent upon the Contractor to complete the project in every respect as though its prosecution had been continuous and without interference.

Where construction of a project is staged in the plans, or otherwise outlined by the contract documents, and if a change in the staging or sequence of operations is desirable, the Contractor may submit such change in writing to the Engineer. Consideration will be given to each such proposal and may be rejected, modified, or accepted by the Engineer as he deems best. The Contractor will not proceed with any such change in the staging until permission is granted by the Engineer in writing.

When detours, temporary connections, crossovers, connection roads, and frontage roads are constructed by the item "Equipment Hours," such item shall be full compensation for excavating, hauling, overhaul, and compacting of the material complete and in place and for all labor involved to complete the detour. Base and surface courses will be paid for at the contract unit price for the particular type of material required. All of the above mentioned roadways will be constructed to the same standards and qualities and subject to the same tests and specifications as the main roadway. Attention is directed to Section 624, "Accommodations for Public Traffic."

When a detour is requested by the Contractor he shall make a written request to the Engineer for the establishment of a detour around all or certain designated sections of work. If arrangements for such a detour can be made which are satisfactory to the State, to the Contractor, and to the governmental agency having jurisdiction over the road to be used, the Engineer will designate that road as a detour, subject to the following conditions:

(a) The Contractor shall provide and maintain the necessary route marking signs.

(b) The Contractor shall construct and maintain in good condition such a detour. If the Contractor fails to maintain the detour in such a condition satisfactory to the Engineer, the State will make such repairs as is deemed

suitable and will deduct the cost thereof from money due or to become due to the Contractor.

(c) Provisions for handling traffic will be subject to the conditions of subsections 624.03.02, "Flagmen," and 624.-03.03, "Pilot Cars" of these Standard Specifications.

(d) Upon abandoning the detour, the Contractor shall obliterate and dispose of such detour and restore as nearly as possible the condition of the ground to its original form and to the satisfaction of the Engineer.

(e) All of the above work will be at the sole expense of the Contractor.

104.05 Rights in and Use of Materials Found on the Work. The Contractor, with the approval of the Engineer, may use on the project such stone, gravel, sand, or other material determined suitable by the Engineer, as may be found in the excavation and will be paid for both the excavation of such materials at the corresponding contract unit price and also at the contract unit price for the pay item for which the excavated material is used. He shall replace at his own expense with other acceptable material all of that portion of the excavation material so removed and used which was needed for use in the embankments, backfills, approaches, or otherwise. No charge for the materials so used will be made against the Contractor. The Contractor shall not excavate or remove any material from within the highway location which is not within the grading limits, as indicated by the slope and grade lines, without written authorization from the Engineer.

Unless otherwise provided, the material from any existing old structure may be used temporarily by the Contractor in the erection of the new structure. Such material shall not be cut or otherwise damaged except with the approval of the Engineer.

104.06 Final Clean Up. Before final acceptance, the Contractor shall remove or obliterate, insofar as feasible, all objects or disturbances of the ground which mar the landscape and were caused by his operations, whether or

not part of the improvement. This shall be required on all areas used or occupied by the Contractor within or outside the right of way limits.

Rubbish, excess material, temporary structures, and discarded equipment shall be collected and buried or otherwise disposed of as directed by the Engineer. Such material may be burned only upon written approval of the governing body and the concurrence of the Engineer. Pits or trenches for equipment setups or campsites shall be filled and the ground restored, insofar as feasible, to its original conditions, within or outside of the right of way limits. Temporary haul roads within the right of way limits shall be scarified and bladed to blend with surroundings. Pits from which materials have been obtained shall be dressed and shaped to conform with the surrounding ground. Waste shall be removed from the tops of banks and placed in the bottom of pit. Unless otherwise specified or directed by the Engineer, banks of pits shall be cut to not steeper than two to one (2:1) slopes to blend with the natural contours. Bottoms of pits shall be reasonably smooth. All other disturbances shall be removed or corrected as directed by the Engineer.

SECTION 105

CONTROL OF WORK

105.01 Authority of the Engineer. The Engineer will decide all questions which may arise as to the quality and acceptability of materials furnished and work performed and as to the rate of progress of the work; all questions which may arise as to the interpretation of the plans and specifications; all questions as to the acceptable fulfillment of the contract on the part of the Contractor.

The Engineer will have the authority to suspend the work wholly or in part due to the failure of the Contractor to correct conditions unsafe for the workmen or the general public; for failure to carry out the provisions of the contract; for failure to carry out orders; for such periods as he may deem necessary due to unsuitable weather; for conditions considered unsuitable for the prosecution of the work or for any other condition or reason deemed to be in the public interest.

Whenever the Contractor fails to carry out orders of the Engineer, the Engineer will have executive authority to enforce such orders and his decision will be final. In the event the Contractor fails to execute work ordered by the Engineer within a reasonable period of time, the Engineer may, after giving notice in writing to the Contractor, proceed to have such work performed as deemed necessary and the cost thereof shall be deducted from compensation due or which may become due the Contractor on the contract.

Decisions of the Engineer shall be subject to appeal to the Board of Directors, whose decisions shall be final and conclusive. Such appeal shall be in writing and shall be made within ten (10) calendar days, but in the meantime the Contractor shall diligently proceed with the work.

105.02 Plans and Working Drawings. Plans will show details of all structures, lines, grades, typical cross

sections of the roadway, location and design of all structures, and a summary of items appearing on the proposal. The Contractor will keep one set of plans available on the work at all times.

The plans will be supplemented by such working drawings as are necessary to adequately control the work. Working drawings for structures shall be furnished by the Contractor. They shall include stress sheets, shop drawings, erection plans, fabrication sheets, falsework plans, cofferdam plans, bending diagrams for reinforcing steel, or any other supplementary plans or similar data required by the Engineer. Unless otherwise specified, all working drawings must be submitted in triplicate ten (10) days prior to start of related work and approved by the Engineer. Such approval shall not operate to relieve the Contractor of any of his responsibility under the contract for the successful completion of the work. It is mutually agreed that the Contractor shall be responsible for agreement of dimensions and details as well as for conformity of his working drawings with the approved plans and specifications.

The contract price will include the cost of furnishing all working drawings.

105.03 Conformity with Plans and Specifications. All work performed and all materials furnished shall be in reasonably close conformity with the lines, grades, cross sections, dimensions, and materials requirements, including tolerances, shown on the plans or indicated in the specifications.

In the event the Engineer finds the materials or the finished product in which the materials are used not within reasonably close conformity with the plans and specifications but that reasonably acceptable work has been produced, he shall then make a determination if the work shall be accepted and remain in place. In this event, the Engineer will document the basis of acceptance by contract modification which will provide for an appropriate adjustment in the contract price for such work or materials as he deems necessary to conform to his determination based on engineering judgment.

In the event the Engineer finds the materials or the finished product in which the materials are used or the work performed are not in reasonably close conformity with the plans and specifications and have resulted in an inferior or unsatisfactory product, the work or materials shall be removed and replaced or otherwise corrected by and at the expense of the Contractor.

105.04 Coordination of Plans, Specifications, Supplemental Specifications, and Special Provisions. The specifications, supplemental specifications, plans, special provisions, and all supplementary documents are essential parts of the contract, and a requirement occurring in one is as binding as though occurring in all. They are intended to be complementary and to describe and provide for a complete work. In case of discrepancy, calculated dimensions will govern over scale dimensions; plans will govern over specifications; supplemental specifications will govern over specifications; special provisions will govern over both specifications and plans.

The Contractor shall take no advantage of any apparent error or omission in the plans or specifications. In the event the Contractor discovers such an error or omission, he shall immediately notify the Engineer. The Engineer will then make such corrections and interpretations as may be deemed necessary for fulfilling the intent of the plans and specifications.

105.05 Cooperation by Contractor. The Contractor will be supplied with a minimum of four sets of approved plans and contract assemblies including special provisions, one set of which the Contractor shall keep available on the work at all times. Additional copies of plans and special provisions may be obtained by the Contractor upon written request to the Department.

The Contractor shall give the work constant attention necessary to facilitate the progress thereof, and shall cooperate with the Engineer, his inspectors, and other Contractors in every way possible.

The Contractor shall have on the work at all times, as

his agent, a competent superintendent capable of reading and thoroughly understanding the plans and specifications and thoroughly experienced in the type of work being performed, who shall receive instructions from the Engineer or his authorized representatives. Such superintendent shall be designated in writing before starting work. 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 irrespective of the amount of work sublet.

Whenever the Contractor or his authorized representative is not present on any particular part of the work where it may be desired to give direction, orders will be given by the Engineer to the Contractor's superintendent, foreman, or other person in charge of the operation, who is present, and these orders shall have the same force and effect as if given to the Contractor or his designated representative.

Any order given by the Engineer, not otherwise required by the specifications to be in writing, will on request of the Contractor be given or confirmed by the Engineer in writing.

105.06 Cooperation with Utilities. The Department will notify all utility companies, all pipeline owners, or other parties affected, and endeavor to have all necessary adjustments of the public or private utility fixtures, pipelines, and other appurtenances within or adjacent to the limits of contruction, made as soon as practicable.

Water lines, gas lines, wire lines, service connections, water and gas meter boxes, water and gas valve boxes, light standards, cable ways, signals, and all other utility appurtenances within the limits of the proposed construction which are to be relocated or adjusted are to be moved by the owners at their expense, except as otherwise provided for in the special provisions or as noted on the plans.

Attention is directed to the possible existence of underground facilities not known to the State or in a location

different from that which is shown on the plans or in the special provisions. The Contractor shall take steps to ascertain the exact location of all undergound facilities prior to doing work that may damage such facilities or interfere with their service.

Where it is determined by the Engineer that the rearrangement of an underground facility, the existence of which is not shown on the plans or in the special provisions, is essential in order to accommodate the highway improvement, the Engineer will provide for the rearrangement of such facility by other forces or such rearrangement shall be performed by the Contractor and will be paid for as extra work as provided in subsection 104.03, "Extra Work."

Any delays to the Contractor's operations as a direct result of utility or other nonhighway facilities not being rearranged as herein provided (other than delays in connection with rearrangements made to facilitate his construction operations) will be considered right of way delays within the meaning of subsection 108.12, "Right of Way Delays."

Compensation for such delay will be determined in accordance with subsection 108.12, "Right of Way Delays," and no further compensation will be allowed therefor. Attention is directed to subsection 107.17, "Contractor's Responsibility for Utility Property and Service."

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

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

Each Contractor involved shall assume all liability, financial or otherwise, in connection with his contract and shall protect and save harmless the Department from any

and all damages or claims that may arise because of inconvenience, delay or loss experienced by him because of the presence and operations of other Contractors working within the limits of the same project.

The Contractor shall arrange his work and shall place and dispose of the materials being used so as not to interfere with the operations of other Contractors within the limits of the same project. He shall join his work with that of the others in an acceptable manner and shall perform it in proper sequence to that of the others.

105.08 Construction Stakes, Lines, and Grades. The Engineer will set construction stakes establishing lines, slopes, and continuous profile-grade in road work, and centerline and bench marks for bridge work, culvert work, protective and accessory structures, and appurtenances 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 by and in accordance with which the Contractor shall establish other necessary controls and perform the work.

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

The Department will be responsible for the accuracy of lines, slopes, grades, and other engineering work which is set forth under this section.

105.09 Authority and Duties of the Resident Engineer. As the direct representative of the State Highway Engineer, the resident engineer has immediate charge of the engineering details of each construction project. He is responsible for the administration and satisfactory completion of the project. The resident engineer shall have the authority to reject defective materials and to suspend any work that is being improperly performed.

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

105.11 Inspection. All materials and each part or detail of the work shall be subject to inspection by the Engineer. The Engineer shall be provided acceptable access to all parts of the work and shall be furnished with such information and assistance by the Contractor as required to make a complete and detailed inspection.

If the Engineer requests it, the Contractor, at any time before acceptance of the work, shall remove or uncover such portions of the finished work as may be directed. After examination, the Contractor shall restore said portions of the work to the standard required by the specifications. Should the work thus exposed or examined prove acceptable, the uncovering, or removing and the replaceing of the covering, or making good of the parts removed will be paid for as extra work; but should the work so exposed or examined prove unacceptable, the uncovering, or removing and 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 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 in writing that the work was to be performed.

When facilities of any unit of government or political subdivision or of any railroad corporation or public utility corporation are adjusted or constructed as a part of the work covered by this contract, its respective representatives shall have the right to inspect the work. Such inspection shall in no sense make any unit of government or political

subdivision or any railroad corporation or public utility corporation a party to this contract, and shall in no way interfere with the rights of either party thereunder.

105.12 Removal of Unacceptable and Unauthorized Work. All work which does not conform to the requirements of the contract will be considered as unacceptable work, unless otherwise determined acceptable under the provisions in subsection 105.03, "Conformity with Plans and Specifications."

Unacceptable work, whether the result of poor workmanship, use of defective materials, damage through carelessness, or any other cause, found to exist prior to the final acceptance of the work, shall be removed immediately and replaced in an acceptable manner.

Work done contrary to the instructions of the Engineer, work done beyond the lines shown on the plans, or as given, except as herein specified, or any extra work done without authority, will be considered as unauthorized and will not be paid for under the provisions of the contract. Work so done may be ordered removed or replaced at the Contractor's expense.

Upon failure on the part of the Contractor to comply forthwith with any order of the Engineer, made under the provisions of this article, the Engineer will have authority to cause unacceptable work to be remedied or removed and replaced and unauthorized work to be removed and to withhold the costs from any money due or to become due the Contractor.

105.13 Load and Speed Restrictions. The Contractor shall be responsible for all damage to the work caused by his hauling equipment.

In hauling material for incorporation in portions of highways under construction or reconstruction, hereinafter called the project, loads which are in excess of the limits set by the Department will not be permitted on any existing bridge or new and existing bituminous base and surface, cement treated base, or Portland cement concrete paving which is to remain in place for vehicular traffic

within the project or between the project and the pits or other sources of materials. Load limits established by the Department for the project shall be complied with regardless of the source of materials, whether from described pits, approved pits or commercial sources. Unless otherwise stated in the special provisions, the maximum loads shall not exceed the limits set forth in Chapter 484 of the Nevada Revised Statutes and all acts amendatory thereto or supplementary thereof.

Construction loads greater than legal loads may be carried over any new bridge structure within the project providing the Contractor complies with all of the following limitations and provisions:

(a) Concrete in any such structure must have attained designed strength as shown on the structure plans.

(b) The gross load of the vehicle shall not exceed 108,000 pounds.

(c) Gross load on any individual axle shall not exceed 48,000 pounds.

(d) The gross load on any individual set of tandem axles spaced not more than six (6) feet apart shall not exceed 72,000 pounds.

(e) The center to center spacing of individual axles or center to center spacing of pairs of tandem axles shall not be less than fourteen (14) feet.

(f) No more than one lane of vehicles shall operate over any structure.

(g) The speed of any vehicle approaching or traveling on any structure shall not exceed ten (10) mph.

(h) The roadway surface approaching any structure shall be kept smooth and uniformly graded for one hundred fifty (150) feet each side of the structure and shall be maintained to provide a uniform transition onto the structure.

(i) A cover of six (6) inches $\pm$ one (1) inch shall be placed and maintained on the decks of all structures. Cover material shall not include rocks of diameter greater than three (3) inches.

The limitations (b, c, d, e, f, i) may be waived for all reinforced concrete box culverts providing that the depth

of fill compacted and in place over the reinforced concrete box culvert is equal to or greater than the distance between inside faces of outside walls measured along centerline of roadway. Fill may be placed not to exceed profile grade elevation.

Construction loads greater than legal loads may be carried over structures within the project which have spans of ten (10) feet to twenty (20) feet only when the Contractor complies with the above items, letters (c) to (i), inclusive; however, the limitations as set forth in paragraphs (c) to (e), inclusive, may be waived by the Engineer for reinforced concrete box structures which are adequately supported by shoring. The Contractor shall submit his proposed shoring details and the actual loads and axle spacings to the Engineer for review prior to the planned hauling. Approval will be based on a review of the shoring details and a physical inspection of the shoring complete and in place.

The Engineer shall make sufficient checks to satisfy himself that the Contractor is complying with all limitations, and any violation shall result in denying the Contractor use of the structure until the violation has been corrected to the satisfaction of the Engineer.

The provision that the Contractor may haul construction loads greater than legal loads on new structures shall not relieve the Contractor of his responsibility for all damage caused by his hauling equipment.

The Engineer may, for the protection of the traveling public, establish speed limits on or adjacent to the project. Such limitations of speed shall be strictly observed by the Contractor.

105.14 Maintenance During Construction. The Contractor shall maintain the work during construction and until the project is accepted, except as provided for in subsections 104.04, "Maintenance of Traffic," and 107.15, "Relief from Maintenance and Responsibility." This maintenance shall constitute continuous and effective work prosecuted day by day, with adequate equipment and forces to the end that the roadway and structures are, at

all times, to be kept in a condition satisfactory to the Engineer.

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

Except as provided for in subsections 104.04, "Maintenance of Traffic," and 107.15, "Relief from Maintenance and Responsibility," all costs of maintenance work during construction and before the project is accepted shall be included in the unit prices bid on the various pay items and the Contractor will not be paid an additional amount for such work.

105.15 Failure to Maintain Roadway or Structure. If the Contractor, at any time, fails to comply with the provisions of subsection 105.14, "Maintenance During Construction," the Engineer will immediately notify the Contractor in writing of such noncompliance. If the Contractor fails to remedy unsatisfactory maintenance within twenty-four (24) hours after receipt of such notice, the Engineer may immediately proceed to maintain the project, and the entire cost of this maintenance will be deducted from money due or to become due the Contractor.

105.16 Final Acceptance. Upon due notice from the Contractor or presumptive completion of the entire project, the Engineer will make an inspection and if all construction and final cleanup provided for and contemplated by the contract 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 final inspection. Attention is directed to subsection 104.06, "Final Cleanup."

If however, the inspection discloses any work, in whole or in part, as being unsatisfactory, the Engineer will give the Contractor the necessary instructions for correction of same, and the Contractor shall immediately comply with

and execute such instructions. Upon correction of the work another inspection will be made which shall constitute the final inspection provided the work has been satisfactorily completed. In such event, the Engineer will make the final acceptance and notify the Contractor in writing of this acceptance as of the date of final inspection.

105.17 Claims for Adjustment and Disputes. If, in any case, the Contractor deems that additional compensation is due him for work or material not clearly covered in the contract or not ordered by the Engineer as extra work as defined herein, the Contractor shall notify the Engineer in writing of his intention to make claim for such additional compensation before he begins the work on which he bases the claim. If such notification is not given, and the Engineer is not afforded proper facilities by the Contractor for keeping strict account of actual cost as required, then the Contractor hereby agrees to waive any claim for such additional compensation. Such notice by the Contractor, and the fact that the Engineer has kept account of the cost as aforesaid, shall not in any way be construed as proving or substantiating the validity of the claim. If the claim, after consideration by the Engineer, is found to be just, it will be paid as extra work as provided herein for "Force Account" work. Nothing in this subsection shall be construed as establishing any claim contrary to the terms of subsection 104.02, "Increased or Decreased Quantities and Change in Character of Work."

SECTION 106

CONTROL OF MATERIAL

106.01 Source of Supply and Quality Requirements. The Contractor shall furnish all materials required to complete the work, except materials that are designated in the special provisions to be furnished by the State as specified in subsection 106.11, "Department Furnished Materials."

Only materials conforming to the requirements of the specifications shall be incorporated in the work.

The materials furnished and used shall be new, except as may be provided elsewhere in these specifications, on the plans or in the special provisions. The materials shall be manufactured, handled, and used in a workmanlike manner to ensure completed work in accordance with the plans and specifications.

The Contractor shall furnish the Engineer a list of his sources of materials. The list shall be submitted on a State-furnished form and shall be furnished to the Engineer in sufficient time to permit proper inspecting and testing of materials to be furnished from such listed sources in advance of their use.

If it is found after trial that sources of supply for previously approved materials do not produce uniform and satisfactory products, or if the product from any source proves unacceptable at any time, the Contractor shall furnish satisfactory materials from other sources.

The Contractor shall furnish without charge such samples as may be required. Inspection and tests will be made by the Engineer or his designated representative, but it is understood that such inspections and tests, if made at any point other than the point of incorporation in the work, in no way shall be considered as a guarantee of acceptance of such material nor of continued acceptance of material presumed to be similar to that upon which inspections and tests have been made.

Manufacturers' warranties, guarantees, instruction sheets, and parts lists, which are furnished with certain articles or

materials incorporated in the work, shall be delivered to the Engineer before acceptance of the contract.

Reports and records of inspections made and tests performed when available at the site of the work may be examined by the Contractor.

106.02 Local Materials. Local material is rock, sand, gravel, earth, or other mineral material, other than local borrow or selected material, obtained or produced from sources in the vicinity of the work specifically for use on the project. Local material does not include materials obtained from established commercial sources.

Local materials shall be furnished by the Contractor from any source the Contractor may elect, except when a mandatory source is designated in the special provisions.

Aggregates for base, surface, and concrete may be the products of approved commercial producers, provided they meet specification requirements.

The furnishing of local materials from any source is subject to the provisions of subsections 102.05, "Examination of Plans, Specifications, Contract Documents, and Site of Work," and 106.03, "Possible Local Material Sources." Material deposits shall not be excavated at locations where their resulting scars will present an unsightly appearance from any highway, unless such deposit is approved in writing by the Engineer.

Generally deposits other than those indicated in the "Materials Information" packet will not be approved if located within one thousand (1,000) feet of right of way line. In any case the Contractor's pit operations shall not encroach within twenty-five (25) feet of highway right of way. Payment will not be made on material obtained in violation of these provisions.

The Contractor shall, at his own expense, make any and all arrangements necessary for hauling over local, public or private roads or property from any source. Full compensation for furnishing all labor, materials, tools, equipment and incidentals, for doing all the work involved in conforming to the provisions in this subsection and for furnishing and producing materials from any source shall be

considered as included in the price paid for the contract item of work involving such material and no additional compensation will be allowed therefor.

106.03 Possible Local Material Sources. If the Contractor desires to use materials from sources other than those described in the "Materials Information," as referred to in subsection 102.05, "Examination of Plans, Specifications, Contract Documents, and Site of Work," he shall, at his own expense, acquire the necessary right to take material and shall obtain all other necessary permits and approvals and shall comply with all the requirements and stipulations in effect by other governing agencies having jurisdiction over the area, and pay all costs involved, including any which may result from an increase in length of haul. All costs of exploring and developing such alternate sources shall be borne by the Contractor and the use of material from such sources will not be permitted until representative samples taken by the Engineer have been approved and written authority issued for the use thereof.

The Contractor's attention is especially directed to the new Part 23 of Title 43 Code of Federal Regulations titled "Surface Exploration, Mining and Reclamation of Lands" which pertains to all exploration, developing and obtaining material from said alternate deposits located upon land under the jurisdiction of the Bureau of Land Management. A pertinent portion of this Part 23 follows:

§ 23.8 Approval of mining plan.

(a) (1) Before surface mining operations may commence under any permit or lease issued under the mineral leasing acts the operator must file a mining plan with the mining supervisor and obtain his approval of the plan. Paragraphs (b) through (g) of this section confer authority upon mining supervisors with respect to mining plans pertaining to permits or leases issued under the mineral leasing acts. The mining supervisor shall consult with the district manager with respect to the surface protection and reclamation aspects before approving said plan.

(2) Before surface mining operations may commence under any permit issued or contract made under the

Materials Act, the operator must file a mining plan with the district manager and obtain his approval of the plan. Paragraphs (b) through (g) of this section confer authority upon district managers with respect to mining plans pertaining to permits issued or contracts made under the Materials Act.

(b) Depending on the size and nature of the operation and the requirements established pursuant to § 23.5, the mining supervisor or the district manager may require that the mining plan submitted by the operator include any or all of the following:

(1) A description of the location and area to be affected by the operations;

(2) Two copies of a suitable map, or aerial photograph showing the topography, the area covered by the permit, lease, or contract, the name and location of major topographic and cultural features, and the drainage plan away from the area to be affected;

(3) A statement of proposed methods of operating, including a description of proposed roads or vehicular trails; the size and location of structures and facilities to be built;

(4) An estimate of the quantity of water to be used and pollutants that are expected to enter any receiving waters;

(5) A design for the necessary impoundment, treatment or control of all runoff water and drainage from workings so as to reduce soil erosion and sedimentation and to prevent the pollution of receiving waters;

(6) A description of measures to be taken to prevent or control fire, soil erosion, pollution of surface and ground water, damage to fish and wildlife, and hazards to public health and safety; and

(7) A statement of the proposed manner and time of performance of work to reclaim areas disturbed by the holder's operation.

(c) In those instances in which the permit, lease, or contract requires the revegetation of an area of land to be affected the mining plan shall show:

(1) Proposed methods of preparation and fertilizing the soil prior to replanting;

(2) Types and mixtures of shrubs, trees, or tree seedlings, grasses or legumes to be planted; and

(3) Types and methods of planting, including the

amount of grasses or legumes per acre, or the number and spacing of trees, or tree seedlings, or combinations of grasses and trees.

(d) In those instances in which the permit, lease, or contract requires regrading and backfilling, the mining plan shall show the proposed methods and the timing of grading and backfilling of areas to be affected by the operation.

(e) The mining supervisor or the district manager shall review the mining plan submitted to him by the operator and shall promptly indicate to the operator any changes, additions, or amendments necessary to meet the requirements formulated pursuant to § 23.5, the provisions of the regulations in this part and the terms of the permit, lease, or contract. The operator shall comply with the provisions of an approved mining plan.

(f) A mining plan may be changed by mutual consent of the mining supervisor or the district manager and the operator at any time to adjust to changed conditions or to correct any oversight. To obtain approval of a change or supplemental plan the operator shall submit a written statement of the proposed changes or supplement and the justification for the changes proposed. The mining supervisor or the district manager shall promptly notify the operator that he consents to the proposed changes or supplement or, in the event he does not consent, he shall specify the modifications thereto under which the proposed changes or supplement would be acceptable. After mutual acceptance of a change of a plan the operator shall not depart therefrom without further approval.

(g) If circumstances warrant, or if development of a mining plan for the entire operation is dependent upon unknown factors which cannot or will not be determined except during the progress of the operation, a partial plan may be approved and supplemented from time to time. The operator shall not, however, perform any operation except under an approved plan.

§ 23.9 Performance bond.

(a) (1) Upon approval of an exploration plan or mining plan, the operator shall be required to file a suitable performance bond of not less than $2,000 with satisfactory surety, payable to the Secretary of the Interior, and the bond shall be conditioned upon the faithful

compliance with applicable regulations, the terms and conditions of the permit, lease, or contract, and the explorations or mining plan as approved, amended or supplemented. The bond shall be in an amount sufficient to satisfy the reclamation requirements of an approved exploration or mining plan, or an approved partial or supplemental plan. In determining the amount of the bond consideration shall be given to the character and nature of the reclamation requirements and the estimated costs of reclamation in the event that the operator forfeits his performance bond.

(2) In lieu of a performance bond an operator may elect to deposit cash or negotiable bonds of the U.S. Government. The cash deposit or the market value of such securities shall be equal at least to the required sum of the bond.

(b) A bond may be a nationwide or statewide bond which the operator has filed with the Department under the provisions of the applicable leasing regulations in Subchapter C of Chapter II of this title, if the terms and conditions thereof are sufficient to comply with the regulations in this part.

(c) The district manager shall set the amount of a bond and take the necessary action for an increase or for a complete or partial release of a bond. He shall take action with respect to bonds for leases or permits only after consultation with the mining supervisor.

(d) Performance bonds will not be required of Federal, State or other governmental agencies. Where the exploration or mining is actually performed for such Federal, State, or governmental agencies by a Contractor who would have to post a bond under the terms of paragraph (a) of this section if he were the operator, such agencies shall require the Contractor to furnish a bond payable to the United States which meets the requirements of paragraph (a) of this section. If, for some other purpose, the Contractor furnishes a performance bond, and amendment to that bond which meets the requirements of paragraph (a) of this section will be acceptable in lieu of an additional or separate bond.

Where the Department has made arrangements with owners of land in the vicinity of a project for obtaining material from an owner's property, such arrangements are made

solely for the purpose of providing all bidders an equal opportunity to obtain material from such property. Bidders or Contractors may, upon written request, inspect the documents evidencing such arrangements between property owners and the Department. The Contractor may, if he so elects, exercise any rights that have been obtained, which may be exercised by a Contractor under such arrangements, subject to and upon the conditions hereinafter set forth.

Such arrangements are not a part of the contract and it is expressly understood and agreed that the Department assumes no responsibility to the bidder or Contractor whatsoever in respect to the Department's arrangements made with the property owner to obtain materials therefrom and that the Contractor shall assume all risks in connection with the use of such property, the terms upon which such use shall be made, and there is no warranty or guarantee, either expressed or implied, as to the quality or quantity of materials that can be obtained or produced from such property or the type or extent of processing that may be required in order to produce material conforming to the requirements of the specifications.

In those instances in which the Department has compiled "Materials Information" as referred to in subsection 102.05, "Examination of Plans, Specifications, Contract Documents and Site of Work," said compilation may include the documents setting forth the arrangement made with some of the property owners for obtaining material from such owners' properties. The inclusion of such documents therein shall not in any respect operate as a waiver of any of the provisions in this section concerning said documents.

The bidder or Contractor is cautioned to make such independent investigation and examination as he deems necessary to satisfy himself as to the quality and quantity of materials available from such property, the type and extent of processing that may be required in order to produce material conforming to the requirements of the specifications and the rights, duties, and obligations acquired or undertaken under such an arrangement with the property owner.

Notwithstanding that the Contractor may elect to obtain materials from any such property owner's property, no material may be obtained from such property unless the Contractor has first either:

(a) Executed a document that will guarantee to hold such owner harmless from all claims for injury to persons or damage to property resulting from the Contractor's operations on the property owner's premises and also agree to conform to all other provisions set forth in the arrangement made between the Department and the property owner. Said document will be prepared by the Engineer for execution by the Contractor, or

(b) Entered into an agreement with the owner of the material source on any terms mutually agreeable to the owner and the Contractor, provided that the Contractor shall furnish to the Engineer a release, in a form satisfactory to the Engineer, executed by the owner, relieving the Department of any and all obligations under the Department's arrangement with the owner.

If the Contractor elects to obtain material under (a), the use of such site shall be subject to the terms, conditions and limitations of the arrangement made between the property owner and the Department and the Contractor shall pay such charges as are provided for in the arrangement made by the Department with the property owner.

If the Contractor elects to obtain material under (b), he shall pay such charges as are provided for in the agreement between the owner and the Contractor.

Unless otherwise provided and before acceptance of the contract, the Contractor shall submit written evidence that the owner of the material source is satisfied that the Contractor has satisfactorily complied with the provisions of either (a), the arrangement between the Department and the owner, or (b), the agreement between the owner and the Contractor, as the case may be.

Where the State has obtained the right to remove materials from lands owned or controlled by the U.S. Government, by withdrawal or otherwise, and these areas are set forth in the "Materials Information" for the project the successful bidder on the project may enter and remove

materials for use on subject project only, without further permission. The Contractor may not enter on or remove materials from any other areas withdrawn or otherwise obtained by the Department from the U.S. Government which is not set forth in the "Materials Information" for the project without prior written approval from the Department.

Should the Contractor enter upon any of the areas withdrawn or otherwise obtained by the Department from the U.S. Government, it shall be his responsibility to determine the rights of others in the area. The Contractor shall not encroach on easements of others without their written permission and shall assume the responsibility for any damages due to his entering said area. In addition, the Contractor shall be bound by the terms, conditions, and reservations contained in the approved application for withdrawal.

Full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in furnishing and producing specified materials from possible local material sources, including the construction of any access roads or fences and any clearing, grubbing, and stripping of material sources, and all processing of whatever nature and extent required, shall be considered as included in the price paid for the contract item of work involving such material and no additional compensation will be allowed therefor.

106.04 Samples and Tests. Except as provided in subsection 106.05, "Certificates of Compliance," all materials will be inspected, tested, and accepted by the Engineer before incorporation in the work. Any work in which untested and unaccepted materials are used without approval or written permission of the Engineer shall be performed at the Contractor's risk and may be considered as unacceptable and unauthorized and will not be paid for.

It is the intent of these specifications that the Contractor shall produce materials at the plant that conform in all respects to the requirements of the specifications; however, blending on the roadbed to correct for minor deficiencies in

grading, sand equivalent, or excess plasticity will be allowed under the following conditions:

(a) All blending material added on roadway and all work involved in processing such material will be at the expense of the Contractor.

(b) Processing of the material will continue until a homogeneous mixture is obtained. Uniform gradation shall be obtained to the degree that sieve analysis tests show less than ten (10) percent difference, plus or minus, in the amount of material passing the No. 16 sieve, determined by comparing sieve analysis tests on two samples of processed and blended material. Samples for tests, taken for the above conditions, shall be confined within a distance of five hundred (500) feet of each other and also taken in the same continuous windrow.

When the Contractor requests progress samples taken at the crushing plant, the plant shall be provided with a mechanical means for obtaining samples. Samples of the finished product of the plant shall be obtained prior to or as the material leaves the conveyor belt for the bin or stockpile. The sampling device shall be so constructed that small representative samples may be taken frequently and these small samples combined to form the complete sample. The samples shall be delivered by mechanical means to a point on the ground or other safe and accessible spot satisfactory to the Engineer. Test results run from samples taken will be furnished to the Contractor's representative at his request. The results of such tests shall not be the basis for final acceptance of the material.

Sampling for final acceptance of materials will be as hereinafter outlined:

(a) Types 1, 2, and 3, Class B aggregate base courses and "Selected Material Base or Surface" will be sampled just prior to final laydown.

(b) Types 1, 2, and 3, Class A aggregate base courses will be sampled from the roadbed directly behind the laydown machine and prior to the first pass of the roller.

(c) Aggregate for cement or lime treated bases will be sampled as follows:

1. Where the material is being mixed at a stationary

plant, samples will be taken from the conveyors just prior to delivery to the mixer and prior to adding lime and cement.

2. Where material is being mixed on the roadbed, samples will be taken after the material has been placed on the roadbed and processed and prior to adding cement or lime.

(d) Aggregates for roadmix bituminous mixtures (including base or surface) will be sampled after the material has been placed on the roadbed and processed and prior to adding the bituminous binder.

(e) Aggregate for plantmix bituminous open-graded will be sampled from the laydown machine.

(f) Aggregate for screenings will be sampled from the loaded truck just prior to placing.

(g) Aggregate for plantmix bituminous mixtures (base or surface) will be sampled for acceptance behind the paver. Samples for plasticity tests will be taken at the bins.

(h) Sampling of bituminous materials, intended for use in prime, tack or seal coats, surface treatments, and base, binder, or surface course mixtures, shall be done after the bituminous material has arrived at job destination and before, or at the time of unloading the materials.

Two samples shall be taken from each railroad tank car or truck transport of material by the Contractor or his designated representative under the observation of and in a manner approved by the Engineer. Where delivery is made in smaller hauling units than those cited above such as a distributor, or where the contents of a storage tank are sampled, the required two samples shall be taken to represent a maximum of ten thousand (10,000) gallons. The Contractor shall take the samples during the established job working hours, unless arrangements are made for a representative of the Department to witness the taking of the samples at another time.

Sampling shall be done by one of the following three methods:

1. In accordance with the provisions of Test Method No. Nev. T723;

2. By bleeding through a drain-cock in the transfer

line during the unloading of the approximate middle third of the load; or

3. By means of a sampling device inserted to a level of approximately the middle third of the load or tank.

The selection of the method of sampling to be used shall be at the option of the Contractor. Where sampling is done by bleeding, five (5) to ten (10) minutes shall elapse between the separate samplings.

It shall be understood and agreed that samples obtained by any one of the above designated methods are presented and accepted by the Contractor, and accepted by the Engineer, as being truly representative of the material delivered for incorporation in the work.

All sampling devices and sample containers will be furnished by the Department. Immediately after filling the sample container, it shall be tightly sealed, properly marked for identification, and presented to the Engineer.

One of the two samples, taken from each load, shall be submitted to the Department's laboratory for testing and the other sample retained by the Resident Engineer to be later submitted to the laboratory for confirming tests in the event the first sample tested should fail to comply with requirements. If the first sample tested complies with requirements, the second sample may be discarded.

Where less than eighty (80) percent of the asphalt deliveries are used on the project, samples shall be taken just prior to delivery to the mixer. Samples shall be taken for every twenty-five (25) tons of asphalt delivered to the project.

(i) Tests for the aforementioned materials produced under conditions other than contemplated herein shall be taken at the time and place deemed by the Engineer to be most appropriate.

106.05 Certificates of Compliance. The Engineer may permit the use of certain materials or assemblies prior to sampling and testing if accompanied by a Certificate of Compliance stating that the materials involved comply in all respects with the requirements of the specifications. The

certificates shall be signed by the manufacturer of the material or the manufacturer of assembled materials. A Certificate of Compliance must be furnished with each lot of material delivered to the work and the lot so certified must be clearly identified in the certificate.

All materials used on the basis of a Certificate of Compliance may be sampled and tested at any time. The fact that material is used on the basis of a Certificate of Compliance shall not relieve the Contractor of responsibility for incorporating material in the work which conforms to the requirements of the plans and specifications and any such material not conforming to such requirements will be subject to rejection whether in place or not.

The Department reserves the right to refuse to permit the use of material on the basis of a Certificate of Compliance.

The form of the Certificate of Compliance and its disposition shall be as directed by the Engineer.

106.06 Cited Specifications. Unless otherwise specified, all tests shall be performed in accordance with the methods used by the Department of Highways. All tests that are performed shall be made by the Engineer or his designated representative.

The Department of Highways has developed test methods for testing the quality of materials and work. These test methods are identified by the prefix Nev. followed by the serial number. Copies of individual test methods are available at the Materials and Research Division, Department of Highways, Carson City, Nevada, and will be furnished to interested persons upon request.

Whenever a reference is made in the specifications to a test method by Nev. number, it shall mean the test method in effect on the date of the advertisement for bid.

Whenever a reference is made in the specifications to a specification or test designation either of the American Society for Testing and Materials, the American Association of State Highway Officials, federal specifications, or any other recognized national organization and the number

or other identification accompanying the test designation representing the year of adoption or latest revision of the test is omitted, it shall mean the test method in effect on the date of the advertisement for bid.

When requested by the Engineer, the Contractor shall furnish, without charge, samples of all materials entering into the work, and no material shall be used prior to approval by the Engineer, except as provided in subsection 106.05, "Certificates of Compliance." Samples of material from local sources shall be taken by or in the presence of the Engineer; otherwise, the samples will not be considered for testing.

106.07 Plant Inspection. The Engineer may inspect the production of material or the manufacture of products at the source of supply. Plant inspection, however, will not be undertaken until the Engineer is assured of the cooperation and assistance of both the Contractor and the material producer. The Engineer or his authorized representative shall have free entry at all times to such parts of the plant as concerns the manufacture or production of the materials. Adequate facilities shall be furnished free of charge to make the necessary inspection.

It is understood that the Department reserves the right to retest all materials prior to incorporation into the work which have been tested and accepted at the source of supply after the same have been delivered and to reject all materials which, when retested, do not meet the requirements of these specifications, or the requirements of the contract documents.

106.08 Storage of Materials. Materials shall be so stored as to assure the preservation of their quality and fitness for the work. When considered necessary by the Engineer, they shall be stored in waterproof buildings, placed on wooden platforms or other hard, clean surfaces, and not on the ground, and shall be covered when directed. Stored materials, even though approved for use before storage, may be inspected prior to their use in the work, and they shall meet the requirements of the specifications at the time

of this proposed use. Stored materials shall be located so as to facilitate their prompt inspection. Upon arrival of the Engineer, that portion of the right of way not required for public travel may be used for storage purposes and for placing of the Contractor's plant and equipment, but any additional space required therefor must be provided by the Contractor at his expense. Private or public property shall not be used for storage purposes without written permission of the owner or lessee. All storage sites shall be restored to their original condition by the Contractor at his expense. This shall not apply to the stripping and storing of top soil or to other material salvaged from the work or specifically prescribed under the specifications.

106.09 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 so constructed as to prevent loss or segregation of materials after loading and measuring in order that there may be no inconsistencies in the quantities of materials intended for incorporation in the work as loaded, and the quantities as actually received at the place of operation.

106.10 Unacceptable Materials. All materials not substantially conforming to the requirements of the specifications at the time they are used shall be considered as unacceptable and all such materials will be rejected and shall be removed immediately from the site of the work unless otherwise instructed by the Engineer. No rejected material, the defects of which have been corrected, shall be used until approval has been given by the Engineer.

106.11 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.

The cost of handling and placing all materials after they

are delivered to the Contractor shall be considered as included in the contract price for the item in connection with which they are used.

The Contractor will be held responsible for all material delivered to him, and deductions will be made from any money due him to make good any shortages 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 AND RESPONSIBILITY TO THE PUBLIC

107.01 Laws To Be Observed. The Contractor shall keep fully informed of all Federal and State laws, all local bylaws, ordinances, and regulations, and all orders and decrees of bodies or tribunals having jurisdiction or authority, which in any manner affect those engaged or employed on the work, or which in any way affect the conduct of the work. He shall at all times observe and comply with all such laws, bylaws, ordinances, regulations, orders, and decrees, and shall protect and indemnify the State and its representatives against any claim or liability arising from or based on the violation of any such laws, bylaws, ordinances, regulations, orders, or decrees, whether by himself or his employees.

107.02 Permits, Licenses, and Taxes. The Contractor shall procure all permits and licenses, pay all charges and fees, and give all notices necessary and incident to the due and lawful prosecution of the work, including vehicular registration or prorate registration and carrier licensing as applicable. Privilege taxes are in addition to the above fees. Contractors having vehicles not licensed or registered in Nevada shall contact the Motor Carrier Division of the Motor Vehicle Department, Carson City, Nevada, for full information.

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 for such use by suitable legal agreement with the patentee or owner. The Contractor and the surety shall indemnify and save harmless the State, any affected third party, or political subdivision 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 State for any costs, expenses, and damages which it may be obliged 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 for same, at any time, is hereby expressly reserved by the Department for the proper authorities of the municipality or other political subdivision in which the work is done and the Contractor shall not be entitled to any damages either for the digging up of the street or for 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 highways. The Contractor shall, when ordered by the Engineer, make in an acceptable manner, all necessary repairs due to such openings, and such necessary work will be paid for as extra work, or as provided in these specifications, and will be subject to the same conditions as original work performed.

107.05 Federal Aid Provisions. (a) Work Subject to Inspection and Approval of Federal Agency. When the United States Government pays all or any portion of the cost of the work, the Federal laws authorizing such participation and the rules and regulations made pursuant to such laws, must be observed by the Contractor. The work shall be subject to the inspection of the authorized representatives of such Federal agencies as are created for the administration of these laws, but such inspection will in no sense make the Federal Government a party to the contract and will in no way interfere with the right of either party hereunder.

(b) Fair Labor Standards Act. The attention of bidders is directed to the fact that this Department has been advised by the Wage and Hour Division, U.S. Department of

Labor, that contractors or subcontractors engaged in highway construction work are required to meet the provisions of the Fair Labor Standards Act of 1938 (52 Stat. 1060) or as amended.

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 and regulations of the State Division of Health and of other bodies or tribunals having jurisdiction thereover. He shall commit no public nuisance.

107.07 Public Convenience and Safety. The Contractor shall at all times conduct the work in such a manner as will obstruct and inconvenience traffic as little as possible. The Contractor shall keep existing travel roads and streets adjacent to or within the limits of the improvement, open to and in a good, dust free and safe condition for traffic at all times. Attention is directed to subsection 107.21, "Dust Control." The Contractor shall maintain said roads and streets to the extent that he shall be responsible for the removal of any material or debris resulting from or caused by his operations and shall repair any damage which may result from his operations. For those roads and streets actually under physical improvement, attention is directed to subsection 104.04, "Maintenance of Traffic." Where grading operations are on or adjacent to the existing traveled way, the grade should be finished immediately after the rough grading is completed and the surfacing material shall be placed thereon as the work progresses. The Contractor shall so conduct his operations as to have under construction no greater length or amount of work than he can prosecute vigorously and he shall not open up sections of the work and leave them unfinished, but he shall finish the work as he goes insofar as practicable.

The Contractor shall perform his work in a manner to assure full compliance with all applicable Federal, State, and local laws and regulations governing safety, health, and

sanitation. He shall provide adequate safeguards, safety devices, and protective equipment such as are specified in other sections of these Standard Specifications or other documents and take any other needed actions 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.

The Contractor shall at all times during the progress of the work or temporary suspension of the work, provide, erect, and maintain all necessary barricades, suitable and sufficient red lights, danger signals, temporary striping and signs, provide a sufficient number of flagmen and take all necessary precautions for the protection of the work and safety of the public, and those engaged on the work. All barricades and obstructions shall be illuminated at night with reflectorized signs and lights, and all lights for this purpose shall be kept burning from sunset to sunrise. All barricades, warning signs, lights, temporary signals and other protective devices must conform with the MUTCD Manual.

107.08 Relations with Railroads. (a) Definitions. The following definitions shall apply to the terms as herein used. *Railroad:* The railway or railroad company whose tracks are crossed or whose property is adjacent to the work or upon whose property the work is performed. *Chief Engineer:* The Chief Engineer of the railroad or his authorized representatives. *Railroad Crossing:* A crossing at grade of the tracks of a railroad and the highway. *Grade Separation:* A permanent structure to affect the separation of grades between the highway and the railroad.

(b) Work or Operations.

1. Work or operations on grade separations, railroad crossings, or upon railroad property shall be subject to inspection by the Chief Engineer, and shall be conducted and performed in a manner satisfactory to the Chief Engineer.

2. Construction operations shall be so arranged and conducted as to insure safe and uninterrupted operation of

the railroad traffic. The Contractor shall be responsible for any damages which result either directly or indirectly from the Contractor's operations.

3. The Contractor shall notify the Chief Engineer in writing, at least forty-eight (48) hours before starting any work in the proximity of the tracks, setting forth specifically the time at which it is planned to start such work.

4. Unless otherwise provided, the Contractor shall not pile or store any material, or park or use Contractor's equipment closer than ten (10) feet from the centerline of the tracks.

5. The track zone shall be kept clean of all loose material or debris at all times. The Contractor shall be responsible for any fouling of railroad ballast resulting from sandblasting and painting operations and shall reimburse the railroad for the replacement of all ballast so fouled.

6. In advance of any blasting, the Contractor shall notify the Chief Engineer in order that proper flagging protection may be provided by the railroad. Excavations in the proximity of the tracks shall be sheeted in a manner satisfactory to the Chief Engineer and plans therefor shall be submitted to and approved by him before any such excavation is commenced.

7. The Contractor shall make arrangements with the railroad for crossing railroad tracks at locations other than existing public crossings and shall bear all costs relative thereto.

8. The Contractor shall submit detail plans of falsework and of forms for track spans and piers or abutments to the Chief Engineer and no work thereon shall be commenced unless and until such plans have been approved by the Chief Engineer. Falsework plans thus approved shall not be deviated from without permission of the Chief Engineer. The temporary vertical and horizontal clearances specified by the Chief Engineer in approving the plans shall be maintained at all times. In the case of impaired vertical clearances above the top of rail, the railroad shall have the option to install telltales, or other such protective devices

the railroad deems necessary, for the protection of trainmen or rail traffic.

9. The Contractor shall comply with the rules and regulations of the railroad with respect to the Contractor's work or operations on or adjacent to railroad property. The Contractor shall arrange with the railroad for the services of such qualified railroad employees as the Chief Engineer may prescribe to protect and safeguard the railroad's property, engines, trains, and cars. The costs incurred for the services of such railroad employees as may be prescribed by the Chief Engineer for necessary safeguard and protection and the costs of installing telltales or other protective devices in the case of impaired vertical clearance, shall be borne by the Contractor without expense to the Department or railroad. Payment for such services, including compensation, insurance, vacation and holiday time, railroad retirement and unemployment taxes, health and welfare, accounting and billing charges, shall be paid by the Department directly to the railroad and the amount thereof shall be deducted by the Department from money due or which may become due the Contractor under the awarded contract. Rates of pay for qualified railroad employees will be the railroad's rates for the various classes of labor customarily used and in effect at the time the work is performed. The Contractor's reimbursement for personnel and protective devices required as set forth herein shall be considered as included in the contract unit prices bid for other items of work.

10. Upon completion of the work covered by the awarded contract to be performed by the Contractor upon railroad's property, the Contractor shall promptly remove from the railroad's property all tools, equipment, and other materials, whether brought upon said property by the Contractor or any subcontractor, and shall cause said property to be left in a clean and presentable condition.

(c) Work or Operations Performed by Railroad. The railroad may undertake certain work or operations incident to the project which are the subject of an agreement between the Department and the railroad. Details of such

work or operations will be set forth in the special provisions and the Contractor shall discuss such items with the Chief Engineer in order to develop a plan whereby the Contractor and the railroad accomplish the work or operations in their logical sequence and order.

Movement or adjustment of telephone, telegraph, or signal facilities owned, operated, or maintained by the railroad and not otherwise provided for on the plans or in the special provisions shall be at the cost and expense of the Contractor.

(d) Insurance. The Contractor shall provide and maintain during the effective life of the awarded contract such special or additional insurance as is required by subsection 107.11, "Responsibility for Damage Claims," herein. The Contractor shall furnish such evidence as may be required that such insurance has been provided.

(e) Qualification. As a prerequisite to award, the Contractor shall be satisfactory as to responsibility to perform work upon the railroad's property.

(f) Reference. The provisions of subsections 624.03.02, "Flagmen," and 624.03.03, "Pilot Cars," subsection 107.11, "Responsibility for Damage Claims," and the special provisions shall inure directly to the benefit of the railroad.

107.09 Liability Insurance. (a) Contractor's Public Liability and Property Damage Liability Insurance. The Contractor shall provide and maintain during the effective life of the awarded contract, regular Contractor's Public Liability and Property Damage Liability Insurance to protect the Contractor and all of the Contractor's construction subcontractors for claims for personal injury, accidental death, and to property, which may arise from operations under said contract, whether such operations be by the Contractor or by such subcontractor or by anyone directly or indirectly employed by either of them.

Whenever construction operations covered under said contract are to be performed upon or in proximity to railroad property, the Contractor's Public Liability and Property Damage Insurance shall provide for limits of coverage

not less than specified in the Railroad Protective Insurance Endorsement appended to the special provisions.

The Contractor shall furnish the Department with one (1) certified copy of all insurance required under this paragraph. The certified copy of the insurance policy(ies) to be furnished to the Department shall be sent directly to the State of Nevada, Department of Highways, 1263 South Stewart Street, Carson City, Nevada 89712, attention: Labor Compliance Officer.

(b) Railroad's Protective Public Liability and Property Damage Insurance. In all cases where construction operations covered by the awarded contract are to be performed upon or adjacent to the property of the railroad, the Contractor shall furnish evidence to the Department that, with respect to the operations the Contractor or any of the Contractor's subcontractors perform, the Contractor has provided for and in favor of the railroad a policy of Public Liability and Property Damage Insurance, to which is attached an endorsement, in the same form and with the same limits of coverage as the Railroad Protective Insurance Endorsement appended to the special provisions.

(c) General. The insurance required under paragraph (b) above shall apply only to that portion of the highway project upon or adjacent to the railroad property.

Railroad's Protective Public Liability and Property Damage Insurance shall be subject to approval by the railroad before any work is commenced on or adjacent to the railroad property.

Such insurance shall be carried, and the premiums therefor paid, by the Contractor until all work required to be performed under the terms of said contract is satisfactorily completed as evidenced by the formal acceptance of the Department and thereafter until all of said tools, equipment, and materials have been removed from the property of the railroad and such property left in a clean and presentable condition. The insurance shall be noncancelable and nonalterable for any cause whatsoever (including failure to pay premiums) either by the Contractor or by the insurance company without thirty (30) days' written notice to the railroad and the Department. In the event such

insurance is canceled as herein provided, the Contractor shall provide other insurance, subject to the same conditions as provided herein, which shall be effective as of the day of such cancellation and cover the unexpired period of the term herein required. The Contractor shall furnish the Department at the time of execution of said contract, three (3) copies of each policy to which is attached an endorsement the same as the Railroad Protective Insurance Endorsement appended to the special provisions. Two (2) copies of each of such policies shall be forwarded by the Department to the Chief Engineer for the railroad's approval.

107.10 Explosives. When the use of explosives is necessary for the prosecution of the work, the Contractor shall exercise the utmost care not to endanger life or property, including new work. The Contractor shall be responsible for all damage resulting from the use of explosives.

All explosives shall be stored in a secure manner in compliance with all laws and ordinances, and all such storage places shall be clearly marked. Where no local laws or ordinances apply, storage shall be provided satisfactory to the Engineer and in general not closer than one thousand (1,000) feet from the road or from any building or camping area or place of human occupancy.

The Contractor shall notify each public utility company having structures in proximity to the site of the work of his intention to use explosives. Such notice shall be given sufficiently in advance to enable the companies to take such steps as they may deem necessary to protect their property from injury.

107.11 Responsibility for Damage Claims. The Contractor shall indemnify and save harmless the Department, its officers and employees, from all suits, actions, or claims of any character brought because of any injuries or damage received or sustained by any person, persons, or property on account of the operations of the said Contractor; or on account of or in consequence of any neglect in safeguarding the work; or through use of unacceptable materials in constructing the work; or because of any claims or amount

recovered under the "Workman's Compensation Act," or any other law, ordinance, order, or decree; and so much of the money due the said Contractor under and by virtue of his contract as may be considered necessary by the Department for such purpose, may be retained for the use of State; or in case no money is due, his surety may be held until such suit or suits, action or actions, claim or claims for the injuries or damages as aforesaid shall have been settled and suitable evidence to that effect furnished to the Department; except that money due the Contractor will not be withheld when the Contractor produces satisfactory evidence that he is adequately protected by public liability and property damage insurance.

Reimbursement to the Contractor by the State in whole or in part for costs of protecting traffic shall not serve to relieve the Contractor of his responsibility as set forth in these Standard Specifications.

The Contractor guarantees the payment of all just claims for materials, supplies, and labor, and all other just claims against him or any subcontractor, in connection with this contract.

107.12 Protection and Restoration of Property and Landscape. The Contractor shall be responsible for the preservation from injury or damage resulting directly or indirectly from the work under his contract of all public and private property, crops, trees, vegetation, monuments, fences, highway signs and markers, etc., along and adjacent to the highway, and shall use every precaution necessary to prevent damage to pipes, conduits, and other underground structures, to poles, wires, cables, and other overhead structures, whether shown on the plans or not, shall protect carefully from disturbance or damage all land monuments and property marks until the Engineer has witnessed or otherwise referenced their location, and shall not remove them until directed. The Contractor shall not willfully or maliciously injure or destroy trees or shrubs and he shall not remove or cut them without proper authority.

He shall be responsible for all damage or injury to property of any character during the prosecution of the work

resulting from any act, omission, neglect, or misconduct in his manner or method of executing said work, or at any time due to defective work or materials, and such responsibility shall not be released until the project shall have been completed and accepted.

The Contractor shall be responsible for the preservation of archeological and paleontological objects, including all ruins, sites, buildings, artifacts, fossils, or other objects of antiquity encountered during construction. When such objects are encountered, the Contractor shall immediately cease operations and notify the Engineer that such objects exist. Construction operations shall be rescheduled to avoid the section until the removal of the artifacts or the gathering of historical data has been accomplished by the appropriate authority. When directed by the Engineer, the Contractor shall excavate the site in such a manner as to preserve the artifacts encountered and shall remove them for delivery to the custody of the proper authorities. Such excavation will be considered and paid for in accordance with subsection 104.03, "Extra Work."

Extension of contract time will be allowed for any delay to the Contractor due to preservation of archeological and paleontological objects.

When or where any direct or indirect damage or injury is done to public or private property by or on account of any act, omission, neglect or misconduct in the execution of the work, or in consequence of the nonexecution thereof on part of the Contractor, he shall restore at his expense such property to a condition similar or equal to that existing before such damage or injury was done by repairing, rebuilding, or otherwise restoring as may be directed, or he shall make good such damage or injury in an acceptable manner. In case of failure on the part of the Contractor to restore such property or make good such damage or injury the Engineer may, upon forty-eight (48) hours' written notice, proceed to repair, rebuild or otherwise restore such property as may be deemed necessary and the cost thereof shall be deducted from any money due, or which may become due the Contractor under the contract.

The Contractor shall restrict the movement of his vehicles and other construction equipment and personnel to the construction area and designated roads. Every precaution shall be taken to prevent the marking of the natural ground with equipment tracks or other means outside of the slope stake areas on either side of the roadway and in median areas where it is not required to disturb the existing ground. Where such markings of the natural ground are caused either by the Contractor's equipment, personnel, or operations, the Contractor, at his own expense, shall eradicate such marks to the satisfaction of the Engineer.

All roads from flat bottom ditches and material deposits shall be spaced at least one thousand (1,000) feet apart, except that such roads may also be located in ditch and dike areas. When roads are located in ditch and dike areas equipment shall not be allowed to travel outside the area to be occupied by said ditch or dike, except as provided for in subsection 203.03.12, "Channels." The crossing of median areas shall be at structures or areas approved by the Engineer.

Where there is a high potential for erosion and subsequent water pollution, the area of erosive land that may be exposed by construction operations at any one time shall be held to a minimum, and the duration of the exposure of the uncompleted construction to the elements shall be as short as practicable. Erosion control features shall be constructed concurrently with other work and at the earliest practicable time.

Disturbance of the lands and of waters that are outside the limits of the construction as staked is prohibited, except as may be found necessary and approved by the Engineer.

107.13 Forest Protection. There shall be no open burning unless approval has been given in writing by the governing body and concurred in by the Engineer. Before setting any fires whatsoever, the Contractor shall notify the responsible Federal, State, or other agency having jurisdiction for the area concerned. All burning shall be done at

night unless otherwise authorized in writing by the Engineer. The Contractor shall abide by such rules and instructions as to fire prevention and control and as to the place and method used for burning as the authorized representative of the appropriate agency having jurisdiction may prescribe. The Contractor shall take all necessary steps to prevent his employees from setting fires not required in the construction of the project and shall, under the direction of the appropriate Federal, State, or other agency, or, in the absence of an officer from any such agency, acting independently, extinguish all fires set or caused by his employees and all other fires which may escape on the project, whether or not set directly or indirectly as a result of construction operations, without expense to the State or Federal Government. Where the Contractor is obligated to suppress any fire without expense to the State or Federal Government, and if the amount of labor, subsistence, supplies, and transportation which he furnishes is inadequate in the opinion of the jurisdictional agency, then such agency may procure additional help or facilities and charge the expenses to the Contractor. These expenses shall be billed to the Contractor for payment directly by him, and if not promptly met by him shall be deducted from the money due or which may become due the Contractor under this contract, or collected from his sureties until the entire amount due for said fire suppression is recovered.

The Contractor shall maintain a fire patrol in the vicinity of blasting and other operations creating a fire hazard. When, in the opinion of the agency having jurisdiction, such a patrol is unnecessary because of weather conditions, the Contractor shall be so notified through the Engineer.

The resident engineer shall have authority to enforce correction of any condition which is, in his opinion, unsafe.

107.14 Disposal of Material Outside Highway Right of Way. The Contractor shall make his own arrangements for disposal of materials outside the highway right of way and he shall pay all costs involved.

When any material is to be disposed of outside the highway right of way, the Contractor shall first obtain a written permit from the property owner on whose property the disposal is to be made and he shall file with the Engineer said permit or the certified copy thereof together with a written release from the property owner absolving the State of any and all responsibility in connection with the disposal of material on said property. Before any material is disposed of on said property, the Contractor shall obtain written permission from the Engineer to dispose of the material at the location designated in the said permit.

Such disposal sites will not be approved when located within one thousand (1,000) feet of a State highway right of way if the material placed thereon can be seen from said highway.

When material is disposed of as above provided and the disposal location is visible from the highway, the Contractor shall dispose of the material in a neat and uniform manner to the satisfaction of the Engineer.

Unless otherwise provided in the special provisions, full compensation for all costs involved in disposing of material as specified in this section, including all costs of hauling, shall be considered as included in the price paid for the contract items of work involving such materials and no additional compensation will be allowed therefor.

107.15 Relief from Maintenance and Responsibility. Upon the written request of the Contractor, or upon order of the Engineer, the Contractor may be relieved of the duty of maintaining and protecting certain portions of the work as described below, which have been completed in all respects in accordance with the requirements of the contract and to the satisfaction of the Engineer, and thereafter except with his consent, the Contractor will not be required to do further work thereon. In addition, such action by the Engineer will relieve the Contractor of responsibility for injury or damage to said completed portions of the work resulting from use by public traffic or from the action of the elements or from any other cause, but not from injury

or damage resulting from the Contractor's own operations or from his negligence.

Portions of the work for which the Contractor may be relieved of the duty of maintenance and protection as provided in the above paragraph include but are not limited to the following:

(a) The completion of one-fourth (¼) mile of roadway or one-fourth (¼) mile of one roadway of a divided highway or a frontage road including the traveled way, shoulders, drainage control facilities, planned roadway protection work, lighting, and any required traffic control and access facilities.

(b) A bridge or other structure of major importance.

(c) A complete unit of a traffic control signal system or of a highway lighting system.

(d) A complete unit of highway protection work.

(e) Any required traffic control and access facilities if the roadway or structure is to be used by public traffic before completion of the contract.

(f) Nonhighway facilities constructed for other agencies.

However, nothing in this subsection providing for relief from maintenance and responsibility will be construed as relieving the Contractor of full responsibility for making good defective work or materials found at any time before the formal written acceptance of the entire contract by the Engineer.

107.16 Contractor's Responsibility for the Work and Materials. Until the acceptance of the contract, the Contractor shall have the charge and care of the work and of the materials to be used therein (including materials for which he has received partial payment as provided in subsection 109.06, "Partial Payments," or materials which have been furnished by the State) and shall bear the risk of injury, loss, or damage to any part thereof by the action of the elements or from any other cause, whether arising from the execution or from the nonexecution of the work, except as provided in subsection 107.15, "Relief from Maintenance and Responsibility." The Contractor shall

rebuild, repair, restore, and make good all injuries, losses, or damages to any portion of the work or the materials occasioned by any cause before its completion and acceptance and shall bear the expense thereof, except as otherwise expressly provided in subsection 203.03.10, "Slides and Slipouts," and subsection 619.05.01, "Payment," for Object Markers and Guide Posts, and except for such injuries, losses, or damages as are directly and approximately caused by acts of the Federal Government or the public enemy. Where necessary to protect the work or materials from damage, the Contractor shall, at his expense, provide suitable drainage of the roadway and erect such temporary structures as are necessary to protect the work or materials from damage. The suspension of the work from any cause whatever shall not relieve the Contractor of his responsibility for the work and materials as herein specified. If ordered by the Engineer, the Contractor shall, at his expense, properly store materials which have been partially paid for by the State or which have been furnished by the State. Such storage by the Contractor shall be on behalf of the State and the State shall at all times be entitled to the possession of such materials, and the Contractor shall promptly return the same to the site of the work when requested. The Contractor shall not dispose of any of the materials so stored except on written authorization from the Engineer.

107.17 Contractor's Responsibility for Utility Property and Service. At points where the Contractor's operations are adjacent to properties of railroad, telegraph, telephone, and power companies, or are adjacent to other property, damage to which might result in considerable expense, loss, or inconvenience, work shall not be commenced until all arrangements necessary for the protection thereof have been made.

The Contractor shall not begin any operations which may interfere with or impair the normal service being rendered by public or private utility operators, until such operators have been notified, and shall cooperate with the owners of any underground or overhead utility lines in their

removal and rearrangement operations in order that these operations may progress in a reasonable manner, and that duplication of rearrangement work may be reduced to a minimum, and that services rendered by those parties will not be unnecessarily interrupted. The Contractor will be held responsible for the protection of the property of public or private utilities within the limits of the work.

In general, the repair and adjustment of street structures such as pipe lines, services, telephone, telegraph, and electric lines, above or below the ground, will be made by the owners thereof. When included in the proposal, the adjustment of sewer manhole frames and covers, inlets and catch basin frames and covers and the like, will be within the Contractor's responsibility. The Contractor shall see that they are adjusted to conform to the lines, grades, and typical cross sections as shown on the plans, or as prescribed, without respect to whether the repairs and the roughing-in work have been performed by the Contractor or others.

Pipes or other construction shall be maintained in continuous service as far as practicable and shall be properly protected and supported. In no case shall interruption of the water service be allowed to exist outside of working hours.

Fire hydrants shall be accessible at all times to the fire department. No material or other obstruction shall be placed closer to a fire hydrant than permitted by ordinances, rules, or regulations, or within fifteen (15) feet of the fire hydrant in the absence of such ordinances, rules, or regulations.

The Contractor shall give notice in writing to the proper authorities in charge of streets, gas, water pipes, electric and other conduits, railroads, poles, manholes, catch basins, and all other property that may be affected by the Contractor's operations, at least forty-eight (48) hours before breaking ground.

In the event of interruption to water or utility services as a result of accidental breakage, the Contractor shall promptly notify the proper authority. He shall cooperate with said authority in the restoration of service as promptly as possible.

Attention is directed to subsection 105.06, "Cooperation with Utilities."

107.18 Furnishing Right of Way. The Department will be responsible for the securing of all rights of way shown in the plans. Any exceptions will be indicated in the contract.

107.19 Personal Liability of Public Officials. In carrying out any of the provisions of these specifications or in exercising any power or authority granted to them by or within the scope of the contract, there shall be no liability upon the directors, Engineer, or their authorized representatives, either personally or as officials of the State, it being understood that in all such matters they act solely as agents and representatives of the State.

107.20 No Waiver of Legal Rights. The Department shall not be precluded or estopped by any measurements, estimate, or certificate made either before or after the completion and acceptance of the work and payment therefor, from showing the true amount and character of the work performed, and materials furnished by the Contractor, nor from showing that any such measurements, estimate, or certificate is untrue or is incorrectly made, nor that the work or materials do not in fact conform to the contract. 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 his sureties, or both, such damages as it may sustain by reason of his failure to comply with the terms of the contract. 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.

107.21 Dust Control. Dust originating from any traffic, any plant or construction operations either inside or outside the right of way shall be controlled at all times by the Contractor in accordance with Federal, State, and local laws, ordinances, and regulations at the sole expense of the Contractor.

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 his right, title, or interest therein, without prior written consent of the Engineer and of the surety.

Requests for permission to sublet, assign, or otherwise dispose of any portion of the contract shall be in writing and accompanied by a letter showing that the organization which will perform the work is particularly experienced for such work.

Consent to sublet, assign, or otherwise dispose of any portion of the contract shall not be construed to relieve the Contractor of his liability under the contract and bonds. The Contractor shall file with the Engineer within seven (7) days after making any subcontract, two (2) certified copies of such subcontract. In preparing such copies, the prices agreed upon for the work may be omitted.

All subcontractors and assignees of the prime or general Contractor shall be required to comply with the provisions of NRS 408.910 in the same manner as the prime or general Contractor.

Contract bid prices will prevail for purposes of computing the monetary value of all subcontracts.

The Contractor shall perform with his own organization, work amounting to not less than fifty (50) percent of the combined value of all items of the work covered by the contract except as follows:

(a) Should the Contractor elect to furnish materials for work to be performed by an approved subcontractor, and the materials are not obtained from the same firm that is to perform the work of incorporating said materials into the project, the cost of said materials, when set forth in a written statement accompanying the subcontract agreement or contained therein, will be excluded from amounts applicable to the subcontracted percentage.

When a firm both sells materials to a Contractor and performs the work of incorporating the materials into the project, these two phases of work must necessarily be considered in combination and, as in effect, constituting a single subcontract.

(b) When performed by subcontract, any items that have been selected as "Specialty Items" for the contract will be excluded from amounts applicable to the subcontracted percentage. "Specialty Items" for the contract are listed as such in the special provisions.

Roadside production of materials is construed to be the production of crushed stone, gravel, or other material with portable or semiportable crushing, screening, or washing plants, established or reopened in the vicinity of the work for the purpose of supplying materials to be incorporated into the work on a designated project or projects. Roadside production of materials shall be considered subcontracting if performed by other than the Contractor.

The Department will not recognize any subcontractor on the work as a party to the contract. Nothing contained in any subcontract shall create any contractual relation between the subcontractor and the Department. The Contractor will be held solely responsible for the progress of the work in accordance with progress required.

108.02 Notice to Proceed. An official Notice to Proceed specifying the date by which construction operations shall be started will be issued to the Contractor by the Engineer. Work shall be commenced not later than the date set forth in the Notice to Proceed. The date set forth in the Notice to Proceed shall not be less than thirty (30) days after the Notice to Proceed is issued. Commencement of the work by the Contractor shall be deemed and taken as a waiver of such notice on his part, but in such case he shall notify the Engineer in writing at least forty-eight (48) hours in advance of the date on which he expects to begin work. In no case, however, shall the Contractor begin work prior to the date of approval of the contract. Contract time will begin on the date specified in the Notice to Proceed, unless

operations begin at an earlier date, in which case the date that such operations were begun will apply.

108.03 Prosecution and Progress. When required by the Engineer, the Contractor shall furnish the Engineer with a "Progress Schedule" for his approval. The progress schedule may be used as the basis for establishing major construction operations and as a check on the progress of the work. The Contractor shall provide sufficient materials, equipment, and labor to guarantee the completion of the project in accordance with the plans and specifications within the time set forth in the special provisions. Should the prosecution of the work for any reason be discontinued, the Contractor shall notify the Engineer at least twenty-four (24) hours in advance of resuming operations.

108.04 Limitation of Operations. The Contractor shall conduct the work at all times in such a manner and in such sequence as will 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 the work is in progress before work is started on any additional sections if the opening of such section is essential to public convenience.

No productive work will be required on Saturdays, Sundays, or State recognized holidays. If, however, the Contractor elects to work on such days, those days worked will be charged as working days. The Contractor shall give the Engineer notice of his intention to work on the aforementioned days at least forty-eight (48) hours in advance of such work. State recognized holidays are enumerated in subsection 101.25, "Holidays" of these specifications.

The Engineer is authorized to notify the Contractor in writing and require the Contractor to cease construction operations the day before, during, and the day after said holidays, or at any other time if the Contractor's operations are of such nature, the project is so located, and

traffic is of such volume that it is deemed expedient to do so.

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

All workmen shall have sufficient skill and experience to perform properly the work assigned to them. Workmen engaged in special or skilled work shall have sufficient experience in such work and in the operation of the equipment required to perform all work properly and satisfactorily.

Any person employed by the Contractor or by any subcontractor who, in the opinion of the Engineer, does not perform his work in a proper and skillful manner or is intemperate or disorderly, shall, at the written request of the Engineer, be removed forthwith by the Contractor or subcontractor employing such person, and shall not be employed again in any portion of the work without the approval of the Engineer.

Should the Contractor fail to remove such person 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 which is proposed to be used on the work shall be of sufficient size and in such mechanical condition as to meet requirements of the work and to produce a satisfactory quality of work. Equipment used on any portion of the project shall be such that no injury to the roadway, adjacent property, or other highway will result from its use.

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

When the contract specifies that the construction be performed by the use of certain methods and equipment, such methods and equipment shall be used unless others are authorized by the Engineer. If the Contractor desires to use methods or types of equipment other than those specified in the contract, he may request authority from the Engineer to do so. The request shall be in writing and shall include a full description of the methods and equipment proposed to be used and an explanation of the reasons for desiring to make the change. If approval is given, it will be on the condition that the Contractor will be fully responsible for producing work in conformity with contract requirements. If, after trial use of the substituted methods or equipment, the Engineer determines that the work produced does not meet contract requirements, the Contractor shall discontinue the use of the substitute method or equipment and shall complete the remaining construction with the specified methods and equipment. The Contractor shall remove the deficient work and replace it with work of specified quality, or take such other corrective action as the Engineer may direct. No change will be made in basis of payment for the construction items involved nor on contract time as a result of authorizing a change in methods or equipment under these provisions.

108.06 Temporary Suspension of Work. The Engineer shall have the authority to suspend the work wholly or in part, for such period as he may deem necessary due to unsuitable weather, or to such other conditions as are considered unfavorable for the suitable prosecution of the work, or for such time as he may deem necessary due to the failure on the part of the Contractor to carry out orders given, or to perform any provision of the contract. The Contractor shall immediately comply with the written order of the Engineer to suspend the work wholly or in part. The suspended work shall be resumed when conditions are favorable and methods are corrected, as ordered or approved in writing by the Engineer.

In the event that a suspension of work is ordered as provided above, and should such suspension be ordered by

reason of the failure of the Contractor to carry out orders or to perform any provision of the contract, or by reason of weather conditions being unsuitable for performing any item or items of work, which work, in the sole opinion of the Engineer, could have been performed prior to the occurrence of such unsuitable weather conditions had the Contractor diligently prosecuted the work when weather conditions were suitable, the Contractor, at his own expense, shall do all the work necessary to provide a safe, smooth and unobstructed passageway through construction for use by public traffic during the period of such suspension as provided in subsection 107.07, "Public Convenience and Safety," and as specified in the special provisions for the work. In the event that the Contractor fails to perform the work above specified, the Department will perform such work and the cost thereof will be deducted from money due or to become due the Contractor.

In the event that a suspension of work is ordered by the Engineer due to unsuitable weather conditions, and in the sole opinion of the Engineer, the Contractor has prosecuted the work with energy and diligence prior to the time that operations were suspended, the cost of providing a smooth and unobstructed passageway through the work will be paid for as extra work as provided in subsection 104.03, "Extra Work," or at the option of the Engineer, such work will be performed by the Department at no cost to the Contractor.

If the Engineer orders a suspension of all of the work or a portion of the work which is the current controlling operation or operations, due to unsuitable weather or to such other conditions as are considered unfavorable to the suitable prosecution of the work, the days on which the suspension is in effect shall not be considered working days as defined in subsection 101.63, "Working Day." If a portion of work at the time of such suspension is not a current controlling operation or operations, but subsequently does become the current controlling operation or operations, the determination of working days will be made on the basis of the then current controlling operation or operations.

If a suspension of work is ordered by the Engineer, due

to the failure on the part of the Contractor to carry out orders given or to perform any provision of the contract, the days on which the suspension order is in effect shall be considered working days if such days are working days within the meaning of the definition set forth in subsection 101.63, "Working Day."

In the event of a suspension of work under any of the conditions set forth in this section, such suspension of work shall not relieve the Contractor of his responsibilities as set forth in Section 107, "Legal Relations and Responsibility to the Public."

108.07 Preconstruction Conference. After the contract has been awarded and prior to commencing work, the Engineer may designate a time and place satisfactory to the Contractor for a preconstruction conference. At such time the Engineer will outline detailed requirements to be followed in performance of the contract.

108.08 Determination and Extension of Contract Time. The contract time for completion will be fixed by the Department, and will be stated in the special provisions, either as a calendar date or based on a number of working days. Attention is directed to subsection 101.63, "Working Day."

The Contractor shall perform the work in an acceptable manner within the time stated in the contract except that the contract time for completion may be adjusted as follows:

(a) If the satisfactory completion of the contract shall require performance of work in greater quantities than those set forth in the proposal, the time allowed for performance shall be increased in the same ratio as the final estimate bears to the original contract amount, except that the final monetary amount of any supplemental agreement or contract change order for which an extension of contract time was previously allowed shall be deducted from the final estimate prior to making the pro rata time adjustment. The final monetary amount of supplemental agreements or contract change orders for which an extension

of contract time has not been allowed will be included in the final estimate for making the pro rata time adjustment. The amount for asphalt cements and liquid asphalts will not be considered in the original or the final estimates for determining time extensions.

(b) In case of suspension of major items of work by order of the Engineer and through no fault of the Contractor, the time for completion shall be extended an amount equal to the elapsed time between effective dates of order to suspend and order to resume.

(c) When delays occur due to unforeseen causes beyond the control and without the fault or negligence of the Contractor, including, but not restricted to acts of God, acts of the public enemy, acts of government agency, fires, floods, epidemics, strikes, and freight embargoes, the time for completion shall be extended an amount determined by the Engineer to be equivalent to the delays; provided, however, written request for such extension of time is made by the Contractor within ten (10) calendar days after the beginning of such delay. No allowance shall be made for delay or suspension of the work due to fault of the Contractor.

Certain critical materials such as steel, copper, aluminum and bituminous products may be difficult to obtain due to a nationally recognized shortage or defense needs. The Contractor shall make every reasonable effort necessary to order and procure all such critical materials sufficiently in advance so as not to delay the completion of the project. Should a delay occur in obtaining critical materials that were properly ordered by the Contractor, the time for completion of the contract may be extended an amount determined by the Engineer to be equivalent to the delay in project progress due to said delay in obtaining critical materials provided that:

1. The delay in furnishing critical materials was due to defense needs or nationally recognized shortage.

2. The Contractor furnishes evidence to the Engineer's satisfaction that he had taken adequate steps for a guaranteed delivery date from his supplier.

3. That (1) is properly certified to by not less than three suppliers of the material or if three suppliers are not available, the Contractor shall so certify and supply certification from such suppliers as there are.

4. That the Department does not find a source when notified of the shortage by the Contractor.

5. That the Contractor obtains such material from the first source available after such certification.

The contract time shall begin as set forth in subsection 108.02, "Notice to Proceed." When the final acceptance has been duly made by the Engineer as prescribed in subsection 105.16, "Final Acceptance," the daily time charge shall cease.

The Department will waive such portions of the liquidated damages as may accrue after all work is completed, except "Final Clean-Up" and seeding deposit areas and haul roads.

108.09 Failure to Complete the Work on Time. Time is an essential element of the contract and it is important that the work be pressed vigorously to completion. The cost to the Department of the administration of the contract, including engineering, inspection, and supervision, will be increased as the time occupied in the work is lengthened. The public is subject to detriment and inconvenience when full use cannot be made of an incomplete project.

Should the Contractor fail to complete the work within the time agreed upon in the contract or within such extra time as may have been allowed by increases in the contract or by formally approved extensions granted by the Department, there shall be deducted from any money or amounts due or that may become due the Contractor, the sum set forth in the special provisions for each and every working day that the work shall remain uncompleted. This sum shall be considered and treated not as a penalty but as liquidated damages due the State from the Contractor by reason of inconvenience to the public, added cost of engineering and supervision and other items which have caused

an expenditure of public funds resulting from his failure to complete the work within the time specified in the contract.

Permitting the Contractor to continue and finish the work or any part of it after the time fixed for its completion, or after the date to which the time for completion may have been extended, will in no way operate as a waiver on the part of the Department of any of its rights under the contract.

The Department will waive such portions of the liquidated damages as may accrue after all work is completed, except "Final Clean-Up" and seeding deposit areas and haul roads.

108.10 Default and Termination of Contract. If the Contractor:

(a) Fails to begin the work under the 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 five (5) days, or

(h) Makes an assignment for the benefit of creditors, or

(i) For any other cause whatsoever, fails to carry on the work in an acceptable manner, 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 ten (10) days after such notice, shall not proceed in accordance therewith, then the Engineer shall have full power and

authority without violating the contract, to take the prosecution of the work out of the hands of the Contractor. The Engineer may, at his option, call upon the surety to complete the work in accordance with the terms of the contract; or he may take over the work, including any or all materials and equipment on the project as may be suitable and acceptable, and may complete the work by force account, or may enter into a new agreement for the completion of said contract according to the terms and provisions thereof, or use such other methods as, in his opinion, will be required for the completion of said contract in an acceptable manner.

All costs and charges incurred by the Department, together with the cost of completing the work under the contract, shall be deducted from any money due or which may become due said Contractor. In case the expense so incurred by the Department shall be less than the sum which would have been payable under the contract if it had been completed by said Contractor, then said Contractor shall be entitled to receive the difference, and in case such expense shall exceed the sum which would have been payable under the contract, then the Contractor and his surety shall be liable and shall pay to the State the amount of said excess.

108.11 Termination of the Contractor's Responsibility. Whenever the improvement contemplated and covered by the contract shall have been completely performed on the part of the Contractor and all parts of the work have been approved and accepted by the Engineer, according to the contract, and the final estimate paid, the Contractor's obligations shall then be considered fulfilled, except as set forth in his contract bond and as provided in subsection 107.11, "Responsibility for Damage Claims."

108.12 Right of Way Delays. If, through the failure of the State to acquire or clear right of way, the Contractor sustains loss which could not have been avoided by the judicious handling of forces, equipment, and plant,

there shall be paid to the Contractor such amount as the Engineer may find to be a fair and reasonable compensation for such part of the Contractor's actual loss, as, in the opinion of the Engineer, was unavoidable, determined as follows:

Compensation for idle time of equipment will be determined in the same manner as determinations are made for equipment used in the performance of extra work paid for on a force account basis, as provided in subsection 109.03, "Extra and Force Account Work," with the following exceptions:

(a) The time for which such compensation will be paid will be the actual normal working time during which such delay condition exists, but in no case will exceed eight (8) hours in any one (1) day.

(b) The days for which compensation will be paid will be the working days charged to the contract except that no compensation will be paid for Saturdays, Sundays, or holidays regardless of working days charged.

Actual loss shall be understood to include no items of expense other than idle time of equipment and necessary payments for idle time of men, cost of extra moving of equipment, and cost of longer hauls. Compensation for idle time of equipment will be determined as provided in this subsection and compensation for idle time of men will be determined as provided in subsection 109.03, "Extra and Force Account Work," and no markup will be added in either case for overhead and profit.

If performance of the Contractor's work is delayed as the result of the failure of the Department to acquire or clear right of way, an extension of time determined pursuant to the provisions in subsection 108.08, "Determination and Extension of Contract Time," will be granted.

108.13 National Emergency and Termination of Contract. The State may, by written notice, with the approval of the Federal Highway Administration where applicable, terminate the contract or a portion thereof when the Contractor is prevented from proceeding with the construction

contract as a direct result of an Executive Order of the President with respect to the prosecution of war or in the interest of national defense.

When contracts, or any portion thereof, are terminated before completion of all items of work in the contract, payment will be made for the actual number of units or items of work completed at the contract unit price, or as mutually agreed for items of work partially completed or not started. No claim for loss of anticipated profits shall be considered.

Reimbursement for organization of the work (when not otherwise included in the contract) and moving equipment to and from the job will be considered where the volume of work completed is too small to compensate the Contractor for these expenses under the contract unit prices, the intent being that an equitable settlement will be made with the Contractor.

Acceptable materials, obtained by the Contractor for the work, that have been inspected, tested, and accepted by the Engineer, and that are not incorporated in the work may, at the option of the Engineer, be purchased from the Contractor at actual cost as shown by receipted bills and actual cost records at such points of delivery as may be designated by the Engineer.

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

SECTION 109

MEASUREMENT AND PAYMENT

109.01 Measurement of Quantities. The measurement and determination of the number of units of each pay item will be made in general as prescribed hereinafter and specifically as set out under Method of Measurement and Basis of Payment in the specification of each pay item.

After the items of work are completed and before final payment is made, the Engineer will determine the quantities of the various items of work performed as the basis for final settlement for all other than lump sum contracts. In the case of unit price items, the Contractor will be paid for the actual amount of work performed and materials used in accordance with these specifications, as shown by the final measurements, unless otherwise specified.

Actual authorized quantities of work satisfactorily completed under the contract, shall be measured by the Engineer in accordance with United States Standard Measures, and well recognized engineer practices. Unauthorized wastings of material will be deducted and only such quantities as are actually incorporated in the completed work will be included in the final estimate.

Unless otherwise specified, longitudinal measurements for area computations will be made horizontally, and no deductions will be made for individual fixtures having an area of nine (9) square feet or less. Unless otherwise specified, transverse measurements for area computation will be the neat dimensions shown on the plans or ordered in writing by the Engineer.

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

All items which are measured by the linear foot such as pipe culverts, underdrains, guardrails, etc., shall be measured parallel to the base or foundation upon which such structures are placed, unless otherwise shown on the plans.

The term "gage," when used in connection with the

measurement of plates, shall mean the U.S. Standard Gauge. When reference is made, however, to the measurements of galvanized sheets used in the manufacture of corrugated metal pipe, metal plate pipe culverts and arches, and metal cribbing, the term "gage" shall mean that specified in the respective test designation for that material as described in the "materials" section of these specifications.

When the term "gage" refers to the measurement of wire, it shall mean the wire gage specified in the AASHTO Designation: M32 for cold drawn steel wire for concrete reinforcement.

When water meters are required, the accuracy of the meters shall be checked by comparing the actual weight of approximately 1,000 gallons, or 125 cubic feet, as metered with the calculated weight using as a reference density 8.33 pounds per gallon or 62.4 pounds per cubic foot. Unless otherwise specified, water meters shall be accurate to within two (2) percent of the indicated amount. The frequency of checking water meters will be determined by the Engineer.

The term ton shall mean the short ton consisting of two thousand (2,000) pounds avoirdupois. All materials which are specified for measurement by ton shall be weighed on accurate, approved scales set at locations designated by the Engineer. All materials shall be weighed on platform scales with the following exception: In lieu of platform scales, the Contractor may provide an automatic printer system which will print the weights of the material delivered, provided the system is used in conjunction with an approved automatic batching control system. Such evidence shall be evidenced by a weigh ticket for each load. The Contractor shall have on hand not less than ten (10) fifty (50) pound standard weights for testing the scales.

All scales shall be furnished by and at the expense of the Contractor and shall have a Certificate of Inspection by the Bureau of Weights and Measures. The scales shall be tested and inspected by the Bureau of Weights and Measures and a new inspection certificate required as often as the Engineer may deem necessary, and after each

scale move, in order to insure the accuracy of the scales. The cost of inspecting the scales shall be borne by the Department.

Platform scales shall be of sufficient size and capacity to weigh, in one operation, the entire loaded vehicle. Combination vehicles may be weighed as separate units, provided the connecting device between vehicles is so constructed that no weight other than that of the device itself is transmitted to either vehicle. When combination vehicles are used, approaches to and from the scale platform shall be level for sufficient distance to accommodate that portion of the combination vehicle that is off the scale platform. In instances where combination vehicles are weighed, the approaches to and from the scale platform must be level with the scale platform for a minimum distance of fifty (50) feet from each end of the scale platform.

If combination vehicles are utilized, provisions must be made to insure that all braking devices are disengaged during weighing operations as insurance against stresses being transmitted between either vehicle.

The scale pit must be of sufficient width to permit access to all scale components for purposes of inspection, repair, cleaning, and adjusting.

Support members for platform scales shall consist of twelve by twelve inch (12″ x 12″) or six by sixteen inch (6″ x 16″) (minimum) timbers placed on a firm gravel foundation. Scales consisting of more than one section shall be supported with twelve by twelve inch (12″ x 12″) or six by sixteen inch (6″ x 16″) (minimum) timbers at each end of each section to avoid settlement of the scale platform. Concrete support members conforming to the minimum timber size requirements may be utilized in lieu of timber at the Contractor's option.

Platform scales shall be equipped with weatherproof housing so constructed as to protect the recording device and permit the weighmaster convenient access to all beams and dials. The housing shall not be less than six (6) feet wide, eight (8) feet long and seven (7) feet high, and shall

have two (2) windows, adjustable for ventilation, one (1) facing the scales, and shall be equipped with an adequate shelf suitable to the Engineer. The Contractor shall provide heat and electric lights when requested by the Engineer.

Conveyor scales of an approved type may be used. The conveyor scales shall be furnished with one (1) master counter to run continuously and one (1) remote counter which will print the weight in individual loads, then reset to zero automatically. The remote unit shall be placed in a weatherproof house with two (2) windows. One (1) window shall face the point of loading and the conveyor scales. This window shall also be equipped with a shelf two (2) feet wide and six (6) feet long. A controlled method of heating shall be supplied for cold weather operations.

A locked door shall be provided on the access to the conveyor balances (where fine adjustment must be made), the key to be in the hands of the Engineer and to be opened only for maintenance and adjustment of conveyor scales to meet the accuracy of the platform scales. This door shall be locked at all other times during the operation of the conveyor scales.

If conveyor weighing equipment is used, the following procedures shall be followed:

(a) The conveyor scales shall be calibrated against the platform scales, which must have a Certificate of Inspection.

(b) At the beginning and middle of each shift, or as requested by the Engineer, two consecutive loads of material weighed over the conveyor scales shall be reweighed on the platform scales. The total weight indicated by the conveyor scales on the two loads must check with the platform scale weight within one half (½) of one (1) percent. If the conveyor scales weigh out of this tolerance, all loads shall be weighed on the platform scales until the condition is rectified.

(c) Consecutively numbered, individual weigh tickets must be used with conveyor scale weights stamped by the remote counter.

Unless otherwise specified, materials shipped by rail

shall be weighed over the authorized project scales before incorporation into the work.

Cement will be measured by the barrel or ton. The term "barrel" will mean three hundred seventy-six (376) pounds of cement.

Timber will be measured by the thousand feet board measure (Mfbm) actually incorporated in the structure with no allowance for any waste except beveled ends. Measurement will be based on nominal widths and thicknesses, and the extreme length of each piece.

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

All materials for which measurements are obtained by the cubic yard "loose measurement" or "measured in the vehicle" shall be hauled in approved vehicles and measured therein at the point of delivery. No allowance will be made for the settlement of material in transit. Vehicles for this purpose may be of any size or type acceptable to the Engineer, provided that the body is of such shape that the actual delivered contents may be readily and accurately determined and will remain constant. Unless all approved vehicles on the work are of uniform capacity, each vehicle must bear a plainly legible identification mark, indicating its specified approved capacity. All vehicles must be loaded to at least their water level capacity and all loads shall be leveled when the vehicles arrive at the point of delivery. Loads not hauled in approved vehicles or of a quantity less than the specific approved quantity for the hauling vehicle will be subject to rejection and no compensation will be allowed for the hauling of the material.

The unit of measurement for liquid asphalts, asphaltic emulsions, and paving asphalts shall be a ton or gallon.

Quantities of bituminous binders wasted or disposed of in a manner not called for under these specifications, or remaining on hand after completion of the work, will not be paid for.

When permitted by the Engineer, pay quantities of bituminous binder may be determined from volumetric measurements of the bituminous binder, in which case the bituminous binder shall be delivered in calibrated tanks and each tank shall be accompanied by its proper measuring stick and a calibration card signed by a sealer of weights and measures, and pay quantities shall be determined in accordance with the following procedure.

Volumetric measurements at any temperature shall be reduced to the volume the material would occupy at sixty (60) degrees Fahrenheit, before converting the volumetric measurements to weight.

The following tables shall be used to convert volumes from gallons to weight. All types, SC, MC, and RC of the same grade, shall be considered to have equal weights and volume.

Average Weights and Volumes of Liquid Asphalt

Grade of Liquid Asphalt	Gallons Per Ton at 60° F.	Barrels Per Ton at 60° F. (42 U.S. Gals.)	Pounds Per Gal. at 60° F.
70	253	6.03	7.90
250	249	5.93	8.03
800	245	5.83	8.16
3,000	241	5.74	8.30

Average Weights and Volumes of Asphalt Cement

Grade	Gallons Per Ton at 60° F.	Barrels Per Ton at 60° F. (42 U.S. Gals.)	Pounds Per Gal. at 60° F.
AR—16,000	235	5.60	8.51
AR— 8,000	235	5.60	8.51
AR— 4,000	235	5.60	8.51
AR— 2,000	237	5.64	8.44
AR— 1,000	239	5.70	8.36

Average Weights and Volumes of Asphaltic Emulsion

Type of Emulsion	Gallons Per Ton at 60° F.	Barrels Per Ton at 60° F. (42 U.S. Gals.)	Pounds Per Gal. at 60° F.
All grades	240	5.71	8.33

When converting the volume of liquid asphalt, asphalt cement, or asphaltic emulsion at any temperature to the volume at sixty (60) degrees Fahrenheit a conversion factor for correlation shall be used. Said conversion factors shall be

those prescribed in "The Asphalt Institute (Pacific Coast Division)" publication of "Specification Tables and Uses," dated February 1955, and revised January 1966.

Rental of equipment will be measured by time within one-half (½) hour of actual working time and necessary traveling time of the equipment within the limits of the project. If equipment has been ordered on the job on a standby basis by the Engineer, half-time rates for the equipment will be paid.

When special equipment has been ordered by the Engineer in connection with force account work, travel time and transportation to the project will be measured as hereinafter outlined. For the use of special equipment moved in on the work and used exclusively for extra work paid for on a force account basis, the Contractor will be paid the rental rates listed in the special provisions or determined as provided in subsection 109.03, "Extra and Force Account Work," and for the cost of transporting the equipment to the location of the work and its return to its original location, all in accordance with the following provisions:

(a) The original location of the equipment to be hauled to the location of the work shall be agreed to by the Engineer in advance.

(b) The State will pay the costs of loading and unloading such equipment.

(c) The cost of transporting equipment in low bed trailers shall not exceed the hourly rates charged by established haulers.

(d) The rental period shall begin at the time the equipment is unloaded at the site of the extra work, shall include each day that the equipment is at the site of the extra work, excluding Saturdays, Sundays, and legal holidays unless the extra work is performed on such days, and shall terminate at the end of the day on which the Engineer directs the Contractor to discontinue the use of such equipment. The rental time to be paid per day will be in accordance with the following:

Hours Equipment Is in Operation	Hours To Be Paid
0	4
0.5	4.25
1	4.5
1.5	4.75
2	5
2.5	5.25
3	5.5
3.5	5.75
4	6
4.5	6.25
5	6.5
5.5	6.75
6	7
6.5	7.25
7	7.5
7.5	7.75
8	8
Over 8	Hours in operation

When hourly rates are listed, less than thirty (30) minutes of operation shall be considered to be one-half (½) hour of operation.

When daily rates are listed, payment for one-half (½) day will be made if the equipment is not used. If the equipment is used, payment will be made for one (1) day.

(e) Should the Contractor desire the return of the equipment to a location other than its original location, the State will pay the cost of transportation in accordance with the above provisions, provided such payment shall not exceed the cost of moving the equipment to the work.

(f) Payment for transporting and loading and unloading equipment as above provided will not be made if the equipment is used on the work in any other way than upon extra work paid for on a force account basis.

Material wasted or disposed of in a manner not called for under the contract, material not unloaded from the transporting vehicle, material placed outside of the limits indicated or given on the plans, or material remaining on hand after completion of the work will not be paid for except as otherwise provided.

109.02 Scope of Payment. Unless otherwise provided under "Basis of Payment," payments to the Contractor will be made for the actual quantities of contract

items performed in accordance with the plans and specifications, and if, upon completion of the construction, these actual quantities show either an increase or decrease from the quantities given in the bid schedule, the contract unit prices will still prevail, except as provided in subsection 109.04, "Eliminated Items," and 104.02, "Increased or Decreased Quantities and Change in Character of Work."

Except as provided in 107.16, "Contractor's Responsibility for the Work and Materials," the Contractor shall accept the compensation, as herein provided, in full payment for the following:

(a) The work complete, including all supervision, labor, material, tools, equipment, and incidentals necessary for all work contemplated and embraced under the contract;

(b) Any loss or damage due to the nature of the work, the action of the elements, strikes or lockouts;

(c) Accidents to employees or the public, or both;

(d) Unforeseen difficulties or obstructions which may arise or be encountered during the prosecution of the work;

(e) All risks whatsoever connected with the work under contract until it is accepted by the Engineer;

(f) All expenses incurred by or in consequence of, the suspension or discontinuance of the prosecution of the work as herein specified, and in completing the work and the whole thereof, including the carrying out of all the requirements of these "general requirements and covenants" in an acceptable manner according to the plans and specifications.

If the "Basis of Payment" clause in the specifications relating to any unit price in the bid schedule requires that the said unit price cover and be considered compensation for certain work or material essential to the item, this same work or material will not also be measured or paid for under any other pay item except as provided for in subsection 104.05, "Rights in and Use of Materials Found in the Work."

The payment of any partial estimate or of any retained percentage, except by and under the approved final estimate and voucher, in no way shall affect the obligation of

the Contractor to repair or renew any defective parts of the construction or to be responsible for all damages due to such defects.

Those subsections containing pay items of bituminous materials are subject to the following requirements:

It is agreed by the parties to the contract that (a) in case the bituminous material does not conform to the requirements set forth in Section 703, "Bituminous Materials," damage will be sustained by the Department, and that (b) it is extremely difficult to ascertain the actual damage which the Department will sustain; therefore, it is agreed the Contractor will pay to the Department as liquidated damages or the Department, at its option, may deduct from any money due or to become due the Contractor from the Department an amount set forth in the following schedule:

Number of Demerits (From Section 703, "Bituminous Materials")	Liquidated Damage (per bid unit)
1–2	$1.00
3–5	2.00
6–9	4.00
10–14	8.00
15–20*	16.00

*Material shown by test to have 21 or more demerits shall be removed and replaced or, at the option of the Engineer, may be left in place. Payment for such material left in place will be assessed liquidated damages at $16.00 per ton. Material removed will not be paid for and the removal thereof will be at the Contractor's expense.

109.03 Extra and Force Account Work. Extra work shall be paid for in accordance with the accepted contract change order. Work specified in the order to be performed at agreed unit prices shall be paid for in the same manner as proposal items.

When extra work paid for on a force account basis is performed by forces other than the Contractor's organization, the Contractor shall reach agreement with such other forces as to the distribution of the payment made by the Department for such work. No additional payment therefor will be made by the Department by reason of the performance of the work by a subcontractor or other forces.

1. Specialized Work:

Whenever the Contractor is required to perform

minor, originally unanticipated work of a specialized nature (electrical, plumbing, landscaping, etc.,) for which he is not properly equipped, he may upon approval of the Engineer have the work performed by a local firm or specialist who is proficient in the type of work to be performed.

Payment for this work shall be the Contractor's actual cost as evidenced by copies of invoices from the person or firm who performed the work. To the Contractor's actual cost shall be added the sum of ten (10) percent for the Contractor's profit and overhead with no further compensation therefore.

2. Owner-Operators:

Whenever the Contractor is authorized by the Engineer to utilize bona fide owner-operators on force account work, payment shall be at the lump sum rate shown on the Contractor's payrolls which includes wages and equipment rental. To this lump sum rate shall be added the sum of ten (10) percent for the Contractor's profit and overhead with no further compensation therefore.

Work specified and performed on a force account basis shall be paid for as follows:

(a) Labor. The Contractor will be paid the cost of labor for the workmen (including foremen when authorized by the Engineer), used in the actual and direct performance of the work. The cost of labor, whether the employer is the Contractor, subcontractor, or other forces, will be the sum of the following:

1. Actual Wages Plus Vacation Pay. The actual wages paid, plus vacation pay, which shall not include any employer payments to, or on behalf of, workmen for health and welfare, pension, and similar purposes.

2. Labor Surcharge. To the actual wages, plus vacation pay, as defined above, will be added a labor surcharge set forth in the special provisions, which labor surcharge shall constitute full compensation for all payments imposed by State and Federal laws.

3. Fringe Benefits. To the sum of paragraph 1, "Actual Wages Plus Vacation Pay," and (a) above, shall be added all other payments made to or on behalf of the

workmen as required by collective bargaining agreements, or as otherwise provided in the special provisions.

4. Subsistence and Travel Allowance. Subsistence and travel allowance paid to such workmen as required by collective bargaining agreements.

To the total of the direct costs computed above, there will be added a markup of twenty (20) percent.

(b) Materials. For materials accepted by the Engineer and used in the work the Contractor shall receive the actual cost of such materials, to which cost shall be added an amount equal to fifteen (15) percent of the sum thereof.

(c) Equipment. For any machinery or special equipment (other than small tools), the use of which has been authorized by the Engineer, the Contractor will be paid for the use of equipment at the rental rates listed for such equipment in the State of Nevada, Department of Highways publication entitled Equipment Rental Rates, which is a part of the contract, regardless of ownership and any rental or other agreement, if such may exist, for the use of such equipment entered into by the Contractor. If it is deemed necessary by the Engineer to use equipment not listed in the Department publication, a suitable rental rate for such equipment will be established by the Engineer. The Contractor may furnish any cost data which might assist the Engineer in the establishment of such rental rate. Except as provided in subsection 109.01, "Measurement of Quantities," payment will be made for actual time that such equipment is in operation on the work, or for standby time, to which rental sum fifteen (15) percent shall be added.

The rental rates paid as above provided shall include the cost of fuel, oil, lubrication, supplies, small tools, necessary attachments, repairs and maintenance of any kind, depreciation, storage, insurance and all incidentals.

(d) Supervision and Tools. No additional allowance shall be made for general superintendents, the use of small tools or other costs for which no specified allowance is herein provided.

(e) Records. At the end of each day the Contractor's

representative and the Engineer shall compare records of the cost of the work to be done as ordered on a force account basis.

(f) Documentation.

1. Labor. No payment will be made for labor performed on force account work until the Contractor shall furnish to the Engineer certified copies of payrolls covering that period when the force account work was performed. The payrolls shall indicate name, classification, dates, daily hours, and hourly rate for each workman.

2. Materials. Copies of the suppliers' invoices, including transportation charges, shall be furnished the Engineer. However, if materials used on the force account work are not specifically purchased for such work, but are taken from the Contractor's stock, then in lieu of the invoices, the Contractor shall furnish an affidavit certifying that such materials were taken from his stock, that the quantity claimed was actually used, and that the price and transportation claimed represent the actual cost to the Contractor.

109.04 Eliminated Items. Should any items contained in the proposal be found unnecessary for the proper completion of the work, the Engineer may, upon written order to the Contractor, eliminate such items from the contract, and such action shall in no way invalidate the contract. When a Contractor is notified of the elimination of items, he will be reimbursed for actual work done and all costs incurred, including mobilization of materials prior to said notification.

109.05 Common Carrier Rate Adjustments. It is understood and agreed that the accepted proposal for the work 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 date of opening of 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 of proposals, and before the date

stipulated for the completion of the work, including authorized extensions of time. Adjustments shall be limited to materials entering into and forming a part of the project and to an amount determined as follows: Adjustments shall be the product of the increase or decrease of said common carrier rates multiplied by the net quantity of material shipped at the new rates to the work, all as shown by the receipted common carrier bill.

109.06 Partial Payment. Partial payments will be made once each month as the work satisfactorily progresses. The progress estimates shall be based upon materials in place, or on the jobsite and invoiced, and labor expended thereon. From the total of the amount ascertained will be deducted an amount equivalent to ten (10) percent of the whole, which ten (10) percent will be retained by the Department until after completion of the entire contract in an acceptable manner; and the balance or an amount equivalent to ninety (90) percent of the whole, plus all previous payments shall be certified for payment, provided that any time after fifty (50) percent of the work has been completed, the Engineer may, if he finds that satisfactory progress is being made, make any of the remaining partial payments in full, or as otherwise provided for in NRS 408.920.

Control of retent funds under the contract:

The Contractor is entitled to exercise the rights of deposit granted under NRS 408.920 of qualified securities of a market value equal to the funds held by the Department under the retent under the contract.

As an alternative to the above if the Contractor so requests the Department agrees to deposit the funds accrued in the retent under the contract in a Nevada bank or other approved financial institution designated by the Contractor. The funds will be deposited in a "Time Deposit Open Account" in an account identified as Nevada Highway Department Retent Funds of Contract No. ..... (Applicable Contract Number).

The Department shall remain in control of the deposit until final acceptance of the project with all right to the

retent as provided in the general provisions. The interest accruing to the deposit shall be for the benefit of the Contractor who may leave the interest on deposit in the account or be entitled to withdraw the interest only from the account. The interest accruing in the above-referenced deposit shall be income to the Contractor for income tax purposes.

Administrative charges, if any, in connection with a requested deposit of the retent or a deposit by the Contractor of securities as provided by NRS 408.920 shall be borne by the Contractor and paid out of the interest accruing on the deposit or on the securities deposited.

The above deposit will be closed out and forwarded to the Contractor when the Department has accepted the project and has determined that the contract should be finalized and final payment made.

No such estimate or payments shall be required to be made, when, in the judgment of the Engineer, the work is not proceeding in accordance with the provisions of the contract, or when in his judgment the total value of the work done since last estimate amounts to less than five hundred (500) dollars.

The cost of materials conforming to the plans and specifications ("materials" being those which are required to be contained and incorporated in a finished contract bid item) delivered to the project and not at the time incorporated in the work, may also be included in the estimate for partial payment.

No such estimate or payment shall be construed to be an acceptance of any defective work or improper material.

The Contractor shall be responsible for, and shall not remove from the project any material that has been included in the estimate for payment.

Partial payments may be made on "Local Materials" meeting the requirements hereinafter outlined:

(a) Materials shall be stockpiled on or in the vicinity of the project (generally on land adjacent to the project).

(b) All materials shall be stored in an approved manner in areas where damage from flood waters is not likely to occur. If at any time stored materials are lost or become

damaged by floods or in any other manner, the Contractor will be responsible for the repair and replacement of such damaged materials. If payment has been made prior to such damage, the amount so allowed, or a proportionate part thereof, shall be deducted from the next partial payment and withheld until satisfactory repairs or replacements have been made.

(c) Partial payments will be made only on materials that conform to plans and specifications (not to be construed as final acceptance). The quantities will be determined by volume measurement and converted to tons if the contract unit price of the item is in tons. In the case of "Portland Cement Concrete Pavement," the unit price will be converted to square yards per ton. However, partial payments shall not exceed the actual cost to the Contractor to produce the material.

(d) No payment shall be made on any commercial stockpile or on any stockpile from which materials are being used for any purpose whatsoever other than incorporation into the project.

(e) Partial payment shall be made at the contract unit price for the percentage of material allowed. The quantity in stockpile, or windrow, to be considered shall not exceed that required for the project.

(f) Schedule of Payments.

1. Not more than forty (40) percent of the quantity of Class A and Class B Aggregate Base Courses in the stockpile may be allowed. Not more than eighty-five (85) percent of the quantity of Class B Aggregate Base Courses in the processed windrow on the roadway may be allowed.

2. Not more than thirty (30) percent of the quantity of Cement Treated Base Aggregate (Roadmix or Plantmix) in the stockpile may be allowed. Not more than eighty-five (85) percent of the quantity of Cement Treated Base Roadmix in the processed windrow on the roadway (prior to adding cement) may be allowed.

3. Not more than twenty (20) percent of the quantity of Plantmix Base, Surface, or Open-Graded Surface Aggregate in the stockpile may be allowed.

4. Not more than eighty-five (85) percent of the quantity of Roadmix Bituminous Surface Aggregate in the processed windrow on the roadway (prior to adding bituminous material) may be allowed.

5. Not more than forty (40) percent of the quantity of screenings in the stockpile may be allowed.

6. Not more than eighty-five (85) percent of the quantity of Selected Material Base, conforming to all the requirements, in windrow may be allowed.

If materials are not specifically purchased for the work, but are taken from the Contractor's stock, then in lieu of invoices, there shall be submitted to the Engineer, statements accompanied by an affidavit of the Contractor, certifying such materials were taken from his stock and the price and transportation claimed represent the actual cost to the Contractor.

No partial payment will be made on living or perishable plant materials until planted.

Unless otherwise specified, all material and work covered by partial payments shall thereupon become the property of the State, but this provision shall not be construed as relieving the Contractor from the sole responsibility for all materials and work upon which payments have been made or the restoration of any damaged work, or as a waiver of the right of the Department to require the fulfillment of all terms of the contract.

Partial payments will be made on the items of "Construction Signs" and "Barricades" as hereinafter outlined:

(a) Watering. No payment, partial or otherwise, will be made for the item of "Watering." Full compensation for developing and maintaining an adequate water supply will be considered included in other items of work.

(b) Construction Signs. When construction signs are placed on the project, in accordance with the plans and specifications, fifty (50) percent of the contract price per square foot of acceptable signs in place will be paid for on the next monthly estimate after placing. The remaining percent will be prorated in accordance with job progress.

However, if signing becomes inadequate for job requirements, in the opinion of the Engineer, an adjustment downward shall be made on the first monthly estimate following such inadequacy.

Once the inadequacies or deficiencies are corrected and the Engineer again resumes normal payment, prorated with progress, the amount of progress accomplished during the delinquent period will be permanently excluded from the factor used by the Engineer to determine the payment due.

(c) Barricades. When barricades are placed on the project in accordance with the plans and specifications, fifty (50) percent of the contract bid price per linear foot or per each (as the case may be) of the barricades thus in use will be paid for on the next monthly estimate after placing. The remaining percent will be prorated in accordance with job progress. However, if barricades become inadequate for job requirements in the opinion of the Engineer, an adjustment downward shall be made on the first monthly estimate following such inadequacy.

Partial payments will be made on the items of fence, guardrail, bridge rail, mobilization, signal systems and/or highway lighting systems, cattle guards and trenching for irrigation systems as hereinafter noted provided that materials and equipment are supplied to the satisfaction of the Engineer:

(a) Fence. When fencing material is stored on the project, invoice prices may be paid as outlined herein. When the fence posts have been placed, sixty (60) percent of the partially completed fence will be eligible for payment at the contract unit bid price. The remaining forty (40) percent will be eligible for payment when the item is complete.

The cost of wire and posts conforming to the plans and specifications which are required to be contained and incorporated in a finished contract bid item delivered to the project and not at the time incorporated in the work, may be included in the estimate for partial payment.

(b) Guardrail and Bridge Rail. When guardrail and bridge rail materials are stored on the project, invoice

prices may be paid as outlined herein. When guardrail and bridge rail are in place, but not painted, ninety (90) percent of the guardrail or bridge rail will be eligible for payment at the contract unit bid price. The remaining ten (10) percent will be eligible for payment when the item is complete.

When posts for guardrail or reconstruct guardrail are complete in place, fifty (50) percent of the contract bid price per foot will be eligible for payment.

(c) Mobilization. Partial payments will be made in accordance with the following schedule:

1. When five (5) percent of the original contract amount is earned, twenty-five (25) percent of the amount bid for mobilization, or two and one-half (2½) percent of the original contract amount, whichever is lesser, will be allowed on the next monthly estimate.

2. When ten (10) percent of the original contract amount is earned, fifty (50) percent of the amount bid for mobilization, or five (5) percent of the original contract amount, whichever is lesser, will be allowed on the next monthly estimate.

3. When twenty-five (25) percent of the original contract amount is earned, sixty (60) percent of the amount bid for mobilization, or six (6) percent of the original contract amount, whichever is lesser, will be allowed on the next monthly estimate.

4. When sixty-five (65) percent of the original contract amount is earned, ninety (90) percent of the amount bid for mobilization, or nine (9) percent of the original contract amount, whichever is lesser, will be allowed on the next monthly estimate.

5. When eighty (80) percent of the original contract amount is earned, one hundred (100) percent of the amount bid for mobilization or ten (10) percent of the original contract amount, whichever is lesser, will be allowed on the next monthly estimate.

6. Upon completion of all work on the project, payment of any amount bid for mobilization in excess of ten (10) percent of the original contract amount will be allowed on the next estimate.

(d) Signal Systems and/or Highway Lighting Systems. The cost of materials for luminaires, poles and mast arms, controllers and cabinets, signal heads and detector units, conforming to the plans and specifications ("materials" being those which are required to be contained and incorporated in a finished contract bid item) delivered to the project and not at the time incorporated in the work, may also be included in the estimate for partial payment. Other items will not be included for partial payment until incorporated in the work.

(e) Cattle Guards. The first monthly estimate after the cattle guard has been completed, but the wings not yet installed, will show this item ninety (90) percent complete.

The remaining ten (10) percent shall be eligible for payment on the first monthly estimate after the wings have been installed.

(f) Trenching for Irrigation Systems. When trenches for irrigation pipe distribution lines have been excavated and the pipe has been placed but not backfilled, seventy-five (75) percent of the partially completed irrigation pipe will be eligible for payment on the next monthly estimate at the contract unit price. Payment will be based on that length of the pipe partially complete.

The remaining twenty-five (25) percent will be eligible for payment on the first monthly estimate following complete installation of the pipe.

109.07 Acceptance and Final Payment. When the final inspection and final acceptance have been duly made by the Engineer, as provided in subsection 105.16, "Final Acceptance," and subject to the terms of subsection 108.09, "Failure to Complete the Work on Time," the Engineer shall prepare the final estimate of the quantities of the various classes of work performed under the contract. The Contractor shall examine such estimate and notify the Engineer in writing of his agreement or file a specific claim covering disputed quantities. Failure on the part of the Contractor to so notify the Engineer or file a claim within a period of thirty (30) days after receipt of

the estimate shall be construed to signify the Contractor's agreement to the quantities as set forth, and he shall have no further claim against the Department, except as indicated in the final estimate of quantities. Final payment shall be due and payable at the expiration of not less than thirty (30) calendar days nor more than sixty (60) calendar days from the date of final acceptance.

Final acceptance of the work by the Engineer shall be withheld until the Contractor furnishes all certificates, guaranties, releases, affidavits, etc., required by these specifications or the special provisions.

SECTION 110

WAGES AND CONDITIONS OF EMPLOYMENT

110.01 Description. The provisions pertaining to wages and conditions of employment shall apply to all work performed (on the contract) by the Contractor with his own organization and with the assistance of workmen under his immediate superintendence, and to all work performed on the contract by subcontractors.

The laborers shall have access to the pertinent minimum wage schedules at all times. The Contractor shall provide and erect a weatherproof bulletin board at the jobsite and post all minimum wage schedules and other required information thereon. The weatherproof bulletin board shall be so constructed that the material thereon is adequately protected from the elements. The cost of providing and erecting the weatherproof bulletin board shall not be measured or paid for directly but shall be considered as included in the contract bid price paid for other items of work.

It is a condition of the contract, and shall be made a condition of each subcontract entered into pursuant to the contract, that the Contractor and any subcontractor shall not require any laborer or mechanic employed in performance of the contract to work in surroundings or under working conditions which are unsanitary, hazardous, or dangerous to his health or safety as determined under construction safety and health standards (Title 29, Code of Federal Regulations, Part 1926—published in the Federal Register on December 16, 1972, and subsequent revisions) promulgated by the United States Secretary of Labor, in accordance with Section 107 of the Contract Work Hours and Safety Standards Act (83 Stat. 96).

110.02 Laws Cited. The Contractor's attention is directed particularly to the provisions and requirements of the following:

(a) Wages, Hours, and Employment on Public Works—Nevada Revised Statutes, Chapter 338.

(b) Nevada Industrial Insurance Act—Nevada Revised Statutes, Chapter 616. (The Contractor will be required to furnish a certificate from the Nevada Industrial Commission as evidence that he has paid all the premiums and percentages as required by the act, and said certificate shall be furnished the Engineer before any work is commenced.)

(c) Unemployment Compensation Law—Nevada Revised Statutes, Chapter 612.

(d) Highway Camp Sanitation—Nevada Revised Statutes, Secs. 444.130, 444.200, and 444.210.

(e) Highways and Roads Law—Nevada Revised Statutes, Chapter 408.

(f) Fair Labor Standards Act of 1938 (52 Stat. 1060).

(g) Work Hours Act of 1962.

(h) Any and all legislation, rules, or regulations promulgated by the State of Nevada, or its agencies, covering any work performed by the Contractor.

(i) Fraudulent and Discriminatory Employment Practices—Nevada Revised Statutes, Chapter 613.

DIVISION II

CONSTRUCTION DETAILS

SECTION 201

CLEARING AND GRUBBING

DESCRIPTION

201.01.01 General This work shall consist of clearing, grubbing, removing, and disposing of all vegetation and debris within the limits of construction, except such objects as are designated to remain or be removed in accordance with other sections of these specifications. This work shall also include the preservation from injury or defacement of all vegetation and objects designated to remain.

CONSTRUCTION

201.03.01 General. The Engineer will establish clearing limits and designate all trees, shrubs, plants, and other things to remain. Areas to be cleared will be as set forth in subsection 201.03.02, "Areas to be Cleared." The Contractor shall preserve all things designated to remain. Paint required for cut or scarred surfaces of trees or shrubs selected for retention shall be an approved asphaltum base paint prepared especially for tree surgery.

201.03.02 Areas to be Cleared. Areas to be cleared shall be one or more of the following:

(a) The entire area upon which highway construction is to be performed to the width of the excavation and embankment slope lines, except where slopes are to be rounded, in which case the area shall extend to the outside limits of slope rounding, as detailed on standard drawing "Standard Slope Rounding and Warping."

(b) Flat bottom ditch and dike areas to the width of the slope lines.

(c) Areas on which service highway or ramps, streets, approaches, and all other accessory roads and connections are to be constructed, such areas to extend to the width of the excavation and embankment slope lines.

(d) Material sites and designated borrow pits.

(e) Areas designated in the plans or special provisions.

201.03.03 Clearing and Grubbing. All surface objects and all trees, stumps, roots, and other protruding obstructions, designated for removal, shall be cleared or grubbed or both. Unless otherwise specified, the Contractor may leave stumps and nonperishable solid objects provided they do not extend more than six (6) inches above the ground line or low water level, and are a minimum of three (3) feet below subgrade or embankment slope.

The Engineer may permit sound stumps to be cut off not more than six (6) inches above the ground and to be left outside of the construction limits of cut and embankment areas, except in the area to be rounded at the top of backslopes where stumps are to be cut off flush with or below the surface of the final slope line.

Where feasible, trees shall be felled toward the center of the area to be cleared. Where trees cannot be felled without danger to traffic or injury to other trees, structures, or property, they shall be cut in sections from the top down.

There shall be no open burning unless approval has been given in writing by the governing agencies and this approval concurred in by the Engineer. If perishable material is burned, it shall be burned under the constant care of competent watchmen at such times and in such a manner that anything designated to remain on the right of way, the surrounding forest cover, or other adjacent property will not be jeopardized. Burning shall be done in accordance with applicable laws, regulations and ordinances. Attention is directed to subsection 107.13, "Forest Protection."

When permitted by the Engineer, materials, debris and perishable materials may be removed from the right of way and disposed of at locations off the project outside the

limits of view from the project with the written permission of the property owner on whose property the materials and debris are placed. The Contractor shall make all necessary arrangements with property owners for obtaining suitable disposal locations and the cost involved shall be included in the unit price bid. Attention is directed to subsection 107.14, "Disposal of Material Outside Highway Right of Way."

Except in areas to be excavated, stump holes and other holes from which obstructions are removed shall be backfilled with suitable material and compacted in accordance with subsection 203.03.17, "Compaction, Dirt Embankment," or 203.03.18, "Compaction, Rock Embankment," if within the roadway prism. Payment for backfilling and compacting will be considered subsidiary to other items of the work and no further compensation will be made therefor.

All merchantable timber in the clearing area shall become the property of the Contractor unless otherwise provided. Timber and debris may be stored or decked within the right of way only in areas approved by the Engineer and must be removed prior to final acceptance of the project.

Low hanging branches and unsound or unsightly branches on trees or shrubs designated to remain shall be removed as directed. Branches of trees extending over the roadbed shall be trimmed to give a clear height of twenty (20) feet above the roadbed surface. All trimming shall be done by skilled workmen and in accordance with good tree surgery practices.

Scalping shall include the removal of material such as brush, roots, sod, grass, residue of agricultural crops, sawdust, and decayed vegetable matter from the surface of the ground.

Unless otherwise permitted by the Engineer, the Contractor shall scalp areas where excavation or embankment is to be made, except that mowed sod need not be removed where the embankment to be constructed is four (4) feet or more in height to subgrade elevation.

METHOD OF MEASUREMENT

201.04.01 Measurement. Measurement will be by one or more of the following alternate methods:

(a) Area Basis. The work to be paid for will be the number of acres and fractions thereof acceptably cleared or grubbed or both within the limits staked for clearing and grubbing by the Engineer. Unless otherwise specified, material sites, borrow pits, and areas not shown on the plans or not staked for clearing and grubbing will not be measured for payment.

(b) Lump Sum Basis. When the bid schedule contains a clearing and grubbing lump sum item, no measurement of area will be made.

(c) Linear Basis. When a linear unit quantity is shown on the bid schedule, the length will be measured along the construction centerline in stations or miles.

(d) Individual Unit Basis.

1. The diameter of trees will be measured at a height of twenty-four (24) inches above the ground. Trees less than six (6) inches in diameter will be classed as brush.
2. Stumps will be measured by individual count.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

201.05.01 Payment. The accepted quantities of clearing and grubbing measured as provided in subsection 201.04.01, "Measurement," will be paid for at the contract prices as follows:

(a) Area Basis. The quantities determined will be paid for at the contract unit price bid per acre respectively for each of the particular pay items listed that appear in the bid schedule.

(b) Lump Sum Basis. When the bid schedule contains a lump sum item the contract lump sum price bid will be paid and shall be full compensation for the work.

(c) Linear Basis. When linear quantities are shown in the bid schedule, the quantities will be paid at the contract unit price bid for this item.

(d) Individual Unit Basis. When individual unit quantities are shown on the bid schedule, the accepted quantities will be paid for at the contract unit price bid for the respective items.

Where trees are designated for removal on a unit "each" basis, payment therefor will be for their complete removal unless stumps are permitted to remain as set forth in subsection 201.03.03, "Clearing and Grubbing."

(e) Exclusion. When the bid schedule does not contain an estimated quantity or a lump sum item for clearing and grubbing, the work will not be paid for directly, but will be considered as a subsidiary obligation of the Contractor under other contract items.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Clearing and Grubbing	Acre, Stations, Miles, Lump Sum
Remove Trees	Each
Remove Stumps	Each

SECTION 202

REMOVAL OF STRUCTURES AND OBSTRUCTIONS

DESCRIPTION

202.01.01 General. This work shall consist of the removal, wholly or in part, and satisfactory disposal of all buildings, fences, guardrail, structures, old pavement, abandoned pipe lines, and any other obstructions which are not designated or permitted to remain, except for the obstructions to be removed and disposed of under other items in the contract. It shall also include the salvaging of designated materials and backfilling the resulting trenches, holes, and pits.

CONSTRUCTION

202.03.01 General. The Contractor shall raze, remove and dispose of all buildings and foundations, structures, guardrail, object markers and guide posts, fences, and other obstructions, any portions of which are on the right of way, except utilities and those for which other provisions have been made for removal. All designated salvable material shall be removed, without unnecessary damage, in sections or pieces which may be readily transported, and shall be stored by the Contractor at specified places within the project limits. Unusable perishable material shall be destroyed. Nonperishable material may be disposed of in accordance with subsection 107.14, "Disposal of Material Outside Highway Right of Way." Basements or cavities left by structure removal shall be filled to the level of the surrounding ground and, if within the prism of construction shall be compacted in accordance with subsections 203.03.17, "Compaction, Dirt Embankment," or 203.03.18, "Compaction, Rock Embankment."

202.03.02 Removal. Bridges, culverts, and other drainage structures in use by traffic shall not be removed

until satisfactory arrangements have been made to accommodate traffic.

All operations necessary for the removal of any existing structure which might endanger the new construction shall be completed prior to the construction of the new work. No equipment or devices shall be used which might damage structures, facilities, or properties which are to be preserved and retained.

Unless otherwise directed, the substructures of existing structures shall be removed down to the natural stream bottom and those parts outside of the stream shall be removed down one (1) foot below natural ground surface. Where such portions of existing structures lie wholly or in part within the limits for a new structure, they shall be removed as necessary to accommodate the construction of the proposed structure.

Blasting or other operations necessary for the removal of an existing structure or obstruction, which may damage new construction, shall be completed prior to placing the new work.

In removing concrete or bituminous pavement, curb, curb and gutter, sidewalk, and similar structures, where portions of the existing structures are to be left in the surface of the finished work, the structure shall be removed to an existing joint, or cut and chipped to a true line with a face perpendicular to the surface of the existing structure. Sufficient removal shall be made to provide for proper grades and connections in the new work.

In removing manholes, catch basins, and inlets, any live sewers connected to them shall be rebuilt and properly reconnected and a satisfactory bypass service shall be maintained during such construction operations. When abandoning manholes, catch basins, and inlets, they shall be thoroughly cleaned and existing pipe connections shall be plugged with concrete of the class and grade specified for structures. The portions of the structures shall then be removed to the required elevations.

202.03.03 Extensions. Where existing culverts and bridges are to be extended or otherwise incorporated in

the new work, only such part or parts of the existing structure shall be removed as is necessary to provide a proper connection to the new work. The connecting edges shall be cut, shaped, and trimmed to the required lines and grades without weakening or damaging the part of the structure to be retained. Reinforcing bars which are to be left in place so as to project into the new work as dowels or ties shall not be injured during removal of concrete.

202.03.04 Closing Culverts. Existing culverts within construction limits, the top of which are five (5) feet or more below finished roadway grade, shall be abandoned and closed unless otherwise noted on the plans. The headwalls of such culverts, or any part of the structure that is within three (3) feet of the finished grade line, shall be removed. The ends of the culvert shall be completely filled with satisfactory soil for a distance of at least two (2) feet, plus the height of the opening of the structure.

202.03.05 Salvage. When specified, gravel, roadmix, or plantmix surface suitable for reuse shall be removed to the depth required and surfacing so removed shall be carefully salvaged and placed in compact stockpiles at locations approved by the Engineer. Care shall be exercised to prevent contamination of stockpiled material. Any remaining unsuitable material shall be scarified and incorporated in embankment as set forth in Section 203, "Excavation and Embankment."

Fences and gates designated for reuse shall be removed in such a manner that so far as practicable all material can be salvaged. Wire shall be carefully removed from the posts and rolled in rolls of such size that can be conveniently handled. Posts shall be removed by methods that will keep breakage to a minimum.

Guardrail, object markers, and guide posts designated for reuse shall be removed in such a manner that so far as practicable all material can be salvaged. Bolts, supports, and other hardware shall be removed from all rails, plates, and posts and all parts shall be sorted and stored at the locations specified. Rail, plates, and posts shall be properly

stacked and miscellaneous hardware shall be stacked or boxed and reasonable care exercised in handling, storage, and preservation of materials as will insure the maximum salvage value for the entire operation. Attention is directed to Sections 618, "Guardrail," and 619, "Object Markers and Guide Posts."

When specified for salvage, structural steel removed from old structures shall be stored in a neat and presentable manner on blocking and at locations suitable for loading. Structures or portions thereof which are specified for re-erection shall be stored in separate piles.

When relay culvert pipe is required, the Contractor shall remove the pipe in such a manner as not to damage the material in any way. If no particular pipe is noted for relay, the Contractor shall salvage and clean sufficient amount of the better grade of pipe to satisfy the relay pipe item. Attention is directed to subsection 604.03.04, "Relay Culvert Pipe."

Timber or piling from all structures designated to be salvaged shall have all nails and bolts removed therefrom and shall be stored in neat piles at locations suitable for loading.

202.03.06 Disposing of Materials. Unless otherwise provided, excavated material shall be used in backfilling excavations made in removing the structure, in constructing embankment, or otherwise disposed of in a manner satisfactory to the Engineer.

When the construction of riprap and similar structures is included in the proposal, suitable broken concrete or masonry removed from old structures may be used in such construction. Any concrete or masonry which cannot be placed in backfills or embankments or used as riprap, shall be disposed of in such a manner as to prevent damage to property or the creation of unsightly conditions. The material shall not be placed where it will obstruct any drainage course.

When concrete or masonry is placed in embankments, it shall be placed in accordance with subsection 203.03.15, "Embankment Material."

Any material removed and not designated for salvage shall become the property of the Contractor and shall be removed from the project prior to completion thereof. Attention is directed to subsection 107.14, "Disposal of Material Outside Highway Right of Way."

METHOD OF MEASUREMENT

202.04.01 Measurement. When the contract stipulates that payment will be made for removal of structures and obstructions on a lump sum basis, the pay item will include removal of all structures and obstructions encountered within the right of way in accordance with the provisions of this section. Where the proposal stipulates that payment will be made for the removal of specific items on a unit basis, measurement will be made by the unit stipulated in the contract.

The length of pipe removed will be measured in linear feet, by measuring in place prior to removal.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

202.05.01 Payment. The accepted quantities of removal of structures and obstructions will be paid for at the contract lump sum price bid, which price shall be full compensation for removing and disposing of the obstructions in accordance with the contract, including excavation and subsequent backfill.

Specific obstruction items stipulated for removal and disposal under unit price pay items will be paid for at the contract unit price bid per unit specified in the proposal—which price shall be full compensation for removal and disposal of such items, excavation and subsequent backfill incidental to their removal. The price shall also include salvage of materials removed, their custody, preservation, storage on the right of way, and disposal as provided herein.

When the proposal does not include any pay item or an appropriate pay item for removal of any structure or

obstruction as set forth in this section, such work shall be performed and payment therefor will be considered as subsidiary to other items of work. No additional compensation will be allowed.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Removal of Structures and Obstructions	Lump Sum
Removal of	Each, Linear Feet, Stations, Miles, Square Yards

SECTION 203

EXCAVATION AND EMBANKMENT

DESCRIPTION

203.01.01 General. This work shall consist of grading and excavating the roadway, excavating borrow pits, removing slide material, and excavating ditches and stream channels and satisfactorily disposing of all excavated material and all work necessary for the construction and completion of cuts, embankments, slopes, ditches, dikes, stream channels, approaches, parking areas, intersecting driveways and highways, and subsidiary work. Exceptions are overhaul, slope rounding, or other separately designated pay items of work which are made a part of the contract. All work shall be in reasonably close conformity with the alignment, grades, and cross sections shown on the plans or established by the Engineer.

MATERIALS

203.02.01 Roadway Excavation. Roadway excavation shall consist of all excavation involved in grading and constructing the roadway and appurtenances, irrespective of the nature or type of material encountered; except excavation designated as structure excavation, drainage excavation, channel, and borrow excavation when these items are provided as items of work under the contract. Dividing the project into construction stages shall not be construed as separate material classification.

203.02.02 Drainage Excavation. Drainage excavation shall include all excavation in the construction of open ditches less than twelve (12) feet in bottom width, excepting ditches that are part of the roadway prism as shown in the plans. The nature or type of material encountered shall have no bearing on the classification of material.

203.02.03 Channel Excavation. Channel excavation shall include all excavation in the construction of open

ditches or stream changes with a bottom width of twelve (12) feet or more with the exception of ditches that are part of the roadway prism as shown in the plans. The nature or type of material encountered shall have no bearing on the classification of material.

203.02.04 Borrow. Borrow shall consist of approved material required for the construction of embankments or for other portions of the work, and shall be obtained from approved sources. The widening of roadway cuts shall be considered as roadway excavation and not as borrow, unless otherwise specified. Borrow excavation will not be classified according to type or character of material encountered in the borrow area unless otherwise required in the special provisions.

203.02.05 Selected Borrow. Selected borrow shall consist of approved material required for the construction of embankments within the required limits shown on the plans or directed by the Engineer, and shall be obtained from approved sources.

Selected borrow shall conform to the requirements set forth in the special provisions.

CONSTRUCTION

203.03.01 Roadway. All excavation shall be made true to lines and grades staked by the Engineer and shall be so conducted as to avoid removing or loosening any material outside the required slopes. If any material is so disturbed it shall be replaced and thoroughly compacted to the required cross section, unless such replacement is impractical as determined by the Engineer.

The work done under this section shall begin at some definite point or points on the project, and be carried forward in an approximately completed manner. The roadway shall be graded to full cross section width before placing base or surfacing of any type, unless otherwise specified.

Intersecting roads, service highways, ramps, approaches,

and driveways shall be graded as shown on the plans or established by the Engineer.

All suitable material removed from the excavation shall be used as far as practicable in the formation of embankments, subgrade, shoulders, slopes, dikes, and backfill for structures, unless otherwise indicated on the plans or disposed of in a manner satisfactory to the Engineer. Excavated material shall not be wasted without permission.

203.03.02 Unsuitable Material. Unsuitable material shall be defined as saturated or unsaturated mixtures of soils or organic matter not suitable for foundation material regardless of moisture content. Material that is unsuitable for planned use, including material below the natural ground surface in embankment areas, shall be excavated and disposed of in a manner approved by the Engineer or as specified in the contract documents.

When unsuitable material is removed and disposed of, the resulting space shall be filled with material suitable for the planned use. Such suitable material shall be placed and compacted in layers as hereinafter specified under embankment.

Disposal of material outside the right of way shall be in accordance with subsection 107.14, "Disposal of Material Outside Highway Right of Way."

203.03.03 Blasting. Any material outside the authorized cross section on the backslopes which may be shattered or loosened because of blasting shall be removed by the Contractor at his expense. Shattered or loosened material below the bottom limits of required excavation shall be uniformly distributed and compacted or otherwise disposed of in a manner satisfactory to the Engineer. The Contractor shall discontinue any method of blasting which leads to overshooting or is dangerous to the public or destructive to property or to natural features.

The use of coyote holes in blasting is prohibited.

Attention is directed to subsection 107.10, "Explosives."

203.03.04 Rock Cuts. In excavating side hill rock

cuts and rock cliffs, the Contractor shall exercise care and use precautionary methods so as not to break down, loosen, or otherwise damage supporting rock below the bottom limits of required excavation. In general, such cuts shall be worked from the top of lifts of such height that will not damage the bench of rock below the bottom limits of required excavation. The Contractor shall be responsible for the methods used, and for any damages to the roadbed resulting from his operations.

The slope of all rock cuts shall be scaled and dressed to a safe, stable condition by removing all loose spalls and rock not firmly keyed to the rock slope. Overhanging rock shall be removed when, in the opinion of the Engineer, it may be a hazard to public use of the roadway.

In solid rock excavation, slopes shall be constructed to the approximate neat lines staked by the Engineer. No rock shall project or overhang more than twelve (12) inches from the true slope.

203.03.05 Overbreak. Overbreak is that portion of material excavated, displaced or loosened outside and beyond the slopes or grade as staked or reestablished, regardless of whether any such overbreak is due to blasting, the inherent character of any formation encountered, or to any other cause. Slides and slipouts as defined in subsection 203.03.10, "Slides and Slipouts," and that portion of rock subgrade as hereinafter set forth, shall not be considered overbreak. All side slope overbreak as so defined shall be removed by the Contractor and shall be disposed of by the Contractor in the same manner as provided for the surplus under the heading of "Surplus Material," but at his own expense and without any allowance for overhaul.

Rock removed to a maximum depth of six (6) inches below subgrade will be measured for payment as described in subsection 203.04.01(b), "Overbreak."

203.03.06 Slopes. All excavation and embankment slopes, except in solid rock, shall be trimmed to the lines

staked by the Engineer. The degree of smoothness shall be that normally obtained by hand shovel operations.

203.03.07 Widening Cuts. If the Engineer directs the Contractor to excavate beyond the limits of the typical cross section originally proposed and within the limits of the right of way, the Contractor shall do so and compensation therefor will be as set forth in subsection 203.04.01(c), "Widening Cuts."

203.03.08 Surplus Material. Unless otherwise specified in the contract documents, surplus excavated material shall be used to widen embankments uniformly, or to flatten slopes, or at other locations, all in a manner satisfactory to the Engineer. No surplus material shall be disposed of above the grade of the adjacent roadbed nor shall the Contractor waste any material unless approved in writing by the Engineer.

If the quantity of surplus material is specified in the contract documents, such quantity shall be considered approximate only. The Contractor shall satisfy himself that there is sufficient material available for the completion of the embankments within the areas involved before disposing of any indicated surplus material inside or outside the right of way. Any shortage of material caused by premature disposal of the indicated surplus material by the Contractor shall be replaced by him and no compensation will be allowed the Contractor for such replacement.

203.03.09 Selected Material. When specified in the contract documents, or when selected by the Engineer, suitable selected material encountered in excavating or widening the roadway prism or any other excavation within the highway right of way, or in the excavation or borrow, shall be used for finishing the top portion of the subgrade.

Selected material shall be defined as material which is excavated from one or more of the above sources and which is used for selective purposes.

When practicable, selected material shall be hauled

directly from excavation to its final position on the roadbed and compacted in place, and such work shall be paid for at the contract unit price for the excavation item involved and overhaul if applicable, as set forth elsewhere in these specifications, and no additional compensation will be made. Attention is directed to subsection 104.05, "Rights in and Use of Materials Found on the Work."

When the transporting of selected material directly from excavation to its final position on the roadway is impractical, the selected material shall be left in place until it can be placed in final position and no additional compensation will be made because of the delayed excavation. If, however, the conditions are such that the undisturbed selected material will hamper ordinary grading operations or cause unnecessary movements of equipment, the Engineer may order in writing the removal of sufficient selected materials and the stockpiling thereof to enable practical hauling operations. If the excavation and stockpiling of selected material is specified in the contract documents or is ordered by the Engineer the excavation shall be from, and the stockpiling at, locations designated by the Engineer. The selected material shall be removed from the stockpile and placed in final position on the roadbed when approved by the Engineer.

Measurement for payment of selected material stockpiled as above provided will be in accordance with subsection 203.04.01(d), "Selected Material."

203.03.10 Slides and Slipouts. Material outside the planned roadway or ditch slopes which is unstable and constitutes potential slides in the opinion of the Engineer, material from slides which has come into the roadway or ditch, and material which has slipped out of new or old embankments shall be excavated and removed. The material shall be excavated to designated lines or slopes either by benching or in such matter as approved by the Engineer. Such material shall be used in the construction of the embankments or disposed of as approved by the Engineer.

The above provisions shall not be so construed as to relieve the Contractor from the duty of maintaining all slopes true and smooth. Erosion, regardless of amount or extent, caused by the action of the elements which results in damage to work or materials, shall in no case be considered a slide or slipout. Measurement for payment will be in accordance with subsection 203.04.01(f), "Slides and Slipouts."

203.03.11 Drainage. During construction of the roadway, the roadbed shall be maintained in such condition that it will be well drained at all times.

V-type ditches shall be formed to the cross section and dimensions on the plans by means of suitable equipment which will deposit all loose material on the downhill side so that the bottom of the finished ditches shall not be less than two (2) feet six (6) inches below the crest of the loose material piled on the downhill side.

In going from cut to fill, the roadway ditches shall be cut to the right or left before reaching the fill so as to avoid damage to embankments by erosion.

The flat-bottom ditches indicated on the plans, or staked by the Engineer, shall be excavated to the required cross section and grade. Materials so obtained shall be used to construct roadway embankments or dikes or both to form a continuous diversion channel as staked by the Engineer.

203.03.12 Channels. To avoid destruction of natural growth during construction of ditches, channels, or dikes, travel of equipment shall be confined to the construction limits as nearly as practicable. Where ditches, channels or dikes are nearly parallel to the roadway, turn-arounds shall not be located closer than two hundred (200) feet apart. Attention is directed to subsection 107.12, "Protection and Restoration of Property and Landscape."

Fine grading of channel bottoms will not be required unless paving is specified.

203.03.13 Borrow. A possible source of borrow material may be indicated in the contract documents. If

the Contractor desires to use borrow materials from sources other than those described in the contract documents, he shall, at his own expense, acquire the necessary right to take materials and pay all costs involved. All costs of exploring such alternate sources shall be borne by the Contractor. Use of material from these sources will not be permitted until approved in writing by the Engineer.

The successful bidder shall, at the time of execution of the contract, execute an "Agreement" for all borrow deposits obtained under an "Option and Agreement for Sale of Materials" when said "Option" is contained in the special provisions. This agreement shall be executed whether the material is to be used or not.

In case designated borrow deposits fail to contain the necessary quantity of acceptable material, the Contractor shall immediately notify the Engineer in writing. The Engineer shall thereupon investigate, and if his investigation shows that there is not a sufficient quantity of acceptable material, he shall designate an alternate deposit in which to obtain the deficit.

Overhaul on borrow will be measured for payment in accordance with subsection 203.04.01(g), "Overhaul," and Section 205, "Overhaul."

In all borrow pits having undesirable material, including overburden, refuse, organic and deleterious substances, the material shall be removed and wasted or redistributed, in a manner satisfactory to the Engineer. All costs incurred therefor shall be considered as incidental and subsidiary to the borrow and no further compensation will be made for undesirable materials removed.

Borrow shall not be obtained until all other excavation items are complete to the extent necessary to determine the need for borrow.

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 materials can be tested before being used. Sufficient time for testing the borrow shall be allowed.

Borrow deposits shall be excavated to regular lines as staked to permit accurate measurement. The dimensions of the borrow deposit will be designated and the Contractor shall not excavate below the depth or outside limits given except with prior approval. The depth of excavation throughout the area of the borrow pits shall be as uniform as practicable and the side slopes shall conform to the requirements of subsection 104.06, "Final Clean Up." Unless otherwise permitted, borrow pits shall be excavated so that they will drain to the nearest natural outlet.

All materials which are not satisfactory for use for the purposes intended shall be rejected at the pit and disposed of in a manner satisfactory to the Engineer.

If the Contractor excavates more material than is required, the excess will not be measured for payment.

All work and materials required to build and maintain borrow haul roads and obliteration of haul roads in accordance with subsection 104.06, "Final Clean Up," shall be considered subsidiary to the "borrow" item and no further compensation will be allowed therefor.

203.03.14 Foundation. When embankment is to be placed and compacted on hillsides, or when new embankment is to be compacted against existing embankments, or when embankment is to be built one half width at a time, the slopes that are steeper than four to one (4:1) when measured at right angles to the roadway shall be continuously benched as the work is brought up in layers. Benching shall be of sufficient width to permit operations of placing and compacting equipment. Each horizontal cut shall begin at the intersection of the original ground and the vertical sides of the previous cuts. Material thus cut out shall be recompacted along with the new embankment material at the Contractor's expense, unless the width of excavation required by the Engineer exceeds six (6) feet, in which case the excavated material in excess of six (6) feet will be measured and paid for as roadway excavation.

All foundations for embankment shall be cleared and

grubbed in accordance with Section 201, "Clearing and Grubbing."

In designated areas, unsuitable material shall be removed and disposed of as prescribed in subsection 203.03.02, "Unsuitable Material."

Where twelve (12) inches or less of embankment is placed over existing bituminous surface, such surface shall be removed and incorporated in the embankment or otherwise disposed of as approved by the Engineer. Where more than twelve (12) inches of embankment is placed over existing bituminous surface, such surface shall be left undisturbed. Measurement for removal of existing bituminous material will be as prescribed in subsection 203.04.01, "Measurement," and paid for as roadway excavation unless the contract documents specifically call for payment under Section 202, "Removal of Structures and Obstructions."

203.03.15 Embankment Material. Embankments shall be constructed with suitable materials, excavated as prescribed and with any excess materials from other operations which are acceptable and suitable for use.

All materials used in embankments shall be free from objectionable material such as leaves, grass, roots, logs, stumps, brush, or other perishable material.

When there is a choice of material and when practicable, the excavation shall be made so the best material will be placed on top of the embankment for at least one (1) foot in depth. This paragraph shall not be interpreted as to require the Contractor to stockpile and subsequently rehandle embankment materials except as provided in subsection 203.03.09, "Selected Material."

Material shall not be placed in the embankment when either the material, foundation or the embankment on which it would be placed is frozen.

Where embankments are to be made of material from rock cuts or other material which is unsuitable for finishing the roadbed, the upper six (6) inches of the roadbed shall be formed of approved material.

203.03.16 Placing Embankment. For embankment

or backfill deposited against structures, attention is directed to subsection 207.03.02, "Placing and Compacting at Abutments, Piers, Wingwalls, and Retaining Walls."

Where structure abutments are placed on embankment, the embankment shall be constructed to subgrade elevation prior to excavating for the construction of the abutment. Structure excavation shall be measured for payment as set forth in subsection 206.04.01, "Measurement." Where the abutment is supported on piles, the embankment shall be constructed to the elevation of the bottom of the footing.

Where structures are located under a rock embankment, they shall be covered with not less than two (2) feet of satisfactory soil or granular materials before the embankment is placed over the structure.

Embankments shall, except as hereinafter specified, be constructed in layers. The construction of an embankment shall begin at the lowest point of the fill below the grade and the bottom of ravines. Individual layers shall be spread evenly to uniform thickness throughout and parallel with the finished grade for the full width of the embankment, unless otherwise permitted. The thickness of the layer shall be as necessary to secure the required compaction with an eight (8) inch maximum thickness before compaction. Excepted provisions are hereinafter outlined for placing in marsh and placement of rock.

When embankments are constructed across wet or swampy ground which will not support the weight of heavy hauling and spreading equipment, the Contractor will be expected to choose such methods of embankment construction and to use such hauling and spreading equipment as will least disturb the soft foundation. When soft foundations are encountered, and when approved by the Engineer, the lower part of the fill may be constructed by dumping and spreading successive vehicle loads in a uniformly distributed layer of a thickness not greater than that necessary to support the vehicle while placing subsequent layers, after which the remainder of the embankment shall be constructed in layers and compacted as specified.

It is not the policy of the Department to allow an increase in the planned depth of embankment material over soft, wet, or swampy ground for the sole purpose of providing support for heavy hauling and spreading equipment, unless the Contractor proves to the satisfaction of the Engineer that the planned depth is inadequate to support light hauling vehicles. If it proves necessary for the Contractor to use smaller hauling vehicles or different methods of embankment construction than he had originally contemplated in order to comply with the foregoing, such shall not be the basis for a claim for extra compensation against the Department; the unit contract price for the various pay items involved shall be full compensation for all labor, materials and equipment necessary to perform the work as outlined herein.

Embankment which, in the opinion of the Engineer, contains a sufficient quantity of rock larger than four (4) inches in size shall be considered as "Rock Embankment." The materials shall be spread in a uniform horizontal layer over the full width of the embankment. The layer thickness shall not exceed one and one-third (1⅓) times the vertical dimension of maximum size material larger than eight (8) inches. The largest size rock allowed in the embankment will be three (3) feet measured in vertical direction and rocks larger than this shall be broken up before being placed in the embankment. Rock to be wasted may exceed three (3) feet and be disposed of in an inconspicuous manner approved by the Engineer.

In rock fills where end dumping is employed, direct end dumping upon the previously constructed layer of embankment will not be permitted. Rock shall be dumped on the layer of embankment being constructed and dozed ahead into place. Care shall be exercised as much as practicable to work the fines and smaller rock into the spaces between the larger rock. Compaction will be required as provided in subsection 203.03.18, "Compaction, Rock Embankment."

To the extent of project requirements for embankment, all rock from excavation shall be used for embankment. The Contractor shall plan his grading operation to use

rock which may be encountered in excavation in accordance with the following provisions:

Rock, in general, shall be placed so as to form the base of embankment for the full width of the cross section; on the side slopes or slopes of a new embankment being placed; on the side slopes or slopes of an embankment already in place requiring widening or where excess rock may be wasted; or on the side slopes and top of rolled embankment made of embankment materials other than rock.

The Contractor shall not place large rock in embankments where piles will be driven. The Contractor shall be responsible for penetrating the embankment with specified piles.

When rock and other embankment materials are excavated at approximately the same time, the rock shall be distributed throughout the fill and not nested in one location.

When there is insufficient material other than rock in the excavation to permit properly compacted layers, the rock shall be placed for the full cross section width with the larger rocks well distributed and the void spaces filled with the smaller rocks and fragments.

When shown on the plans or considered necessary by the Engineer, embankments shall be built to such elevation above required grade to allow for settlement, or sufficient surcharge shall be placed above the required elevation of earth grade over deposits of unstable material to secure displacement or settlement. Surcharge shall be removed only after the fill has reached stability or the required settlement.

203.03.17 Compaction, Dirt Embankment. Optimum moisture content of the various soils will be determined by the Engineer. At the time of compaction, the moisture content of the various soils shall be within the following ranges:

Optimum Moisture Content	Tolerances
0 –20%	+2% to —4%
20%–30%	+2% to —5%
31% or more	+3% to —6%

When necessary, each layer, before being compacted, shall be processed as required in order to bring its moisture content within the prescribed limits. The material shall be wetted by the application of water or dried as necessary and either process may be carried out either on the embankment or at the source of the material or otherwise as approved by the Engineer. Full compensation for any work involved in wetting or drying embankment material to obtain the required moisture content shall be considered as included in the contract unit price bid for excavating or furnishing the material and no additional compensation will be allowed therefor.

Hauling and leveling equipment shall be routed and distributed full width over each layer of the fill in such a manner as to uniformly distribute the compaction afforded thereby. In addition to hauling and leveling equipment, the Contractor shall provide compaction equipment that is specifically designed and manufactured for the purpose of compacting dirt embankments. Said compaction equipment shall work continuously with the grading equipment.

The base of cuts, natural ground having less than five (5) feet of embankment, measured from the subgrade, and embankment material, shall be compacted to not less than ninety (90) percent of the maximum density as determined by Test Method No. Nev. T101. Test Method No. Nev. T102 or No. Nev. T103 may be used to determine the in-place density. Test method to be determined by the Engineer. When natural ground material is encountered that cannot be compacted to the required density, compaction requirements shall be determined by the Engineer.

All selected borrow and structure backfill placed within the limits of embankments shown on the plans for approaches to bridges shall be compacted to not less than ninety-five (95) percent of the maximum density as determined by Test Method No. Nev. T101. Test Method No. Nev. T102 or No. Nev. T103 may be used to determine the in-place density. Test method to be determined by the Engineer.

It is to be expected that a loss of density in the upper portion of earth subgrade may occur due to the elements,

or for lapse of time, or for other reasons. Recompaction to the specified density will be required prior to placement of any subsequent course and no additional compensation will be allowed therefor.

203.03.18 Compaction, Rock Embankment. Field density tests will not be required on rock embankment. In lieu thereof, the required compaction shall be tested by proof rolling. In this case, compaction shall be attained and tested by using construction methods and equipment as follows:

(a) Methods. The material for the embankment shall be deposited, spread and leveled the full width of the embankment, and in layers not exceeding eight (8) inches in thickness before compaction, except large rock fills in which the layer thickness may be one and one-third (1⅓) times the vertical dimension of maximum size material. The maximum layer thickness shall not exceed four (4) feet.

Hauling and leveling equipment shall be routed and distributed over each layer of the fill in such a manner as to make use of the compaction afforded thereby. In addition, one of the rollers, vibrators, or compactors meeting the requirements set forth under (b) "Equipment" below, shall compact the embankment full width with a minimum of three (3) complete passes for each layer of embankment. The compacting equipment shall not exceed a speed of five (5) miles per hour and shall work continuously with the grading equipment.

Rolling shall be done in a longitudinal direction along the embankment and shall generally begin at the outer edges and progress toward the center. The travel paths of traffic and construction equipment shall be kept dispersed over the entire width of the embankment so as to aid in obtaining uniform compaction. Weights of equipment used in making embankments over soil having an excessive moisture content may be limited, if, in the judgment of the Engineer, such limitations are necessary in order to maintain the fill in a satisfactory condition.

Water shall be applied to the embankment in the amount necessary to obtain the required compaction.

(b) Equipment. Compaction equipment shall be adequately designed to obtain compaction requirements without adverse shoving, rutting, displacement, or loosening and shall meet the requirements hereinafter specified. Rollers shall have displayed thereon in permanent legible characters, the manufacturer's guaranteed net operating weights as distributed on each axle.

Sheepsfoot or tamping rollers shall consist of metal drums or shells, not less than four (4) feet in diameter, equipped with self-cleaning tamping feet projecting at least seven (7) inches from the face of the drum or shell. The cross sectional area of the face of each tamping foot shall be not less than four (4) nor more than twelve (12) square inches. The feet shall be uniformly spaced on the roller. The weight and dimensions of the roller, the number, spacing, and dimensions of the tamping feet and the provisions for adding ballast, shall be such that the total load on a single row of the tamping feet in the contract with a level surface can be made as great as two hundred (200) pounds per inch of length of roller drum. The weight shall be adjusted to that which will produce the specified density with the least number of passes. Tamping rollers shall make at least three (3) complete coverages of the material being compacted and rolling shall continue until the tamping feet "build up" or "walk out" of the surface.

Grid rollers shall consist of at least two similar metal drums; not less than five (5) feet in diameter, whose cylindrical faces present the appearance of an open woven bar mesh. The drums shall be at least two and one-half (2½) feet long and they shall be independently mounted close together on the same axle. The complete roller, when operating without ballast, shall weigh not over six (6) tons or two hundred (200) pounds per inch of length of roller drum. Arrangements shall be provided for adding ballast, to such an extent that the total weight of the unit can be increased to at least fifteen (15) tons and four hundred fifty (450) pounds per inch of length of roller drum.

Pneumatic tired rollers shall be of an approved, self-propelled, reversible type and shall have not less than seven (7) wheels mounting pneumatic tires of equal size which may be either treaded or smooth faced, but which shall all be alike. Wheels shall be equally spaced along both axle lines so that their center to center distance is not greater than one and seven-eighths (1⅞) times the nominal tire width and they shall be arranged so that those on one axle track midway between those on the other. Tires shall be capable of operating at inflation pressures up to one hundred twenty (120) pounds per square inch. They shall be kept uniformly inflated at whatever operating pressure is specified so that the difference between the pressure in any two tires shall never exceed five (5) pounds per square inch. The Contractor shall provide means for checking the tire pressure on the job at any time. For each size and type of tire used, the Contractor shall furnish the Engineer a copy of the tire manufacturer's chart showing the internal volume of the tire as well as the relationship between wheel load, inflation pressure and tire contact width and area. The roller shall be equipped with a means of adjusting its total weight by ballasting so that the load per wheel can be varied from three thousand five hundred (3,500) to eight thousand (8,000) pounds. The Contractor shall furnish the Engineer a copy of the roller manufacturer's calibration chart for the ballast box showing the empty or tare weight of the roller. In operating, the tire inflation pressure and the wheel loads shall be adjusted, as required to meet the requirements of each particular application and of the material being rolled. On the axle having an even number of wheels, the wheels shall be arranged to oscillate in pairs or they may be individually sprung. The roller shall be equipped with dual operating controls, power steering and some type of fluid drive or torque converter.

Pneumatic tired rollers meeting the requirements of the proof roller may be used in lieu of those specified above.

Pneumatic tired compactors shall have not less than four (4) wheels abreast on the line of the main axle. The

compactor shall be so articulated or shall have pairs of wheels mounted on oscillating axles in such a manner as to insure that a constant and uniform load is carried by each wheel. Wheels shall be uniformly spaced along axle lines so that their center to center distance is not greater than one and three-fourths (1¾) times the nominal tire width. If there is more than one line of axles, then the wheels on each line shall be spaced the same distance apart and shall be so aligned that the wheels on one axle will track midway between those on the other. All tires shall be of equal size and diameter and shall be capable of operating at an air pressure of at least ninety (90) pounds per square inch. They shall be kept uniformly inflated so that the difference in the pressure in any two tires shall never exceed five (5) pounds per square inch and means shall be provided for checking the tire pressure on the job at any time. For each size and type of tire used, the Contractor shall furnish the Engineer a copy of the tire manufacturer's chart showing the internal volume of the tire as well as the relationship between wheel load, tire inflation pressure and tire contact width and area. When operating light, no wheel on any axle shall carry a load of more than five thousand (5,000) pounds. Means shall be provided for adding sufficient ballast so that each wheel may be loaded to at least twenty-five thousand (25,-000) pounds. In addition, the compactor shall be capable of applying to the ground, loads as great as fifty (50) tons and twelve hundred (1,200) pounds per linear inch on nominal tire width, measured along an axle line. The weight of the compactor and the air pressure in the tire shall be adjusted to that which will produce the specified density with the least number of passes without exceeding the shear value of the soil. The Contractor shall furnish the Engineer with a copy of the roller manufacturer's calibration chart for the ballast box showing the volume of the box, in cubic feet, for at least three (3) inch increment of depth and also showing the empty or tare weight of the roller. Compactors shall make at least two (2) complete coverages of each layer of material being compacted or at least four (4) coverages in the cases of compactors having

only a single line of axles. The compactor, together with its towing unit, if any, shall be capable of making a one hundred eighty (180) degree turn in a width of not over thirty (30) feet.

Vibratory compactors shall not be used until approved by the Engineer.

The proof roller shall be a pneumatic tired roller or pneumatic tired compactor weighing not less than fifty (50) tons and capable of applying to the ground loads of not less than twenty-five thousand (25,000) pounds per wheel. All tires shall be of equal size and diameter and shall be capable of operating at an air pressure of at least ninety (90) pounds per square inch. They shall be kept uniformly inflated so that the difference in the pressures in any two tires shall never exceed five (5) pounds per square inch and means shall be provided by the Contractor for checking the tire pressure on the job at any time.

(c) Tests. Subsequent layers shall not be placed until the previous layer of the embankment is compacted to the degree that no further appreciable deflection is evidenced under the action of proof rolling equipment, as determined by the Engineer.

Rolling and proof rolling may be deleted on any layer or portion thereof when, in the judgment of the Engineer, accomplishment is physically impractical.

Payment for rolling and proof rolling or for the correction of any subgrade weakness or deficiencies disclosed by the proof rolling operation shall be considered subsidiary to the price bid for the "Excavation" item.

203.03.19 Maintenance. Embankment material which may be lost or displaced as a result of natural settlement of the ground or foundation upon which the embankment is constructed shall be replaced by the Contractor with acceptable material from excavation or borrow, etc. The quantity of material required will be paid for at the regular contract price for the type of materials used, also overhaul, if applicable, and no additional compensation will be allowed therefor.

The Contractor shall, at his expense, remove and replace

with acceptable material, any embankment or portion thereof which has been constructed with unapproved material as well as remove and replace portions of the embankment which may become unstable or displaced as the result of carelessness or negligence on his part.

METHOD OF MEASUREMENT

203.04.01 Measurement. Unless otherwise specified, excavation will be measured on a volume basis by cross sectioning the area to be excavated and computing neat lines for an end area. The average end area method will be used with no allowance made for curvature. If for any reason it is impossible or impractical to measure quantities by average end areas, the Engineer will compute the quantities by a method which, in his opinion, is best suited to obtain an accurate determination.

The quantity of excavation to be measured for payment will be the number of cubic yards excavated and placed as required. The estimated quantities shown on the plans, plus or minus authorized quantity changes, will be the quantity used for payment. The State or the Contractor may, however, request a final measurement in which case final cross sections will be taken. When final cross sections are taken the determination of quantities derived therefrom will be the quantities used for payment. Furthermore, when the Contractor requests final measurement and the quantities thus determined are less than the planned quantities plus authorized changes, the Contractor shall reimburse the State for the State's expenses incurred by such final measurement.

When changes are made during construction such as widening cuts, changing grades, disposing of unsuitable material, stockpiling selected material, and other changes resulting in increases or decreases in quantities, then additional measurements for payment will be made by the Engineer as hereinafter outlined:

(a) Unsuitable Material. When the removal and disposal of unsuitable material is shown in the contract documents, such material will be measured for payment as excavation for the related item.

Removal and disposal of unsuitable material, not shown on the plans, will be measured and paid for as "Roadway Excavation" and "Overhaul." However, if removal and disposal of unsuitable material not shown on the plans requires special equipment or unusual operations, it may be paid for as extra work according to the provisions of subsection 104.03, "Extra Work."

No measurement will be made of suitable material temporarily removed and replaced to facilitate compaction of material.

(b) Overbreak. All sideslope overbreak as defined in subsection 203.03.05, "Overbreak," shall not be paid for.

Rock removed to a maximum depth of six (6) inches below subgrade will be measured for payment provided the rock has been removed sufficiently to permit accurate cross sectioning. Replacement to this depth shall be with material designated on the plans or approved by the Engineer and will be measured and paid for at the contract unit price for the material used.

Rock loosened or removed in excess of six (6) inches below subgrade will not be measured or paid for. When ordered by the Engineer, the loosened material will be removed and the resultant space refilled with approved material at the expense of the Contractor.

(c) Widening Cuts. If the Engineer directs the Contractor to excavate beyond the limits of the typical cross section and before the excavation is substantially completed, the material shall be classified as "Roadway Excavation" and shall be paid for at the contract bid price. However, if widening cuts requires special equipment, or unusual and extra expense, it may be paid for as extra work according to the provisions of subsection 104.03, "Extra Work."

(d) Selected Material. Selected material stockpiled as provided in subsection 203.03.09, "Selected Material," will be measured for payment as roadway excavation both in its original position and also from the stockpile. Measurement of the material taken from stockpile will be made of the volume actually removed.

(e) Surplus Material. Surplus excavated material will

be measured for payment as roadway excavation and no further compensation will be allowed by virtue of the method of disposing, placing, or widening embankments caused from such surplus material. Any additional "Overhaul" resulting from the disposal of surplus material beyond the designated balance will be measured for payment.

(f) Slides and Slipouts. In the event of slides and slipouts, the Engineer and Contractor shall negotiate in each case and decide the relative difficulty of performing the work, and payment will be made either as "Roadway Excavation" or as "Extra Work" as provided in subsection 104.03, "Extra Work."

Where slopes have been previously completed by the Contractor, the cost of resloping required in areas where unstable material is removed will be paid for as extra work as provided in subsection 104.03, "Extra Work."

The cost of pioneering work necessary to make slide or slipout areas accessible to normal excavation equipment and the cost of necessary clearing and grubbing will be paid for as extra work as provided in subsection 104.03, "Extra Work."

Only those quantities of slide or slipout material which are authorized and actually removed will be measured for payment.

(g) Overhaul. Overhaul, where applicable, will be paid for on the above items of excavations. Overhaul on borrow material from sources furnished by the Contractor will be paid for according to the actual amount of overhaul from the sources from which the borrow is taken, provided, however, that no allowance will be made for overhaul from such sources in excess of overhaul distance computed from the sources designated. Attention is directed to Section 205, "Overhaul."

Excavation in excess of the staked or authorized cross section will not be measured for payment, except as outlined above.

Material used for surcharge, whether shown on the plans or called for by the Engineer, will be measured for payment as roadway excavation both in its original position and also from the surcharge position.

Earthwork quantities within the limits of "Slope Rounding" will not be measured for payment.

V-type ditches will be measured parallel to the ground and each one hundred (100) linear feet shall constitute a unit of measure. The volume of excavation for such ditches will not be measured for payment.

The quantity of selected borrow or selected borrow excavation to be measured for payment will be the number of cubic yards or tons measured as set forth in the special provisions.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

203.05.01 Payment. The accepted quantities of excavation measured as specified in subsection 203.04.01, "Measurement," will be paid for at the contract unit price bid for each of the pay items listed in the bid schedule. Such price shall include excavating, loading, hauling (except overhaul), depositing, spreading, compacting, and maintaining the material complete and in place. Watering will be paid for in accordance with Section 210, "Watering."

The accepted quantities of selected borrow or selected borrow excavation will be paid for at the contract unit price bid per cubic yard or ton for "Selected Borrow" or "Selected Borrow Excavation" which price shall be full compensation for furnishing all materials, loading, hauling, depositing, spreading, watering, compacting and maintaining the material complete and in place.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Roadway Excavation	Cubic Yard
Drainage Excavation	Cubic Yard
Channel Excavation	Cubic Yard
Borrow Excavation	Cubic Yard
V-type Ditches	Stations
Selected Borrow	Cubic Yard or Ton
Selected Borrow Excavation	Cubic Yard or Ton

SECTION 204

ROUNDED AND TRANSITION SLOPES

DESCRIPTION

204.01.01 General. This work shall consist of rounding and shaping slopes in accordance with the plans and where designated by the Engineer.

CONSTRUCTION

204.03.01 General. The top of cut slopes shall be rounded by excavating to blend the cut slopes with the adjacent natural terrain. At the intersection of cuts and fills, slopes shall be adjusted and warped to blend into each other or into the natural ground surface without noticeable break.

Slopes will be staked for flattening and rounding in places where the material is other than solid rock. Rock formations such as shales, decomposed sandstone and granite that can be readily excavated by means of hand tools, shall have the slopes flattened and rounded the same as earth slopes. A layer of earth overlying a rock cut shall be rounded above the rock the same as earth slopes. Where the depth of cut is insufficient to provide the full rounding required, the distance for rounding shall be proportionately adjusted.

Slope rounding and warping shall also apply to all drainage ditches when such rounding will improve the appearance of the roadside.

Whenever the treatment of the slopes may destroy or injure standing timber, trees or other vegetation which should be preserved, adjustments in slope grading will be made. These adjustments shall be effected by a gradual transition from the theoretical grading section required.

The degree of smoothness required in rounding and warping slopes shall be as specified in subsection 203.-03.06, "Slopes."

METHOD OF MEASUREMENT

204.04.01 Measurement. The quantity of rounded cut slopes or roadway ditch slopes to be paid for shall be measured in linear feet of slopes, treated as specified, measured along the roadway ditch each side of the roadway centerline. The quantity of rounded embankment slopes to be paid for shall be measured in linear feet, treated as specified, measured along the centerline of the embankment to be rounded, and each side shall be considered separately. In all cases, each one hundred (100) feet shall constitute the unit of one station. Earthwork quantities within the limits of "Slope Rounding" will not be measured for payment.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

204.05.01 Payment. The accepted quantity of slope rounding measured as specified in subsection 204.04.01, "Measurement," will be paid for at the contract unit price bid per station of the completed work.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Slope Rounding	Stations

SECTION 205

OVERHAUL

DESCRIPTION

205.01.01 General. This work shall consist of authorized hauling of roadway excavation, channel excavation, and borrow in excess of the free-haul distance.

Free-haul distance is the specified distance that excavated material shall be hauled without additional compensation. Unless otherwise provided in the contract documents, the free-haul distance shall be two thousand (2,000) feet.

METHOD OF MEASUREMENT

205.04.01 Measurement. The limit of free haul shall be determined from a mass diagram by fixing on the volume curve, two points, one on each side of the neutral grade point, one in excavation and the other in embankment, such that the distance between them equals the free-haul distance, and the included quantity of excavation and embankment are in balance. All materials within the free-haul limit shall be eliminated from further consideration. The distance between the center of gravity of the remaining mass of excavation and the remaining mass of embankment minus the free-haul distance shall be the overhaul distance. The quantity of overhaul shall be the product of the overhaul distance measured in miles multiplied by the number of cubic yards of material hauled in excess of the free-haul distance. Analytical methods may be used for computing overhaul in lieu of the mass diagram method described herein.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

205.05.01 Payment. The accepted quantities of overhaul measured as specified in subsection 205.04.01,

"Measurement," will be paid for at the contract unit price bid per yard mile of the completed work.

When overhaul does not appear as an item in the proposal, the contract unit price bid per cubic yard for roadway excavation, borrow excavation, and channel excavation shall be considered as including payment for overhaul.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Overhaul	Yard Mile

SECTION 206

STRUCTURE EXCAVATION

DESCRIPTION

206.01.01 General. This work shall consist of the removal of all material of whatever nature encountered for the construction of foundations for bridges, retaining walls, headwalls for culverts and other structures; the excavation of trenches for pipe and box culverts, cutoff walls for slope paving and concrete aprons, footings for riprap and other excavation specifically designated on the plans, in these specifications or in the special provisions as structure excavation, including the work of disposing of surplus material and cleaning up the sites. Structure excavation shall include dewatering and the furnishing of all equipment and the construction or installation of all cofferdams, cribs, and other facilities which may be necessary to perform the excavations and the subsequent removal of such facilities except where they are required or permitted by the plans or specifications to remain in place. It shall also include all the necessary clearing and grubbing within the proposed structure area and removing old structures or parts thereof as required if the proposal does not include separate bid items for such work.

For specific requirements pertaining to the excavation involved in the installation of pipe culverts and underground piping, attention is directed to those sections of these specifications governing such work.

206.01.02 Classification. Classification of structure excavation will not be made on the basis of materials or conditions encountered. Classification of excavation, if made, will be on the basis of the material removed between certain elevations, and such classification as shown on the plans or set forth in the special provisions shall not be changed regardless of the material encountered.

CONSTRUCTION

206.03.01 General. The Contractor shall notify the Engineer a sufficient time in advance of the beginning of excavation for structures so that elevations and measurements may be taken of the existing ground before it is disturbed and of existing substructure units within the limits of excavation for structures before they are removed. Any material excavated or removed before these measurements have been taken will not be paid for.

The excavated area shall conform to the outlines of the footings, as shown on the plans, and shall be of sufficient size to permit placing of the full width and length of the footings shown. The elevation of the bottoms of footings as shown on the plans shall be considered as approximate only, and the Engineer may order, in writing, such changes in dimensions or elevation of footings as may be necessary to secure a satisfactory foundation.

Unless otherwise permitted by the Engineer, foundations for culvert pipe and structures shall be compacted to not less than ninety (90) percent of the maximum density as determined by Test Method No. Nev. T101. Test Method No. Nev. T102 or No. Nev. T103 may be used to determine the in-place density. Test method to be determined by the Engineer.

All rock or other hard foundation material shall be freed from all loose material, cleaned and cut to a firm surface, either level, stepped or serrated, as may be permitted by the Engineer. All seams and crevices shall be cleaned out and filled with concrete mortar or grout.

Where masonry is to rest on material other than rock or boulders, special care must be given not to destroy its bearing value.

Should the Contractor remove foundation excavation below grade, he shall backfill to the required elevation at his own expense with backfill or with foundation fill in a manner satisfactory to the Engineer.

Wet pits shall be unwatered for inspection and for construction of foundations unless otherwise provided.

Excavated material which is suitable for backfilling shall be so utilized or used in embankments, in a manner satisfactory to the Engineer. Surplus or unsuitable material shall be disposed of so as to cause no obstruction to flow of streams; or otherwise impair the efficiency or appearance of the structure. It shall be disposed of in such manner as to prevent damage to property or the creation of unsightly conditions, and shall not be placed where it will interfere with the operation of drains or impair the roadway ditches, etc.

206.03.02 Inspection. After each excavation is completed, the Contractor shall notify the Engineer, and no masonry shall be placed until the Engineer has approved the depth of excavation and the character of the foundation material.

METHOD OF MEASUREMENT

206.04.01 Measurement. The quantity of structure excavation measured for payment will be the number of cubic yards calculated and shown on the plans, plus or minus quantities covered by approved changes. The Engineer or the Contractor may request recalculation if a possible error is suspected in the quantities shown on the plans. If the Contractor requests recalculation of quantities, such request shall be in writing. When quantities are recalculated, the quantities derived therefrom will be the quantities used for payment. All calculations will be made according to the dimensions shown on the standard sheets appended to the plans. Only those quantities complete and in place will be measured for payment.

The yardage of water or any other liquid will not be included in the measurement for payment, except that the yardage of mud, muck, or similar semi-solid matter not resulting from construction operations and which cannot be pumped or drained away shall be included.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

206.05.01 Payment. The accepted quantity of structure excavation measured as provided in subsection 206.-04.01, "Measurement," will be paid for at the contract unit price bid per cubic yard, which payment will be full compensation for clearing, grubbing, cofferdams, cribs, sheeting, shoring, bracing, pumping, unwatering, and disposing of all materials, as well as any other additional work which may be required to comply with safety regulations, including but not limited to, additional sloping outside the designated pay limits.

No compensation will be made for the removal and disposal of material which may come into an excavation from outside the designated limits or for the removal and disposal of swell material resulting from the driving of piles in an excavation.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Structure Excavation	Cubic Yard

SECTION 207

BACKFILL

DESCRIPTION

207.01.01 General. This work shall consist of placing and compacting, to the lines designated on the plans or as established by the Engineer, backfill or granular backfill material in excavations for bridges, retaining walls, headwalls for culverts, and other structures; placing and compacting backfill or granular backfill material in trenches for culverts and pipes; and other backfill specifically designated in the contract documents as structure backfill. This item does not include backfilling minor miscellaneous structure excavations outside the limits of the roadway.

When the terms "backfill" or "structure backfill" are used herein, they shall be construed to mean backfill or granular backfill, or both.

MATERIALS

207.02.01 Backfill. Material used for backfill shall be of a quality acceptable to the Engineer. The backfill material shall be free from stones or lumps of material exceeding three (3) inches in greatest dimension and shall be free from sod, frozen earth, and organic materials. Acceptable material from excavation may be used for backfilling unless granular backfill is specified and the material from excavation does not conform to the requirements therefor.

207.02.02 Granular Backfill. Material used for granular backfill shall consist of natural sand or a mixture of sand with gravel, crushed gravel, crushed stone, or other broken or fragmented material to fill the voids in the coarser material. In addition thereto, the material shall conform to the following requirements:

Sieve Sizes	Percentage by Weight Passing
3"	100
No. 4	35–100
No. 200	0–15

The liquid limit of the material shall not be greater than thirty-five (35) and the plasticity index shall not be more than ten (10).

CONSTRUCTION

207.03.01 General. Compaction of backfill or embankment around all structures shall be secured with mechanical tamping units and the material shall be placed at a rate which will permit efficient use of mechanical tampers in securing the required compaction.

Unless otherwise permitted by the Engineer, foundations for culvert pipe and reinforced concrete boxes shall be compacted to not less than ninety (90) percent of the maximum density as determined by Test Method No. Nev. T101. Test Method No. Nev. T102 or No. Nev. T103 may be used to determine the in-place density. Test method to be determined by the Engineer.

Backfill material shall be placed in uniform horizontal layers not exceeding eight (8) inches in loose thickness before compaction and shall be brought up uniformly on all sides of the structure or improvement. Each layer of backfill shall be moistened as necessary and thoroughly compacted until ninety (90) percent of the maximum density is achieved, except that each layer of backfill so placed within the limits shown on the plans for selected borrow embankments for approaches to bridges shall be thoroughly compacted until ninety-five (95) percent of the maximum density is achieved. In all instances, Test Method No. Nev. T101, No. Nev. T102, or No. Nev. T103 may be used to determine the in-place density. Test method to be determined by the Engineer.

Compaction of backfill material by ponding or jetting will not be permitted.

Material resulting from structure excavation and not used as structure backfill shall be deposited in roadway

embankments in accordance with the requirements specified elsewhere or otherwise disposed of along the roadway in a manner approved by the Engineer and no additional compensation will be allowed for such work.

Structure backfill shall not be placed until the structure or facilities have been inspected by the Engineer and approved for backfilling. Backfill material shall not be deposited against the back of concrete abutments, concrete retaining walls or the outside walls of concrete box culverts until the concrete has reached an age of fourteen (14) days or the concrete has developed a strength of two thousand five hundred (2,500) pounds per square inch in compression as determined by Test Method No. Nev. T475.

Where backfill is placed against waterproofed surfaces, care shall be taken that no damage is done to the waterproofing material.

207.03.02 Placing and Compacting at Abutments, Piers, Wingwalls, and Retaining Walls. With the approval of the Engineer, all spaces excavated and not occupied by abutments, piers, or other permanent work shall be refilled with earth up to the surface of the surrounding ground or to the limits designated on the plans or as described herein. All backfill shall be thoroughly compacted in accordance with the provisions set forth in subsection 207.03.01, "General."

Where backfill is to be placed on one side of an abutment, wingwall, pier, or headwall, care shall be exercised to prevent over compacting to the point of displacing line or batter or both.

Existing slopes, which are shaped so as to cause a wedge action in the backfill, shall be step-cut or benched before backfilling.

207.03.03 Placing and Compacting at Culverts. After the bedding has been prepared and the culverts installed or constructed as required by the pertinent specifications, acceptable material from excavation or from other sources

shall be placed along both sides of the culvert equally in uniform layers not exceeding eight (8) inches in depth (loose measurements), wetted as required and thoroughly compacted to the density requirements as set forth in subsection 207.03.01, "General."

Special care shall be taken in placing and thoroughly compacting the material under the haunches of all pipe.

Unless otherwise directed, the backfilling shall continue as described to the level of the ground or to an elevation six (6) inches above the structure in the case of a pipe culvert in projection, or even with the top of the structure in the case of an RCB culvert in projection.

No construction or other traffic shall be permitted to cross any culvert until a safe minimum depth of fill above the culvert has been placed and consolidated in accordance with these specifications. The Contractor shall be solely responsible for protecting the structure from superimposed loading created by construction equipment or otherwise and shall repair any damage done to the structure or replace the structure as ordered without extra compensation.

Special care shall be taken in backfilling arches, particularly half-circle arches. The arch shall be covered in layers, each layer conforming to the shape of the arch and tamped thoroughly.

207.03.04 Placing and Compacting of Bin-Type Retaining Walls. Placing and compacting backfill material for bin-type retaining walls shall progress concurrently with the assembly of the bins, and backfilling around the outer sides thereof shall be kept approximately level with the inside fills. The materials shall be thoroughly tamped and meet the density requirements as set forth in subsection 207.03.01, "General." Care shall be exercised to completely fill the depressions of stringers and spacers without over compacting to the point of displacing them from established line and batter.

METHOD OF MEASUREMENT

207.04.01 Measurement. The quantity of backfill or granular backfill measured for payment will be the number of cubic yards calculated and shown on the plans, plus or minus quantities covered by approved changes. The Engineer or the Contractor may request recalculation if a possible error is suspected in the quantities shown on the plans. If the Contractor requests recalculation of quantities, such request shall be in writing. When quantities are recalculated, the quantities derived therefrom will be the quantities used for payment. All calculations will be made according to the dimensions shown on the standard sheets appended to the plans. Only those quantities complete and in place will be measured for payment.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

207.05.01 Payment. The accepted quantities of backfill or granular backfill measured as provided in subsection 207.04.01, "Measurement," will be paid at the contract unit price bid per cubic yard for backfill or granular backfill.

When structure excavation is unacceptable as backfill and backfill material is obtained from the roadway prism or from borrow or from base materials, it will be paid for both as backfill and the respective bid item from which it is obtained. When granular backfill is called for it will be paid as granular backfill only and no further compensation will be paid for borrow or base items.

Payment for backfill or granular backfill shall be full compensation for furnishing, hauling, and compacting all material.

When an item for backfill does not appear in the proposal, backfill will be considered as incidental to the installation of the structure and compensation shall be included in the contract prices for other items of the work.

Water applied will be paid for in accordance with Section 210, "Watering." All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Backfill	Cubic Yard
Granular Backfill	Cubic Yard

SECTION 208

FOUNDATION FILL

DESCRIPTION

208.01.01 General. This work shall consist of furnishing and placing sand, gravel, rock, or any suitable combination of these materials in areas where unstable foundation materials have been excavated below the foundation elevation for culverts, bridges, and all other structures in accordance with these specifications and in conformity with the grades and elevations shown on the plans or established by the Engineer.

MATERIALS

208.02.01 General. Material shall be as set forth in the special provisions.

CONSTRUCTION

208.03.01 General. Unsatisfactory material shall be removed to the depth required and piles driven if designated. Foundation fill shall be placed to bring the subfoundations to the required elevation.

Compaction of foundation fill shall be secured with mechanical tamping units or other compaction methods approved by the Engineer. Material shall be placed at a rate which will permit efficient use of compaction methods.

Unless otherwise permitted by the Engineer, foundation fill shall be compacted to not less than ninety (90) percent of the maximum density as determined by Test Method No. Nev. T101. Test Method No. Nev. T102 or No. Nev. T103 may be used to determine the in-place density. Test method to be determined by the Engineer.

Compaction by ponding or jetting will not be permitted.

METHOD OF MEASUREMENT

208.04.01 Measurement. The quantity of foundation fill to be measured for payment will be the number of

cubic yards measured in accordance with the dimensions shown on the plans or established by the Engineer.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

208.05.01 Payment. The accepted quantities of foundation fill measured as provided in subsection 208.04.01, "Measurement," will be paid for at the contract unit price bid per cubic yard of foundation fill complete and in place.

Full compensation for furnishing, hauling, placing, and compacting foundation fill shall be considered as included in the contract price paid for foundation fill.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Foundation Fill	Cubic Yard

SECTION 209

DRAIN BACKFILL

DESCRIPTION

209.01.01 General. This work shall consist of furnishing, hauling, placing, and compacting drain backfill material around structures or perforated underdrains to the lines designated on the plans or established by the Engineer.

MATERIALS

209.02.01 General. Material shall conform to the requirements as set forth in subsection 704.03.01, "Drain Backfill."

CONSTRUCTION

209.03.01 Underdrains. The trench shall be excavated and drain backfill placed in accordance with the provisions of Section 607, "Underdrains."

Trenches for blind drains shall be excavated to the width and depth shown on the plans, or established by the Engineer. The trench shall be filled with drain backfill material to the depth required by the plans. Any remaining upper portion of trench shall be filled with either granular or impervious material as may be specified.

Where drain backfill is part of the structural section, it shall be compacted to not less than ninety (90) percent of the maximum density as determined by Test Method No. Nev. T101. Test Method No. Nev. T102 or No. Nev. T103 may be used to determine the in-place density. Test method to be determined by the Engineer.

Compacting by ponding or jetting will not be permitted.

METHOD OF MEASUREMENT

209.04.01 Measurement. The quantity of drain backfill to be measured for payment will be the number of cubic yards measured in accordance with the dimensions

shown on the plans or established by the Engineer complete and in place.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

209.05.01 Payment. The accepted quantities of drain backfill measured as provided in subsection 209.04.01, "Measurement," will be paid for at the contract unit price bid per cubic yard of drain backfill.

Full compensation for furnishing, hauling, placing, and compacting drain backfill shall be considered as included in the contract price paid for drain backfill.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Drain Backfill	Cubic Yard

SECTION 210

WATERING

DESCRIPTION

210.01.01 General. This work shall consist of but is not limited to furnishing, hauling, and applying all water required for compaction of embankment foundation areas, embankments, subgrade, mineral aggregate base and surfacing materials, structure backfill, processing cement treated base or subgrade material, and for laying dust caused by grading operations and traffic.

MATERIALS

210.02.01 General. All materials shall conform to the requirements set forth in Section 722, "Water."

CONSTRUCTION

210.03.01 Equipment. Equipment used for applying water required for compacting embankment materials, subgrade, base and surfacing materials, and for laying dust shall be pressure type distributors equipped with a spray system that will ensure uniform application of water. All the watering equipment used for the application of water shall be equipped with a positive means of shutoff and the use of equipment not so equipped will not be permitted. An approved pump, pipe, hose, and nozzle equipment may be used in embankment construction. Where the head is sufficient to provide equal pressure, the pump requirement may be eliminated.

The Department does not require that watering equipment be provided with measuring or metering devices.

210.03.02 General. Water for dust control shall be applied in the amounts and on the areas designated by the Engineer.

The Contractor shall apply water in the amount necessary to attain the compaction in those materials requiring

a specified density. In certain of the base courses, water shall be introduced into the aggregate at the plant and when necessary to attain the specified compaction, shall be supplemented by additional wetting as specified above.

Excavation areas and borrow pits may be watered prior to excavating material.

When water is applied directly to the roadbed, the material shall be processed by suitable equipment until the layer is uniformly wet. Care shall be taken to avoid disturbing layers which have been previously placed and compacted.

The Contractor shall make all arrangements for providing an adequate water supply. He shall negotiate with owners of supply and sign an agreement with each owner prior to removing the water. A copy of said agreement shall be furnished the Engineer. He shall pay all royalties occurring under such agreements and shall also obtain any necessary right of way.

METHOD OF MEASUREMENT

210.04.01 Measurement. The developing of an adequate water supply, the furnishing of all necessary equipment for obtaining water from the source or sources, water, and the furnishing of equipment necessary to apply the water, will not be measured for payment.

BASIS OF PAYMENT

210.05.01 Payment. Full compensation for developing an adequate water supply, for furnishing all necessary equipment, for obtaining water from the source or sources, for water, and for furnishing of equipment necessary to apply the water, shall be considered as included in the contract unit price paid for other appropriate items and no separate payment will be made therefor.

SECTION 211

EROSION CONTROL

DESCRIPTION

211.01.01 General. This work shall consist of preparing slopes, placing and compacting top soil, seeding, fertilizing, jute matting, and mulching all graded and disturbed areas in accordance with these specifications and the details shown in the contract documents.

MATERIALS

211.02.01 General. The materials used shall be those prescribed for the several items which constitute the finished work and shall conform to the applicable requirements of Section 726, "Roadside Materials."

211.02.02 Topsoil. Unless designated in the contract documents, the Contractor shall make his own arrangements for obtaining topsoil and he shall pay all costs involved. Topsoil shall be transported directly from the source to final position unless otherwise permitted. Topsoil shall not be obtained from an area known to have noxious weeds growing in it.

Prior to removal of topsoil from the source, the Contractor shall contact the County Weed Control Agency or the State Quarantine Officer for the inspection and destruction of injurious and noxious weeds. Topsoil that has been treated with herbicides or sterilents shall be tested by the Nevada State Department of Agriculture to determine the residual in the soil.

211.02.03 Seed. All seeds shall conform with all laws and regulations pertaining to the sale and shipment of seed required by the Nevada State Department of Agriculture and the Federal Seed Act. All shipments of seed

shall be reported to the Nevada State Department of Agriculture for inspection. Seed shall be of the varieties and proportions specified in the contract documents.

211.02.04 Fertilizer. All fertilizer shall conform with all "Rules and regulations governing the registration, licensing and collection of license fees for commercial fertilizer in the State of Nevada" as required by the Nevada State Department of Agriculture. Commercial fertilizer formulation and rate of application shall be as specified in the contract documents.

211.02.05 Mulch. (a) Hay or Straw. Hay or straw shall be acceptable to the Engineer. All shipments of hay or straw shall be reported to the Nevada State Department of Agriculture for inspection. Hay or straw delivered to the project shall meet the requirements of the Nevada State Department of Agriculture. Rate of application shall be as specified in the contract documents.

(b) Wood Cellulose Fiber. Wood cellulose fiber shall be manufactured in such a manner that after addition and agitation in slurry tanks with fertilizers, grass seeds, water, and other improved additives, the fibers in the material will become uniformly suspended to form a homogeneous slurry. When hydraulically sprayed on the ground, the material shall be uniformly impregnated with grass seed. Rate of application shall be as specified in the contract documents.

211.02.06 Asphalt Emulsion. Asphalt emulsion used as a tie-down for mulch shall be as described in the contract documents.

CONSTRUCTION

211.03.01 Preparation. Excavation slopes shall be thoroughly cultivated to the depth shown in the contract documents, after which topsoil, if required by the contract, shall be uniformly spread to an approximate thickness of two (2) inches, the exact thickness will be determined by the Engineer.

Cultivation of embankment slopes and covering with topsoil will not be required unless specified in the contract documents or ordered by the Engineer. If cultivation of embankment slopes and covering with topsoil is ordered by the Engineer, the cost of such work will be paid for as extra work as provided in subsection 104.03, "Extra Work."

Cultivation shall not be performed until all equipment is through working in the area, except equipment required to cultivate the area and spread topsoil.

After cultivation and prior to seeding, all rocks six (6) inches in smallest dimension and larger shall be removed from all slopes to be seeded and disposed of as approved by the Engineer.

211.03.02 Placement of Topsoil. Topsoil shall be evenly spread over the specified areas to the depth shown on the plans unless otherwise approved by the Engineer. After the topsoil has been spread, all large clods, hard lumps, rocks, and litter shall be raked up, removed, and disposed of by the Contractor.

Topsoil shall not be placed when the ground or topsoil is frozen, excessively wet, or, in the opinion of the Engineer, in a condition detrimental to the work.

All damage occurring to existing roadbeds, shoulders, walks, curbs, or other existing adjacent structures or areas due to the Contractor's operation in hauling and placing the topsoil shall be repaired by the Contractor at his own cost and expense.

211.03.03 Compaction. All topsoil shall be compacted unless otherwise specified or approved by the Engineer. Compaction shall be by sheeps-foot roller, cleated crawler tractor, or similar equipment approved by the Engineer, which will produce a minimum of one hundred fifty (150) pounds per square inch ground pressure to a maximum of three hundred (300) pounds per square inch ground pressure. Equipment shall be so designed and constructed to produce a uniform rough textured surface ready for seeding and mulching, and which will bond the topsoil

to the underlying material. The entire area shall be covered by a minimum of four (4) passes or two (2) round trips of the roller or approved equipment. Compaction equipment shall be operated parallel to the natural flow of water on the slopes unless otherwise approved by the Engineer. Conveying the roller or approved equipment up and down the slopes shall be by means devised by the Contractor, providing that the required results are obtained to the satisfaction of the Engineer. After compaction, the finished grade of the topsoil shall be one (1) inch below the top of all curbs, catch basins and other structures.

If, in the opinion of the Engineer, water is required to condition the topsoil for compaction, it shall be immediately furnished and applied by the method and in the amount designated by the Engineer.

211.03.04 Seeding and Fertilizing. The Contractor shall notify the Engineer not less than twenty-four (24) hours in advance of any seeding operation and he shall not begin the work until areas prepared or designated for seeding have been approved. Following the Engineer's approval, seeding and fertilizing of the approved slopes shall begin immediately.

Seeding shall not be done during windy weather or when the ground is frozen. Seed and fertilizer shall be uniformly spread over the area at the rate and mix specified in the contract documents. Seed and fertilizer may be sown by one of the following methods:

(a) An approved type hydro-seeder which utilizes water as the carrying agent and maintains a continuous agitator action that will keep seed and fertilizer mixed in uniform distribution until pumped from the tank. Pump pressure shall be such as to maintain a continuous, nonfluctuating stream of solution.

(b) Approved blower equipment with an adjustable disseminating device capable of maintaining a constant, measured rate of material discharge that will ensure an even distribution of seed and fertilizer at the rates herein specified.

(c) Helicopters properly equipped for aerial seeding and fertilizing. Helicopters so equipped shall have the following:

1. Two hoppers or seed compartments each capable of containing a minimum of one hundred (100) pounds of grass seed or granular fertilizer.

2. Power-driven, readily adjustable disseminating mechanisms capable of maintaining a constant, measured rate of distribution of grass seed or granular fertilizer.

3. Where liquid fertilizer is furnished in lieu of dry granular fertilizer, the helicopter shall be equipped with two barrels or containers capable of containing a minimum of fifteen (15) gallons each. Distribution shall be by a spray boom of sufficient size and length, fitted with proper nozzles to distribute uniformly, liquid fertilizer as herein specified.

(d) Approved power-drawn drills, with double-disc front delivery openers, and depth bands for positive depth control. Depth control shall be set at a depth of three-fourths (¾) inch for consistent furrow bottom placement. An approved deep furrow drill may be used where it is determined the seedbed is firm and there is little danger of soil blowing. An approved spreader may be used for fertilizer placement. Drills and spreaders shall be calibrated before use on the project.

Areas inaccessible to above methods of application shall be seeded and fertilized by approved hand methods. Distribution of the material shall be uniform and at the rates specified.

It shall be the Contractor's responsibility to provide qualified personnel experienced in all phases of the seeding and fertilizing operations, equipment, and methods as herein specified.

211.03.05 Spreading Mulch. (a) Hay or Straw. Hay or straw mulch shall be furnished, hauled, and evenly applied at the rates indicated, and shall be spread by means of an approved type mulch spreader. The spreader shall produce a uniform distribution of the hay, without

cutting or breaking it into short stalks. Areas beyond the range of the mulch spreader shall be mulched by approved hand methods. Distribution of the material shall be uniform and at the rate specified in the contract documents.

Straw, grass hay or shredded bark, unless otherwise specified, shall be anchored into the soil by use of a heavy disc with flat serated discs approximately one-fourth (¼) inch thick, having dull edges and spaced no more than nine (9) inches apart. Anchoring shall be to a depth of two (2) inches, across the slope, and with no more than one pass of the equipment on the same surface.

(b) Wood Cellulose Fiber. Wood cellulose fiber utilized as a mulch may be applied with seed and fertilizer in one operation by approved hydraulic equipment. The equipment shall have a built in agitation system with an operating capacity sufficient to agitate, suspend and homogeneously mix a slurry of the specified amount of fiber, fertilizer, seed, and water. Distribution and discharge lines shall be large enough to prevent stoppage and shall be equipped with a set of hydraulic discharge spray nozzles which will provide a uniform distribution of the slurry.

211.03.06 Applying Asphalt Emulsion. When called for in the contract documents, mulch material shall be anchored in place with asphalt emulsion as herein specified. Asphalt emulsion shall be sprayed into the mulch as it leaves the blower pipe and shall be uniformly mixed with the mulch. Asphalt emulsion as specified shall be applied at the rate of two hundred fifty (250) gallons per acre. Any mulch disturbed or displaced following application shall be removed, reseeded, and remulched as specified.

211.03.07 Placing Jute Matting. Jute matting shall be unrolled and placed parallel to the flow of water immediately following the bringing to finished grade the area specified on the plans or the placing of seed and fertilizer. Where more than one strip is required to cover the given areas, they shall overlap a minimum of four (4)

inches. Ends shall overlap at least six (6) inches with the up-grade section on top. The up-slope end of each strip of matting shall be buried in six (6) inch slots with the soil firmly tamped against it. The Engineer may require that any other edge exposed to more than normal flow of water or strong prevailing winds be buried in a similar manner. Check slots shall be placed between the ends of strips by placing a tight fold of the matting at least six (6) inches vertically into the soil. These shall be tamped and stapled the same as up-slope ends. Check slots must be spaced so that one check slot or one end occurs within each fifty (50) feet of slope.

Edges of matting shall be buried around the edges of catch basins and other structures as herein described. Matting must be spread evenly and smoothly and in contact with the soil at all points.

Jute matting shall be held in place by approved wire staples, pins, spikes, or wooden stakes driven vertically into the soil. Matting shall be fastened at intervals not more than three (3) feet apart in three (3) rows for each strip of matting, with one (1) row along each edge and one (1) row alternately spaced in the middle. All ends of the matting and check slots shall be fastened at six (6) inch intervals across their width. Fastening devices shall anchor the matting against the soil and be driven flush with the finished grade.

METHOD OF MEASUREMENT

211.04.01 Measurement. The quantity of topsoil measured for payment will be the number of cubic yards in the haul conveyance at the point of delivery and placed in the work. The quantity of seeding and fertilizing and mulching to be measured for payment will be the actual number of acres or square yards completed and measured along the ground slope. The quantity of jute matting to be measured for payment will be the number of square yards covered and measured along the ground slope.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

211.05.01 Payment. The accepted quantity of topsoil measured as provided in subsection 211.04.01, "Measurement," will be paid for at the contract unit price bid per cubic yard of topsoil which price shall include hauling and placing.

The accepted quantities of seeding, fertilizing, mulching, and jute matting will be paid for at the contract unit price bid per acre or square yard as set forth in the proposal.

The contract unit price bid for seeding shall also be considered full compensation for removing and disposing of rocks, six (6) inches in smallest dimension and larger, from slopes as specified in subsection 211.03.01.

Water will be considered subsidiary to the major items of work and no further compensation will be allowed therefor.

Asphalt emulsion will be considered subsidiary to the item "Mulching" and no further compensation will be allowed therefor.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Topsoil	Cubic Yard
Seeding (type)	Acre, Square Yard
Fertilizing (type)	Acre, Square Yard
Mulching (type)	Acre, Square Yard
Jute Matting	Square Yard
(type) Matting	Square Yard

SECTION 212

LANDSCAPING

DESCRIPTION

212.01.01 General. This work shall consist of furnishing and planting trees, shrubs, and ground covers where shown on the plans or established by the Engineer, all in accordance with specifications and accepted horticultural practices.

MATERIALS

212.02.01 General. The materials used shall be those prescribed for the several items which constitute the finished work and shall conform to the applicable requirements of Section 726, "Roadside Materials."

212.02.02 Nomenclature. Nomenclature for plant names and varieties shall be in accordance with the latest edition of "Standardized Plant Names" as prepared by the American Joint Committee on Horticultural Nomenclature.

All plant material will be classified by group as follows:

Plants, Group A.....Denotes canned plant material
Plants, Group B.....Denotes balled and burlapped plant material
Plants, Group C.....Denotes ground cover
Plants, Group D.....Denotes grass (turf)
Plants, Group E.....Denotes grass (meadow)

212.02.03 Quality of Plant Materials. It is the intent of these Standard Specifications that all plant material meet the standards as set forth herein, throughout the life of the contract. During inspections, as set forth hereinafter, all plant material will be judged and rejections shall be based upon these standards.

It is to be understood that when plant materials do not meet the standards and are rejected, that no consideration will be given to the possibility of survival.

All plants shall be first-class nursery grown representatives of their normal species and shall be true to type or

name as shown on the plans and shall conform to the American Standard for Nursery Stock, No. 1 grade, American Association of Nurserymen, Inc., latest edition, ASA Spec. Z60.1 and shall be tagged in accordance with the most recent standard practice recommended by the American Association of Nurserymen and to the latest edition of Standardized Plant Names, American Joint Committee on Horticultural Nomenclature.

All plants shall comply with Federal and State laws requiring inspection for plant diseases and infestations. Inspection certificates required by law shall accompany each shipment of plants, and certificates shall be delivered to the Engineer.

In determining the quality of plant material, the following elements shall be valued:

1. Root condition.
2. Plant size (above ground).
3. Insect and disease free condition.
4. General appearance (color, shape, prior pruning).

A deficiency in any one or more of these areas shall be sufficient reason to reject selectively or by lot.

Grass seeds shall conform to the requirements of subsection 211.02.03, "Seed."

212.02.04 Handling and Shipping. Plants shall be packed for shipment according to standard practice for the type of plant being shipped. The root system of all plants shall not be permitted to dry out at any time. Plants shall be protected at all times against heat and freezing temperatures, sun, wind, climatic, or seasonal conditions during transit. All plant material shall be furnished in containers unless otherwise specified. All plants specified balled and burlapped (B & B) shall at all times be handled by the ball of earth and not the plant. Broken or "made" balls will not be accepted. Container grown plants shall be well developed with sufficient root development to hold the earth intact after removal from the container without being root bound.

All Group A–1, A–5, and A–15 plants are to be hardened material. This is to be accomplished by storing all

plants in the immediate area of planting for a period of not less than three (3) weeks prior to planting. Plants shall be stored in a licensed commercial nursery, or the Contractor may provide equivalent storage and care with written approval of the Engineer.

Prior to moving plants from nursery or storage area to jobsite, they shall be thoroughly sprayed with a solution of an anti-desiccant/anti-transpirant which will meet the requirements set forth in the special provisions.

212.02.05 Inspection of Plant Material. The Contractor shall inform the Engineer, as soon as practical, of the source of plant material for the project. At the Engineer's option an inspection of all plant materials at the source may be required prior to shipping of plants from the nursery. This inspection shall coordinate the judgment areas regarding size and quality of plant material between the Highway Department, the Contractor and the nursery. However, there will be no acceptance of any plant material during this inspection.

All plant material will be inspected by the Engineer on arrival at the storage area. This inspection shall determine the acceptance or rejection of the plant material based on quality as specified in subsection 212.02.03 "Quality of Plant Materials." This inspection is for quality of plant material only and does not constitute final acceptance. Plants which are rejected shall be immediately removed from the holding area and replaced by the Contractor at his expense.

All plant material will be continually inspected by the Engineer from the time of arrival at the holding area, during planting and through the plant establishment period. Plants may be individually rejected during this time based on mechanical damage, quality or physical change of the plant which is not normal to the plant or to the season of the year. Plants which are rejected shall be immediately removed from either the holding area or the project and replaced by the Contractor at his expense.

212.02.06 Substitution of Plants. No substitution of

plant material will be permitted unless evidence is submitted in writing to the Engineer that a specified plant cannot be obtained and has been unobtainable since the award of the contract. If substitution is permitted, it can be made only with written approval by the Engineer. The nearest variety, size, and grade as approved by the Engineer shall then be furnished.

212.02.07 Temporary Storage. Plant material delivered and accepted shall be planted immediately. Plants that cannot be planted within one (1) day after arrival shall be "heeled-in" in accordance with accepted horticultural practice, and as follows:

(a) Balled and burlapped plants shall have the root ball protected by moist earth, sawdust, or other acceptable material.

(b) Canned plants shall be placed in and under shelter and kept moist.

Plants stored under temporary conditions shall be protected at all times from extreme weather conditions, and shall be kept moist.

212.02.08 Topsoil. Topsoil shall conform to the applicable requirements of Section 726, "Roadside Material."

212.02.09 Lumber. Lumber for header boards and plant boxes shall conform to the requirements of Section 718, "Timber."

CONSTRUCTION

212.03.01 Site Preparation. This work shall consist of all work necessary, as set forth in the contract documents, such as roadway construction, drainage facilities, grading, cleaning, etc., to prepare the area for the actual landscaping work. All work as set forth herein shall be completed and approved by the Engineer prior to beginning any preparation of the planting areas.

212.03.02 Layout of Planting. The Contractor will

designate, by means of stakes or other approved markings, the ground location of each random placed plant. Areas of massed or uniform solid plantings shall be marked at their outer extremes only. The Engineer's approval of plant stakeout will be required prior to the commencement of the preparation of planting areas.

In mixed planting areas, trees shall be planted first, followed by the larger shrubs, low shrubs, and the final planting of ground covers.

212.03.03 Preparation of Planting Areas. During the preparation of planting areas, all clods, rocks, or other debris over one (1) inch in largest dimension shall be removed from both cultivated areas and backfill material, and disposed of as directed by the Engineer. In addition thereto, the following requirements will apply:

(a) Planter Boxes. Backfill material shall consist of one (1) part humus to three (3) parts topsoil by volume. This material shall be thoroughly and uniformly mixed before placing in the planter boxes. After placing in the planter box, the material shall be watered until it is completely saturated. Sufficient backfill mixture shall be added and adequately wet so that after settlement has taken place, the material is approximately two (2) inches below the top of the box.

(b) Planting Beds. The soil preparation shall not be initiated until after all grading has been completed and the irrigation system has been installed, tested, adjusted, and accepted by the Engineer. The ground surface within the area shall then be loosened and thoroughly pulverized to a depth of six (6) inches. When required, humus, commercial fertilizer, and other additives shall be incorporated at the rate specified in the contract documents, and shall be thoroughly and uniformly tilled into the soil to a depth of six (6) inches. The area shall then be brought to a plane in conformance to the elevations shown on the plans. The area to be planted shall then be consolidated with approved cultipackers or rollers.

(c) Seed Beds. The soil preparation shall be the same as specified for planting beds.

(d) Planting Holes. Prior to drilling holes, the proposed location of the irrigation lines shall be designated by means of stakes or other approved markings. In the event of conflict between individual planting holes and irrigation lines, the planting holes in question shall be drilled prior to installing the irrigation lines.

All holes shall be drilled with a power auger to the dimensions specified in the contract documents unless otherwise approved by the Engineer. Holes shall be drilled at the location of each individual plant, the stake or marking being considered the center of the hole. The holes shall have vertical walls and horizontal bottoms.

When required, humus, commercial fertilizer, and other additives shall be incorporated at the rates specified in the contract documents and shall be thoroughly and uniformly mixed with the material removed from the holes prior to backfilling. After backfilling the holes, the material shall be saturated with water to the full depth of the hole and until ponding appears in the basin. Sufficient backfill material shall be placed so that after planting and settlement has taken place, the basin will conform to the section as shown in the plans.

(e) Planting Trenches. Trenches shall be excavated to the dimensions specified in the contract documents and shall be centered on the planting line as staked or otherwise marked.

When required, humus, commercial fertilizer, and other additives shall be incorporated at the rates specified in the contract documents and shall be thoroughly and uniformly mixed with the material removed from the trenches prior to backfilling. After backfilling the trenches, the material shall be saturated with water to the full depth of the trench. Cross checks may be formed as necessary to permit ponding of water during the saturation period but must be removed prior to planting. Sufficient backfill material shall be placed so that after planting and settlement has taken place, the basin will conform to the section as shown in the plans.

212.03.04 Planting. No planting shall be done in any area until the Contractor has received from the Engineer a

written statement that the area concerned has been satisfactorily prepared as provided in subsection 212.03.03, "Preparation of Planting Areas."

No more plants shall be distributed within the project area on any one day than can be planted and watered on that day.

Any planting done in soil that is too wet or too dry or not properly conditioned as provided herein will not be accepted. No payment will be made for such planting and any further planting work will be suspended until the Contractor has complied in every way with the specifications.

(a) Plants (Group A). Nursery stakes supporting plants in containers shall be removed and the plants properly pruned as specified herein.

Containers shall be cut, at least twice, from top to bottom and plants shall be removed from the containers in such a manner that the ball of earth surrounding the roots is not broken and they shall be planted and watered as hereinafter specified immediately after removal from the containers. Containers shall not be cut prior to delivery of the plants to the planting areas.

(b) Plants (Group B). Balled and burlapped material shall have all strings or cords cut, and the burlap shall be laid back from the top half of the ball. This shall be done only after the plant is placed in its final position and before completion of the backfill.

(c) Plants (Group C). As soon as each plant is removed from its container, it shall be planted in the prepared planting bed, in a hole previously prepared with a broad, blunt end trowel. The plant shall be carefully lifted with the trowel, inserted in the hole, and the earth shall be gently firmed around it to eliminate air pockets.

Plants brought to the jobsite in plastic or clay pots shall be tapped loose from their containers in such a manner that the ball of earth surrounding the roots is not broken, and then immediately planted. Plants which are brought to the jobsite in peat pots may be planted in the pots, provided the peat fiber is thoroughly wet. Plants which are brought to the jobsite in other cellulose fiber pots shall have the pots carefully removed by tapping or peeling

before planting. No plants brought to the jobsite in flats, pony packs, or bare root will be accepted.

Plants shall be watered as hereinafter specified immediately after planting.

Roots of plants not in containers shall be kept moist and covered at all times and shall not be exposed to the air except while actually being placed in the ground.

Plants shall be set in a plumb position in the backfill mixture material to such a depth that, after the soil has settled, the top of the plant ball will be level with the finished grade.

Plants shall be planted in such a manner that the roots will not be restricted or distorted. Soil shall not be compacted around the roots or ball of the plant during or after planting operations. Any plants which have settled deeper than specified in the above paragraph shall be raised back to the required level, or replaced, at the option of the Contractor.

(d) Plants (Group D). The seedbed shall be in a moist friable condition when seeding is begun. Seeding shall be done as soon as soil conditions allow after the initial watering of the amended soil. Seeding done in soil that is too wet or too dry, or in a condition not generally accepted as satisfactory for lawn seeding will not be accepted. No payment will be made for seeding when the soil condition is considered unsatisfactory and any further seeding work will be suspended until the Contractor has complied in every way with these provisions.

Seed shall be sown from standard mechanical grass seeding equipment with adjustable gate, as appropriate to the area, and at the rate shown on the plans. After sowing, the seed shall be covered by light raking or dragging and seeded areas compacted by rolling. The Contractor shall exercise care to avoid leaving any footprints or other depressions in the compacted seedbed.

Humus mulch shall be evenly applied immediately after the seedbed has been compacted, with manure spreaders, mulch blowers or other approved equipment. Humus shall be spread at the rate of one (1) cubic yard per

thousand (1,000) square feet. As soon as mulch is in place, the surface of the seedbed is to be dampened with a fine spray from a nozzle until the mulch is thoroughly moist.

(e) Plants (Group E). The seedbed shall be in a moist, friable condition when seeding is begun. Seeding shall be done as soon as soil conditions allow after the initial watering of the amended soil. Seeding done in soil that is too wet or too dry, or in a condition not generally accepted as satisfactory for lawn seeding will not be accepted. No payment will be made for seeding when soil condition is considered unsatisfactory and any further seeding work will be suspended until the Contractor has complied in every way with these provisions.

Seed shall be sown from standard mechanical grass seeding equipment with adjustable gate, as appropriate to the area, and at the rate shown on the plans. After sowing, the seed shall be covered by rolling. The Contractor shall exercise care to avoid leaving any footprints or other depressions in the compacted seedbed.

212.03.05 Staking and Guying. All staking and guying shall be done concurrently with the planting operation.

(a) Staking. Plants which are to be staked will be specified in the contract documents.

The size, number of stakes, and the depth to be driven shall be as specified in the contract documents, or as approved by the Engineer.

The stakes shall be placed against but not through the plant ball in the case of Plants (Groups A and B).

(b) Tree Ties. The method of attaching the ties to stakes and trees shall provide firm connection, as shown in the plans, or as approved by the Engineer. It may, on occasion, as determined by the Engineer, be considered necessary to use No. 10 gage galvanized wire encased in at least one-half (½) inch black rubber hose as tree ties, in which case all connections shall be twisted.

(c) Guying. Plants which are to be guyed will be specified in the contract documents.

All guying shall be done as specified in the contract documents or as approved by the Engineer.

212.03.06 Pruning. Pruning shall be done as determined by the Engineer before plant materials are brought to the jobsite and planting areas.

Pruning of evergreen coniferous plants will not be permitted except under the direction of the Engineer.

Removal of dead leaves from ground cover plants shall be done before these plants are brought to the planting areas.

212.03.07 Watering. If water is available from a new or existing State-owned irrigation system within the limits of the project, it may be obtained from such system free of charge. Where water is not available from such State-owned facility, the Contractor shall make his own arrangements for furnishing and applying water and he shall pay all costs involved.

Valves at meters shall be kept closed at all times, except while the irrigation system is actually in use.

Precautions shall be taken during times when the irrigation system is on to prevent water from wetting vehicles, pedestrians, and pavement. Any erosion, slippage, or settlement of the soil caused by watering shall be repaired by the Contractor at his expense.

Compliance with the provisions in this section shall not relieve the Contractor of his responsibility for his replacement of plants as provided hereinafter.

(a) Plants (Groups A and B). All plants shall be watered immediately after planting. Water shall be applied in a moderate stream until the backfill soil around and below the roots or ball, or earth around each plant, is thoroughly saturated. Where watering is done with a hose, a metal or plastic pressure reducing device approved by the Engineer shall be used. Under no circumstances shall the full force of the water from the open end of a hose be allowed to fall within the basin around any plant.

After the first watering, water shall be applied to all plants as often and in sufficient amount as conditions may require to keep the soil set above, around, and below the root systems of the plants during the life of the contract.

After the installed irrigation system has been accepted, it may be used to water the planted area.

Any additional watering measures required to initially saturate the backfill, water the plants immediately after planting, or to maintain the plants in a satisfactory growing condition shall be anticipated and furnished by the Contractor at his expense.

(b) Plants (Group C). As soon as all the perennials in a given area have been planted, water shall be applied to that area in a fine mist from an atomizing nozzle until the entire planting bed is saturated. This initial watering shall not be done with the installed irrigation system.

After the first watering, water shall be applied to the areas as often and in sufficient amount as conditions may require to keep the soil wet above, around, and below the root systems of the plants during the life of the contract.

(c) Plants (Groups D and E). The seedbeds shall be kept in a moist but not soggy condition until after germination. After germination, water shall be applied to the areas as often and in sufficient amount as conditions may require during the life of the contract.

The installed turf irrigation system may be used to water those areas as long as care is taken to prevent erosion or other damage to the area. However, should the irrigation system prove to be unsatisfactory, other means of watering, as approved by the Engineer, shall be used until germination is complete and all grass has attained a height of one (1) inch. After a uniform stand of grass which has attained a height of one (1) inch has been achieved over the entire turf area, the installed turf irrigation system may be used to keep the area moist.

212.03.08 Replacements. (a) Plants (Groups A, B, and C). During the planting and plant establishment period of the project, all plants that show signs of failure to grow normally or which are so injured or damaged as to render them unsuitable for the purpose intended, as determined by the Engineer, shall be removed and replaced in kind. The Engineer will inspect the work on the first

or second working day of each week during the planting and plant establishment periods, and will mark or otherwise indicate all plants to be replaced. The Contractor shall complete replacement of such plants as soon as possible, but in no case shall the Contractor take more than two (2) weeks to complete the replacement.

Plants required to replace plants shall be furnished and planted by the Contractor at his expense.

(b) Plants (Groups D and E). The Engineer will inspect the turf at the time of the second cutting and the meadow area when the grass has reached a height of approximately two (2) inches and will designate any areas which need reseeding. Seed used for reseeding shall be the same types and amounts as specified for the initial planting and shall be planted in accordance with the contract documents or as directed by the Engineer. The cost of the seed and actual reseeding shall be borne by the Contractor.

212.03.09 Fertilizers and Additives. When fertilizers or additives are called for, they shall be applied at the rates and as specified in the contract documents or as approved by the Engineer.

212.03.10 Protection of Existing Facilities. Any existing buildings, equipment, piping, pipe covering, sprinkling systems, sewers, sidewalks, landscaping, utilities, roadways, or any other improvement of facilities damaged due to the Contractor's operations shall be repaired or replaced by the Contractor at his expense as directed by the Engineer.

212.03.11 Plant Establishment Work. This work shall consist of watering and caring for all of the plants and planting areas, the replacement of plants, the weeding and general maintenance as specified in the contract documents.

The plant establishment period shall begin at such time as all planting has been accomplished and all other work has been completed and the project is in a neat and clean condition.

The length of the plant establishment period shall be as specified in the contract documents.

The Engineer will notify the Contractor in writing of the start of the plant establishment period and will furnish statements regarding days credited to the plant establishment period after said notification.

The time required for plant establishment work shall be considered as included in the total time limit specified for the contract. Any day upon which no work is required, as determined by the Engineer, will be credited as one of the plant establishment days regardless of whether or not the Contractor performs plant establishment work.

Any day when the Contractor fails to adequately water plants, replace unsuitable or damaged plants, do weed control, adjust or replace bracing and ties, or other work, as determined necessary by the Engineer, will not be credited as one of the plant establishment days. No extension of contract time will be granted beyond the final completion date by reason of failing to perform plant establishment work on days when such work is necessary.

All plants shall be kept watered as provided in "Watering" in these Standard Specifications.

Surplus earth, papers, trash, and debris, which accumulate in the planted areas shall be removed and disposed of in accordance with the provisions in subsection 107.14, "Disposal of Material Outside the Highway Right of Way," and the planted areas shall be so cared for as to present a neat and clean condition at all times.

During the plant establishment period, trees and shrubs shall be pruned or headed back by the Contractor at his expense, when and as directed by the Engineer.

In order to carry out the plant establishment work the Contractor shall furnish sufficient men and adequate equipment to perform the work during the plant establishment period.

METHOD OF MEASUREMENT

212.04.01 Measurement. The quantity of materials and work measured for payment will be materials and work

complete and in place. The various items will be measured in the manner and by the unit as follows:

(a) Site preparation will be measured by the acre.

(b) Topsoil will be measured by the cubic yard in the hauling vehicle at the jobsite.

(c) Preparing soil (plant boxes) will be measured by the square foot.

(d) Preparing soil (plant bed) will be measured by the square foot.

(e) Fertilizer will be measured by the pound determined by marked quantities and sack count, by the ton, by each stick or pellet, or by the gallon, all as designated in the proposal.

(f) Humus will be measured by the cubic yard in the hauling vehicle at the jobsite or by the cubic yard determined by marked quantities and sack count.

(g) Mulch will be measured by the cubic yard in the hauling vehicle at the jobsite or by the cubic yard determined by marked quantities and sack count.

(h) Hole preparation will be measured by the actual number of holes prepared.

(i) Trench preparation will be measured by the linear foot and the depth and width of the trench will be designated in the contract documents.

(j) Tree rings will be measured by the number of rings used in the work. Each size will be considered separately and so designated in the proposal.

(k) Mowing strips will be measured by the number of linear feet along the top of the strip.

(l) Planter boxes will be measured by the number of boxes placed on the project that conform to the sizes specified in the contract documents.

(m) Header boards will be measured by the thousand foot board measure (Mfbm).

(n) Plants in Groups A through C will be measured by the number of plants in each group.

(o) Plants in Groups D and E inclusively will be measured by the square foot in place, with each group considered separately.

(p) The unit of measure for plant establishment work will be lump sum.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

212.05.01 Payment. The accepted quantities for items of this section measured as provided in subsection 212.04.01, "Measurement," will be paid for at the contract unit price bid for the type, size, group, or whatever information is necessary for identification, and so identified in the proposal. Such payment shall be full compensation for all the labor, materials, and incidentals necessary to complete the work.

Water will be considered subsidiary to the major items of work and no further compensation will be allowed therefor.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Site Preparation	Acre
Topsoil	Cubic Yard
Preparing Soil (plant boxes)	Square Foot
Preparing Soil (planting bed)	Square Foot
Fertilizer (type and class)	Pounds, Ton, Each, Gallons
Humus (type)	Cubic Yard
Mulch (type)	Cubic Yard
Hole Preparation	Each
Trench Preparation	Linear Foot
Mowing Strips	Linear Foot
Planter Boxes (type, size)	Each
Header Boards (type lumber, size)	Mfbm
Plants (Groups A–C)	Each
Plants (Groups D–E)	Square Foot
Plant Establishment Work	Lump Sum

SECTION 213

IRRIGATION SYSTEMS

DESCRIPTION

213.01.01 General. This work shall consist of furnishing all materials and labor required to install an irrigation system in accordance with these specifications and the details shown on the plans. The irrigation system as shown on the plans is diagrammatic only, the various components of the system shall be installed so as to provide complete and adequate coverage of the areas to be irrigated.

This work shall also consist of furnishing and installing asbestos cement pipe conduit for future irrigation systems as shown on the plans and as specified herein.

MATERIALS

213.02.01 General. All materials and equipment incorporated in the irrigation system shall be new, undamaged, of standard quality and shall be subject to testing as specified herein. The materials used shall be those prescribed for the several items which constitute the finished work and shall conform to the applicable requirements of Section 726, "Roadside Materials."

The Contractor shall submit three sets of brochures or shop drawings for each accessory or fixture, and each item of hardware or equipment he intends to use, prior to ordering these items. Brochures shall contain pertinent dimension, finish, installation, and maintenance data necessary for the proper placement or use of each item. If approved as appearing to meet specification and building requirements, one set of brochures for the item will be returned to the Contractor stamped "Approved." Installation of items noted above will not be allowed if pertinent brochures have not been approved unless otherwise approved by the Engineer. The approval of a brochure does not constitute final approval of the item. The Engineer reserves the right to reject any work, material or item that does not conform to

the requirements of the plans or specifications as set forth herein even though the pertinent brochure may have been approved.

213.02.02 Pipe and Fittings. Pipe and pipe fittings shall conform to the requirements of subsection 726.03.09, "Pipe and Fittings."

Asbestos cement pipe conduit shall be bedded and backfilled with sandy material as shown on the plans. Material used for bedding and backfilling of asbestos cement pipe conduit shall consist of natural sand or a mixture of sand with gravel, crushed gravel, crushed stone, or other broken or fragmented material to fill the voids in the coarser material. In addition thereto, the material shall conform to the following requirements:

Sieve Sizes	Percentage by Weight Passing Sieve
3/8"	100
No. 200	0–15

213.02.03 Control Tubing. Tubing and fittings shall be capable of withstanding a three hundred (300) p.s.i. operating pressure, and shall be of the size indicated on the plans.

213.02.04 Automatic Controllers. When called for on the plans, the Contractor shall furnish and install on a concrete base, automatic controllers as herein specified. They shall be an electrically timed device for automatically opening and closing control valves for predetermined periods of time and mounted so that all normal adjustments will be conveniently located for use by the operator. Controllers shall be enclosed in a weatherproof metal housing with hasp and lock or locking device. All locks or locking devices shall be master keyed and three (3) sets of keys provided. Operating features shall include the following:

(a) Each valve in the circuit shall be adjustable for setting to remain open for any desired period of time—from five (5) minutes or less to at least thirty (30) minutes.

(b) The controller shall operate on 110–117 volts and

shall be equipped with a circuit breaker or fuseable connection to protect the controller from overloads.

(c) The controller shall have a master on-off switch to turn all stations off without disturbing the clock settings or automatic timing sequences.

(d) Controls shall allow any position to be operated manually both on or off whenever desired.

(e) Controls shall provide for resetting the start of the irrigation cycle at any time and advancing from one position to another.

213.02.05 Sprinkler Heads. Sprinkler heads shall be of the type, pattern and coverage shown on the plans.

Soaker valves shall be constructed of polyvinyl chloride (PVC) and shall be of the configuration and dimension shown on the plans. Soaker valves shall be of a make and type of construction so that they may be installed directly in the flexible plastic pipe supply line, and shall have no external working parts. Each soaker valve shall be capable of being adjusted to deliver one to three (1–3) gallons per hour at ten (10) to twenty (20) p.s.i., final adjustment shall be as determined by the Engineer. Adjustment shall be accomplished with a seven-sixteenths ($\frac{7}{16}$) inch socket wrench.

213.02.06 Valve Protection Sleeves. Concrete valve protectors shall be precast reinforced Portland cement concrete sleeves with a cast-iron lid of the dimensions shown on the plans. Concrete shall be Class D made with Type II cement. Valve protectors shall have extensions as necessary to reach the depth indicated. Extensions shall be made of the same materials as the valve protectors. Valve protectors and extensions may be the product of commercial producers upon prior approval of the Engineer.

213.02.07 Gate Valves. Valves two and one-half (2½) inches and smaller shall be of the same size as the pipes on which they are placed unless otherwise indicated on the plans. Service rating for nonshock cold water shall

be two hundred (200) p.s.i. These valves shall be all bronze, split wedge type, with rising stem and union bonnet. Packing shall be teflon impregnated asbestos and the valve shall be capable of being repacked under pressure. Handwheels shall be malleable iron. Valves two and one-half (2½) inches and smaller shall be the threaded type and installed with a union on either side of the valve.

Gate valves three (3) inches and larger shall be iron body, bronze mounted, double disc, parallel seat type with "O" ring seal and shall comply with AWWA standards. These valves shall have a working pressure of two hundred (200) p.s.i. and a test pressure of four hundred (400) p.s.i. A shut-off rod, six (6) feet in length that will fit a two (2) inch wrench nut, shall be furnished by the Contractor.

213.02.08 Control Valves. Manual control valves shall be straight or angle pattern globe valves of all brass or bronze construction with replaceable compression disks. Manual control valves shall be of the same size as the pipes on which they are placed unless otherwise indicated on the plans, and shall be provided with a union connection. Manual control valves shall be capable of withstanding a cold water working pressure of one hundred fifty (150) p.s.i.

Electric control valves shall be of the diaphragm type, normally closed, 24-volt, 60-cycle. The valve solenoids shall operate with 18–30 volts of power. The solenoid shall be completely encapsulated for positive waterproofing. The valve body and bonnet shall be of cast brass or bronze, flange or threaded type. If threaded type is used it shall be provided with a union connection. The time interval between opening and closing the valve shall not be less than five (5) seconds. The solenoid plunger shall be spring loaded so the valve may operate when installed in any position and shall be constructed of stainless steel with neoprene seat. Valve bonnet shall have a bleed screw for manual operation and a manual flow control adjustment. Electric control valves shall be capable of withstanding a nonshock cold water working pressure of one hundred fifty (150) p.s.i.

213.02.09 Quick Coupler Valves. The quick coupler valve shall be of brass or bronze construction with three-fourths (¾) inch F.I.P. bottom connection. The valve shall be of two (2) piece construction with removable upper body. The valve body shall be designed with a single slot to receive a single slot coupler.

The three-fourths (¾) inch male and one-half (½) inch female I.P.S. coupler for the quick-coupler valve shall be single slot of bronze construction.

213.02.10 Valve Boxes. Valve boxes shall be reinforced precast Portland cement concrete boxes of the general dimensions shown on the plans with a steel lid. Class D concrete made of Type II Portland cement shall be used. Valve boxes shall have extensions as necessary to reach the depth indicated. Valve boxes may be the product of commercial producers and may be used upon prior written approval of the Engineer. Extensions shall be of the same material as the concrete valve box.

213.02.11 Backflow Preventers. Backflow preventers shall meet the requirements of the governing agency concerned. Each backflow preventer shall be equipped with a gate valve at each end of the backflow prevention unit. Three (3) inch and larger valves shall be flanged type, iron body, brass trimmed, wedge gate valves with nonrising stem, and shall be capable of withstanding a cold water working pressure of two hundred (200) pounds per square inch. Two and one-half (2½) inch and smaller valves shall be as specified above, except they shall be screwed type and shall be installed with a union between each valve and the backflow prevention unit. Backflow preventers and valves shall be the size shown on the plans.

It will be the responsibility of the Contractor to determine the requirements of the governing agency in regard to the type and detail of backflow prevention required.

For purpose of payment the valves required to be installed at each end of the backflow prevention unit and all fittings between such valves required for proper installation shall be considered as a part of the backflow preventer.

213.02.12 Drain Valves. Automatic ball check drain valve shall be of precision machined brass with a threaded keeper rather than a crimped type at the inlet end. Ball checks shall be spring loaded and shall close under a pressure of two (2) to four (4) p.s.i. Valves shall be installed with a gravel sump as shown on the plans.

The gravel to be used in gravel sumps for ball check drain valves shall conform to the requirements for Size No. 67 as specified in subsection 706.03.01 of the Standard Specifications.

213.02.13 Hose Bibs. The hose bib shall be a no-freeze burial type hydrant with a self-closing handle and shall have three-fourths (¾) inch male I.P.S. threads at the supply line end.

213.02.14 Vacuum Breakers. When called for in the contract documents or as required by local ordinances, vacuum breakers meeting the following requirements shall be furnished and installed. All vacuum breaker installations are subject to inspection by authorized county or municipal authorities.

Atmospheric vacuum breakers shall have all bronze bodies and be of the same dimension as the pipe on which it is attached. Design shall permit free flow of water under pressure. When vacuum conditions exist it shall automatically close the check valve stopping all flow of water and admit air into the main line. Upon restoration of water pressure the air intake shall be shut off and the check valve reopened without spillage. Unless otherwise specified, the vacuum breaker shall be installed on the discharge side of the control valve six (6) inches above the highest sprinkler head on the line. Vacuum breakers shall not be required on sprinkler lines when all sprinkler heads on the line are elevated to a minimum of six (6) inches above the finished grade, such as sprinkler lines irrigating shrub beds. Atmospheric vacuum breakers shall have a service rating of one hundred fifty (150) p.s.i. for nonshock cold water and shall be designed for operation up to temperatures of one hundred forty (140) degrees Fahrenheit.

Pressure type vacuum breakers shall be installed on the discharge side of the meter or service connection as shown on the plans. Vacuum breakers shall be of heavy duty construction with all bronze bodies, check valves, and test cocks. Pressure type vacuum breakers shall be designed to operate under continuous pressure permitting the free flow of water at all times. Air intake shall be spring loaded to insure positive opening upon release of pressure or vacuum created in the supply lines. Vacuum breakers shall be furnished with approved check valves, inlet and discharge shut-off valves and field testing cocks. Assembly for various pipe sizes shall be according to local requirements or as specified in the contract documents. Unless otherwise specified pressure type vacuum breakers shall have a service rating of three hundred (300) p.s.i. for nonshock cold water.

All vacuum breaker installations shall meet local ordinances and plumbing requirements.

213.02.15 Air Relief Valve. The air relief valve shall be designed to release air entrapped in a pipeline until liquid reaches the float which will rise to the seat and close the valve. The float shall be stainless steel resting within a stainless steel or bronze cup. The valve body and flange shall be gray iron casting. The valve shall be one (1) inch size with screwed inlet, and shall be capable of withstanding pressures up to three hundred (300) p.s.i. The valve shall be fitted with a galvanized steel return elbow as indicated on the plans.

CONSTRUCTION

213.03.01 General. The Contractor shall not alter or change the location of pipes, valves, sprinklers, or other equipment as shown on the plans unless so authorized by the Engineer. All necessary arrangements for connecting to mains shall be made by the Contractor with the agency supplying the water, and such installations and equipment shall conform to the requirements set forth by the supplying agency.

213.03.02 Excavation. Trenches shall be of sufficient width to permit snaking of all plastic pipe not connected by rubber ring-type fittings. Pipe connected with rubber ring-type fittings shall not be snaked. The top six (6) inches of topsoil, when such exists, shall be kept separate from subsoil and shall be replaced as the top layer when backfill is made. Trenches shall be excavated with vertical sides and provided with bracing and shoring to be placed as designated by the Engineer. Trenches in rock or like material shall be excavated two (2) inches below the required depth and shall be backfilled to required depth with sand or other suitable material free from rock or stones.

213.03.03 Excavation Adjacent to Trees. Care shall be exercised by the Contractor when excavating trenches near existing trees. Where roots are two (2) inches and greater in diameter, except in the direct path of the pipe, the pipe trench shall be hand excavated and tunneled. When large roots are exposed they shall be wrapped with heavy burlap for protection and to prevent excessive drying. Trenches dug by machines adjacent to trees having roots two (2) inches and less in diameter shall have the sides hand trimmed making a clean cut of the roots. All roots one-half (½) inch or greater in diameter that are cut and trimmed shall be treated with an approved tree wound dressing. Trenches having exposed tree roots shall be backfilled within twenty-four (24) hours unless adequately protected by moist burlap or canvas.

213.03.04 Piping. All live main lines shall be a minimum of thirty-six (36) inches below finished grade, measured from the top of the pipe. Other lines shall be a minimum of eighteen (18) inches below finished grade, except flexible soaker lines which shall be four (4) inches below finished grade, measured from the top of the pipe. All water lines, except soaker lines, above thirty-six (36) inch depth shall be provided a means for drainage to prevent freezing. Pipes shall be sloped to drain without sags.

Unless otherwise specified, drain valves shall be placed only at the low point of all lateral or section lines. All live mains located under existing pavement shall be placed in conduits jacked under pavement unless otherwise noted on the plans or approved by the Engineer. Conduits shall be no larger than necessary to conveniently accommodate the pipe and fittings. Where necessary, live mains and control tubing may be placed in separate conduits laid adjacent and parallel. All jacking operations shall be performed in a manner approved by the Engineer and conduit run at a depth below the pavement as may be ordered. Where possible, mains and laterals or section piping shall be placed in the same trench.

213.03.05 Jointing. All galvanized steel pipe shall have sound, clean cut standard pipe threads well fitted. All pipe shall be well reamed to the full diameter and burrs removed before assembly. Threaded joints shall be made up with the best quality pure lead paste, applied smoothly and evenly to the male thread only. All screwed joints shall be made tight with tongs and wrenches without the use of handle extensions. Any joints that leak shall be cleaned and remade with new material. Caulking or thread cement to make joints tight will not be permitted.

213.03.06 Control Tubing. Copper control tubing shall be joined with brass or bronze screwed compression type fittings. Ends of tubing to be joined shall be uniformly cut, burred, and flanged. Directional changes requiring less than a three (3) inch radius shall be made with ninety (90) degree ell fittings.

213.03.07 Installation. Conduit shall be installed not less than one and one-half (1½) feet below the curb grade in sidewalk areas and not less than three and one-half (3½) feet below the finished grade in all other areas. Conduit shall be installed under existing pavement by approved jacking or drilling methods. Pavement shall not be disturbed without the approval of the Engineer, and then only in the event obstructions are encountered. When permitted

by the Engineer, small test holes may be cut in the pavement to locate obstructions. Jacking or drilling pits shall be kept at least two (2) feet from pavement edge wherever possible. Excessive use of water that will soften subgrade or undermine the pavement will not be permitted.

Where conduit is installed in an open trench, excavation and backfill shall conform to the provisions in Sections 206, "Structure Excavation," and 207, "Backfill." The conduit shall be laid in the trench to the lines and grades established by the Engineer. The bottom of the trench shall be graded and prepared to provide a firm and uniform bearing throughout the entire length of the conduit. During backfilling operations, the conduit shall be rigidly supported so that no movement of or damage to the conduit or joints will result.

After the conduit is installed, if shown on the plans or specified in the special provisions, galvanized steel pipe shall be placed therein.

Asbestos cement pipe conduit shall be installed as shown on the plans and the ends of the conduit shall be marked with "T" post markers and shall be capped by a nonpermanent cap that will prevent the conduit from being filled.

Where connection is made to existing supply lines, compression type fittings may be used.

A backflow preventer shall be installed at each meter if called for on the plans.

Where supply lines or conduits are to be installed through existing paved areas, the subbase, base, and paving removed shall be replaced with material of equal quality.

All pipe shall be cut straight and true. After cutting, the ends shall be reamed out to the full inside diameter of the pipe.

Foreign material shall be prevented from entering the irrigation system during installation. Immediately prior to assembling, all pipes, valves, and fittings shall be cleaned. All unattached ends of pipe, fittings, and valves shall be plugged or capped pending attachment of additional pipe

or fittings. All lines shall be thoroughly flushed out prior to attachment of terminal fittings.

Before any portion of the pipeline is backfilled, water shall be turned into that portion of the line and maintained at full pressure for a period of not less than eight (8) consecutive hours after all air has been expelled from the line. Any leaks that develop in the portion of the system installed by the Contractor shall be repaired and all defective materials shall be replaced by him. The pipe shall be plugged or capped where sprinklers are to be installed while making this test. The entire system shall then be checked for uniform and complete coverage after installing sprinklers.

Nozzle lines shown on the plans immediately adjacent to a fence or guard railing shall be installed on the fence or guard railing, and those immediately adjacent to a curb or shoulder shall be installed three (3) feet from the curb or paved shoulder unless otherwise noted on the plans.

All nozzle lines, except those installed on a fence or guard railing, shall be installed on three-fourths (¾) inch pipe anchor posts unless otherwise shown on the plans.

Sprinkler connections shall be installed on swing joints as detailed on the plans.

All plastic irrigation pipe shall be installed and laid according to the manufacturer's instructions, and as directed by the Engineer. Before joints of PVC plastic pipe are made up, the plastic pipe fittings shall be exposed to the same temperature for a reasonable length of time. Pipe shall be cut with a fine-tooth hacksaw and any burrs shall be removed. The outside surface of the pipe and the inside surface of the fittings shall be cleaned and softened with an approved primer, using a dauber, brush top applicator, or paint brush about one-half (½) the pipe diameter. A light second coat of primer shall be applied to the fitting socket. Primer shall not be allowed to run down the inside of the pipe.

The cement solution shall be applied to the pipe and fitting socket with an applicator having a width of approximately one-half (½) the diameter of the pipe, using the

proper cement for the size of pipe. Apply a full, even layer of cement on the pipe equal to the depth of socket. Flow the cement on with the applicator, do not brush it out to a thin paint type layer. Apply a medium layer of cement to the fitting socket, avoid puddling cement in the socket. On bell end pipe do not coat beyond the socket depth or allow cement to run down in the pipe beyond the bell. Apply a second full even layer of cement on the pipe. Assemble the pipe and fitting without delay, making certain cement is wet. Use sufficient force to ensure that the pipe bottoms in the fitting socket. Twist the pipe one-eighth (⅛) to one-fourth (¼) turn as it is inserted. Hold the fitting and the pipe together until cement takes its initial set. After assembly a joint shall have a ring or bead of cement completely around the junction of the pipe and fitting. If voids in this ring are present, sufficient cement was not applied and the joint will be considered defective. Using a rag, remove all the excess cement from the pipe and fitting including the ring or bead. Avoid disturbing or moving the joint. Handle newly assembled joints carefully until initial set has taken place. Recommended setting time allowed before handling or moving is related to temperature, type of cement, and size of pipe, and shall be according to manufacturer's recommendations. Old or thickened cement shall be discarded and replaced. The male pipe thread of all threaded connections on PVC plastic pipe shall be coated with a joint compound or tape suitable for use on plastic pipe.

Cement solution for flexible PVC shall be an approved type for joining flexible PVC to itself or to rigid PVC.

All pipe shall be cut straight and true. After cutting, the ends shall be reamed out to the full inside diameter of the pipe. Polyvinyl chloride pipe shall be partially backfilled between joints with small amounts of backfill material to prevent movement during the pressure test.

213.03.08 Control Tubing Installation. Control tubing shall be placed with the main supply line. Tubing shall be bundled together by four wraps of friction tape

at six (6) foot intervals. Location of the bundle of control tubing shall be to one side of the pipe, and a minimum of two (2) inches from any galvanized pipe.

213.03.09 Flushing and Testing. All main supply lines shall be flushed completely of foreign particles before placing section control valves, quick-coupler valves and hose bibs. After flushing and when valves are in place, all main supply lines shall be tested at one hundred fifty (150) p.s.i. with valves closed. Pressure shall be maintained for a period of eight (8) consecutive hours. All joints showing leaks shall be cleaned, remade, and tested.

After installation of section lines, the piping shall be completely flushed of foreign particles before attaching sprinkler heads and drain valves. After flushing, section lines shall be tested with risers capped and drain valves closed. The test shall be made at maximum operating pressure for a period of one (1) hour. Any pipe, fittings or joints showing leaks will not be accepted. All joints showing leaks shall be cleaned, remade and tested. Control tubing shall be tested in the manner specified hereinbefore for the main supply lines. Tubing shall be flushed for five (5) minutes before connection with the control valves.

Automatic controllers shall be tested by actual operation for a period of two (2) weeks under normal operating conditions. Should adjustments be required, the Contractor shall do so according to manufacturer's direction and test until operation is satisfactory.

213.03.10 Adjusting System. Before final inspection the Contractor shall adjust and balance all sprinklers to provide adequate and uniform coverage. Spray patterns shall be balanced by adjusting individual sprinkler heads with the adjustment screws or replacing nozzles to produce a uniform pattern. Unless otherwise specified, sprinkler spray patterns will not be permitted on pavement, walks, or structures.

213.03.11 Backfill. Backfill shall not be started until all piping has been inspected, tested, and approved by the

Engineer, after which, backfilling shall be completed as soon as possible. Upon completion of all piping in the same trench, backfill shall be completed as specified. Trenches containing control tubing shall have a three (3) inch sand or sandy loam cushion free from rocks or stones larger than three-eighths (⅜) inch in diameter placed over all control tubing. Backfill from the bottom of the trench to approximately six (6) inches above the pipe shall be by continuous tamping in such a manner that will not damage pipe or control tubing and shall proceed evenly on both sides of the pipe. The remainder of the backfill shall be thoroughly tamped, except that heavy equipment shall not be used within eighteen (18) inches of any pipe. All backfill material shall be free of rocks, roots, or other objectionable material. The top six (6) inches of the backfill shall be of topsoil material or the first six (6) inches of material removed in the excavation.

METHOD OF MEASUREMENT

213.04.01 Measurement. The materials to be measured for payment under these specifications will be listed in the contract items by size, class, type, gage, or whatever information is necessary for identification.

The quantity of pipe and tubing to be measured for payment will be the actual number of linear feet of the type specified complete and in place. Pipe bends, wyes, tees, and other branches will be measured along centerlines to the point of intersection.

The quantity of sprinklers, couplers, heads, valves, vacuum breakers, hose bibs, concrete valve boxes, valve assemblies, riser assemblies, and faucets will be measured per each of the type and size specified complete and in place.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

213.05.01 Payment. The accepted quantities of pipe and tubing measured as specified in subsection 213.04.01,

"Measurement," will be paid for at the contract unit price bid per linear foot for the types and sizes specified.

The accepted quantity of all other attachments measured as specified in subsection 213.04.01, "Measurement," will be paid for at the contract unit price bid per each for the types and sizes specified.

Payment per linear foot of conduit involved shall be fuil compensation for furnishing and installing pipe conduit, bedding and backfilling, caps, markers, and incidentals necessary to install the conduit complete in place.

The above payment will be full compensation for furnishing all the material and labor necessary to install the system. Such payment shall include excavation, backfill, restoring sidewalk, curb, gutter, pavement, and appurtenances damaged or destroyed by construction and making all required tests.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
(size) (type) Pipe	Linear Foot
(size) (type) (name of attachment)	Each

SECTION 301

SELECTED MATERIAL BASE OR SURFACE

DESCRIPTION

301.01.01 General. This work shall consist of excavating and placing selected granular materials in one or more courses for base or 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 by the Engineer.

MATERIALS

301.02.01 General. Material shall be as set forth in the special provisions.

CONSTRUCTION

301.03.01 Subgrade Preparation. The surface of the subgrade upon which the selected material is to be placed shall conform to the established lines and grade, shall be reasonably smooth and uniform and shall be compacted to the required density.

301.03.02 Placing. In producing, handling, and placing selected materials, care shall be taken to prevent segregation of the fine particles from the coarse. When the required compacted thickness is more than six (6) inches the material shall be placed in layers, none of which shall exceed six (6) inches in depth after compaction, except as provided in subsection 301.03.04, "Compaction."

After the material has been uniformly deposited, it shall be thoroughly blademixed to the full depth of the layer by alternately blading the entire layer to the center and back to the edges of the roadbed. It shall then be spread and finished to the required cross section. At the option of the Contractor, selected material may be spread with equipment meeting the requirements of subsection 303.03.03, "Spreading and Finishing."

Binder material, if required, shall be incorporated either in the surfacing aggregate at the plant when the aggregate is produced, or shall be incorporated uniformly on the roadbed in amounts designated by the Engineer.

301.03.03 Watering. Water shall be applied prior to and during all blading operations, to moisten the material sufficiently to prevent segregation of the fine and coarse particles. Water shall also be applied during the compaction and maintenance stages in sufficient amounts to attain compaction and prevent raveling.

301.03.04 Compaction. Compaction shall immediately follow the spreading operation. Where the required thickness is six (6) inches or less, the base course may be spread and compacted in one layer. However, if vibratory compaction equipment approved by the Engineer is used, and the requirement for density is complied with, the compacted thickness of any one layer may be increased to eight (8) inches. Aggregate bases, placed on road approaches and connections, street intersection areas, median strip areas, shoulder areas, and at locations which are inaccessible to the spreading equipment, may be spread in one or more layers by any means to obtain the specified results.

Each layer of material shall be compacted to not less than ninety-five (95) percent of the maximum density as determined by Test Method No. Nev. T101. Test Method No. Nev. T102 or No. Nev. T103 may be used to determine the in-place density. Test method to be determined by the Engineer.

It is to be expected that a loss of density in the upper portions of the material may occur due to the elements, or for a lapse in time, or for other reasons. Recompaction to the specified density will be required prior to placement of any subsequent course and no additional compensation will be allowed for such recompaction.

METHOD OF MEASUREMENT

301.04.01 Measurement. The quantity of selected material base or surface to be measured for payment will be the number of cubic yards or tons complete and in place.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

301.05.01 Payment. The accepted quantity of selected material base or surfacing, measured as provided above, will be paid for at the contract unit price bid per cubic yard or ton for selected material base or surface, which price shall be full compensation for stripping the pit, crushing, screening, loading, hauling, placing, compacting, and maintaining the base or surface as shown on the plans and as directed by the Engineer.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Partial payments may be made in accordance with subsection 109.06, "Partial Payments."

Payments will be made under:

Pay Item	Pay Unit
Selected Material Base	Cubic Yard or Ton
Selected Material Surface	Cubic Yard or Ton

SECTION 302

AGGREGATE BASE COURSES

DESCRIPTION

302.01.01 General. This work shall consist of furnishing, placing, and compacting aggregate base courses constructed in accordance with the requirements hereinafter set forth and in reasonably close conformity with the lines, grades, thicknesses, and cross sections shown on the plans or established by the Engineer.

MATERIALS

302.02.01 General. All materials shall conform to the requirements as set forth in the following subsections:

Type 1 Class B Aggregate Base	Subsection 704.03.03
Type 2 Class B Aggregate Base	Subsection 704.03.05
Type 3 Class B Aggregate Base	Subsection 704.03.07
Type 1 Class A Aggregate Base	Subsection 704.03.02
Type 2 Class A Aggregate Base	Subsection 704.03.04
Type 3 Class A Aggregate Base	Subsection 704.03.06

Acceptance sampling will conform to the test requirements as set forth in the above mentioned subsections and in subsection 106.04, "Samples and Tests."

CONSTRUCTION

302.03.01 Subgrade Preparation. Any ruts, holes, defects, or soft yielding places which occur in the subgrade or subbase for any cause whatsoever shall be corrected and compacted to required density and stability before an aggregate base course is placed thereon. The above-mentioned repairs are to be made at the expense of the Contractor, except as provided for in subsection 203.03.02, "Unsuitable Material."

302.03.02 Spreading Class A Aggregates. The aggregate shall be spread in one operation with a self-propelled spreader ready for compaction without further shaping

except for trimming to correct minor deficiencies as hereinafter specified. The spreader shall be provided with a screed that strikes off and distributes the material to the required width and to the surface tolerances hereinafter set forth. The screed shall be adjustable to the required cross section. Screed action includes any cutting, oscillating, or other practical motion that produces a finished surface texture of uniform appearance. The spreader shall be self-propelled and capable of spreading not less than twelve (12) feet in width. Equipment not propelled by the unloading vehicle will be considered self-propelled. In narrow trench widenings, aggregate base course may be placed with self-propelled trench widening spreaders. If the spreader leaves ridges, indentations, or other objectionable marks that cannot be prevented by adjustments or eliminated by rolling, its use shall be discontinued.

A motor grader will be considered to be a self-propelled mechanical spreader if it has been equipped with end wings on the blade, and with cross slope and automatic grade controls.

Aggregate bases, placed on road approaches and connections, street intersection areas, median strip areas, shoulder areas, and at locations which are inaccessible to the spreading equipment, may be spread in one or more layers by any means to obtain the specified results.

Other than previously provided in this subsection, the use of motor graders will not be permitted during depositing, spreading and compacting operations, except as follows:

(a) Motor graders may be used to correct unavoidable segregation at edges and to trim the surface of the aggregate base after compaction in order to finish the base within the tolerances specified.

(b) When the area of the base is small or irregular, and it is impractical to use self-propelled spreading equipment, the base material may be spread by motor grader or other approved methods.

302.03.03 Spreading Class B Aggregates. The aggregate shall be uniformly deposited on the approved subgrade by means of the hauling vehicle with or without spreading devices. Aggregate will be distributed over the surface to the depth specified on the plans or established by the Engineer.

After base course material has been deposited, it shall be thoroughly blade-mixed to full depth of the layer by alternately blading the entire layer to the center and back to the edges of the road. It shall then be spread and finished to the required cross section by means of a self-propelled pneumatic-tired motor grader.

At the option of the Contractor, the aggregate may be spread with a self-propelled spreader with the aggregate ready for compaction without further shaping. If this option is exercised, however, the operation shall become subject to the requirements of subsections 302.03.04, "Watering and Mixing Class A Aggregates," and 302.-03.02, "Spreading Class A Aggregates."

302.03.04 Watering and Mixing Class A Aggregates. The base course material and water shall be mixed in a mixer approved by the Engineer. Water shall be added during the mixing operation by means of spray bars in the amount necessary to provide the optimum moisture content for compacting. Attention is directed to subsection 210.03.01, "Equipment." After mixing to the extent that the product has a uniform homogeneous appearance, the base material shall be transported to the job while it contains the proper moisture content and shall be placed on the roadbed by means of an approved self-propelled aggregate spreader as provided for in subsection 302.-03.02, "Spreading Class A Aggregates." If the material has dried appreciably prior to final compacting, additional water shall be added by means of a pressurized water truck to assist in compaction and to prevent raveling.

302.03.05 Watering Class B Aggregates. Water shall be applied prior to and during all blading and processing

operations to moisten the material sufficiently to prevent segregation of the fine and coarse particles. Water shall be applied during the compaction and maintenance stages in sufficient amounts to assist in compaction and prevent raveling. Reference is made to Section 210, "Watering."

302.03.06 Compaction. Compaction shall immediately follow the spreading operation. Where the required thickness is six (6) inches or less, the base course may be spread and compacted in one layer. However, if vibratory compaction equipment of a type approved by the Engineer is used, and the requirement for density is complied with, the compacted thickness of any one layer may be increased to eight (8) inches. Aggregate bases, placed on road approaches and connections, street intersection areas, median strip areas, shoulder areas, and at locations which are inaccessible to the spreading equipment, may be spread in one or more layers by any means to obtain the specified results. Each layer of material shall be compacted to not less than ninety-five (95) percent of the maximum density as determined by Test Method No. Nev. T101. Test Method No. Nev. T102 or No. Nev. T103 may be used to determine the in-place density. Test method to be determined by the Engineer.

It is to be expected that a loss of density in the upper portions of the material may occur due to the elements, or for a lapse in time, or for other reasons. Recompaction to the specified density will be required prior to placement of any subsequent course and no additional compensation will be allowed for such recompaction.

302.03.07 Tolerance for Type 2 Class A Aggregate. When a twelve (12) foot straightedge is laid in any direction, the finished surface shall not deviate at any point more than 0.04 foot from the bottom thereof.

METHOD OF MEASUREMENT

302.04.01 Measurement. The quantity of aggregate

base to be measured for payment will be the number of cubic yards or tons complete and in place.

The weight of material will be determined by deducting from the weight of material delivered to the work, the weight of water in excess of optimum plus one percentage point. Optimum moisture will be determined by Test Method No. Nev. T101 or No. Nev. T102 as determined by the Engineer. Moisture content will be determined by Test Method No. Nev. T112. The weight of water thus deducted will not be measured for payment.

Due to possible variations in the specific gravity and voids of the aggregates, the tonnage used may vary from the proposal quantities and no adjustment in contract unit price will be made because of such variation.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

302.05.01 Payment. The accepted quantity of aggregate base material, measured as provided in subsection 302.04.01, "Measurement," will be paid for at the contract unit price bid per cubic yard or ton, for the type and class specified, which price shall be full compensation for stripping the pit, crushing, screening, mixing, hauling, placing, compacting, and maintaining the base courses as shown on the plans and as directed by the Engineer.

It is to be expected that deviations in thickness will occur in placing aggregate base courses. It shall be the inherent responsibility of the Contractor to bring the various base courses to the required grade line. Payment will be limited to the number of tons or cubic yards complete and in place and no additional payment will be made for any labor or equipment used in bringing the courses to grade.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Partial payments may be made in accordance with subsection 109.06, "Partial Payments."

Payment will be made under:

Pay Item	Pay Unit
Type 1 Class B Aggregate Base	Cubic Yard or Ton
Type 2 Class B Aggregate Base	Cubic Yard or Ton
Type 3 Class B Aggregate Base	Cubic Yard or Ton
Type 1 Class A Aggregate Base	Cubic Yard or Ton
Type 2 Class A Aggregate Base	Cubic Yard or Ton
Type 3 Class A Aggregate Base	Cubic Yard or Ton

SECTION 303

PLANTMIX BITUMINOUS BASE

DESCRIPTION

303.01.01 General. This work shall consist of aggregate and bituminous material mixed in a central plant and spread and compacted on a prepared 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 by the Engineer.

The requirements of Section 401, "Plantmix Bituminous Pavements—General," shall be applicable to this work, except as hereinafter specified.

MATERIALS

303.02.01 General. The materials shall conform to the requirements as specified in subsections 401.02.01 through 401.02.04, inclusive, of Section 401, "Plantmix Bituminous Pavements—General."

CONSTRUCTION

303.03.01 General. The construction requirements shall conform to the requirements as specified in subsections 401.03.01 through 401.03.13, inclusive, of Section 401, "Plantmix Bituminous Pavements—General," with the following exceptions:

303.03.02 Rollers. There shall be operating with each paver, three (3) rollers meeting the requirements of (a), (b), and (c) of subsection 401.03.04, "Rollers," except as hereinafter noted.

When two (2) pavers are paving in echelon within four hundred (400) feet of each other and each paver is placing not more than one hundred fifty (150) tons of bituminous mixture per hour, then three (3) rollers meeting the requirements of (a), (b), and (c) of subsection 401.03.04, "Rollers," may be used with both pavers.

303.03.03 Spreading and Finishing. Unless otherwise specified, bituminous plantmix base shall not be placed in courses exceeding four (4) inches in compacted thickness. When more than one course is placed, the courses shall be of approximately equal thickness.

303.03.04 Surface Tolerances. The completed surfacing shall be thoroughly compacted, smooth and free from ruts, humps, depressions, or irregularities. When a straightedge twelve (12) feet long is laid on the finished surface and parallel with the centerline of the highway, the surface shall not vary more than 0.02 foot from the lower edge of the straightedge. The transverse slope of the finished surface shall be uniform to a degree such that no depressions greater than 0.02 foot are present when tested with a straightedge twelve (12) feet long laid in a direction transverse to the centerline and extending from edge to edge of a twelve (12) foot traffic lane.

Any ridges, indentations, or other objectionable marks left in the surface of the bituminous mixture by blading or other equipment shall be eliminated by rolling or other means. The use of any equipment that leaves ridges, indentations, or other objectionable marks in the bituminous mixture shall be discontinued and other acceptable equipment shall be furnished by the Contractor.

METHOD OF MEASUREMENT

303.04.01 Measurement. Plantmix bituminous base will be measured as specified in subsection 401.04.01, "Measurement."

BASIS OF PAYMENT

303.05.01 Payment. The accepted quantity of materials measured as provided in subsection 303.04.01, "Measurement," will be paid for at the contract unit price bid per ton for plantmix bituminous base aggregate, per ton for mineral filler (type) and per ton for bituminous material (asphalt cement or liquid asphalt).

The above prices shall be full compensation for furnishing all the material, mixing, loading, hauling, placing, compacting, and incidentals necessary for doing all the work involved in constructing plantmix bituminous base.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Partial payments for plantmix bituminous base aggregate may be made as set forth under subsection 109.06, "Partial Payments."

Payment will be made under:

Pay Item	Pay Unit
Plantmix Bituminous Base Aggregate (type)	Ton
Mineral Filler (type)	Ton
Asphalt Cement (grade)	Ton
Liquid Asphalt (grade)	Ton

SECTION 304

PORTLAND CEMENT TREATED BASE

DESCRIPTION

304.01.01 General. This work shall consist of constructing one or more courses of a mixture of aggregate and Portland cement on a prepared surface in accordance with these specifications in reasonably close conformity with the lines, grades, thicknesses, and typical cross sections shown on the plans or established by the Engineer.

The method to be used, either plantmix or roadmix, shall be designated in the contract documents.

MATERIALS

304.02.01 General. All material shall conform to the requirements specified in the following sections and subsections:

Portland Cement	Section 701
Water	Section 722
Aggregate for Portland Cement Treated Base	Subsection 704.03.08
Liquid Asphalt	Subsection 703.03.03
Emulsified Asphalt	Subsection 703.03.04

CONSTRUCTION

304.03.01 Proportioning. Portland cement shall be applied to the mineral aggregate at not less than two (2) percent nor more than four and one-half (4½) percent of the weight of the dry mineral aggregate. Any allowable variations hereinafter set forth are to be inclusive of the above stated percentages. The exact rate of application of cement shall be as determined by the Engineer. Immediate control of the cement content shall be accomplished by testing the fresh, moist cement aggregate mixture, by Test Method No. Nev. T239.

304.03.02 Mixing—Roadmix Method. (a) Depositing Untreated Aggregate. Untreated aggregate shall be deposited on the prepared area by means of spreader boxes

equipped with a readily adjustable strike-off device resulting in a uniform windrow or a uniform spread, to provide the required width and surface tolerance specified in subsection 304.03.06, "Finished Surface." Aggregate to be treated shall not be mixed with roadbed material that is not to be treated.

(b) Mixing. Cement treated base may be mixed either on the roadbed or at a location off the roadbed by the roadmixed method or the plantmixed method as the Contractor may elect.

If the Contractor elects to use the plantmixed method, all the requirements in subsection 304.03.03, "Mixing—Plantmix Method," will apply, except the following:

1. The separation of aggregates into two sizes and storing in separate stockpiles as provided in subsection 304.03.03, "Mixing—Plantmix Method," will not be required.

2. The 0.4 of a percentage point variation in the cement content as provided in subsection 304.03.03, "Mixing—Plantmix Method," will be increased to 0.6 of a percentage point as specified in this subsection.

If the Contractor elects to use the roadmix method, the roadmixing machine shall be of the pugmill or auger type, or other type meeting the approval of the Engineer. The machine shall be designed to pick up the material to be mixed from the windrow or blanket so that during at least fifty (50) percent of the mixing cycle all the material is picked up and mixed while separated from the mixing table.

Cement to be mixed with aggregate may be furnished in sacks or in bulk. If sacked cement is used, the sacks shall be distributed on the aggregate at the required intervals and then be emptied by hand methods following which the cement from each sack shall be distributed in a layer of uniform thickness. If the cement is furnished in bulk, it shall be spread by mechanical equipment. Each load in the spreading equipment shall be calibrated so the average rate of spread can be determined by the Engineer. The rate of cement spread per linear foot of windrow or blanket shall not vary more than ten (10) percent from the designated

rate. The tops of windrowed aggregate shall be flattened or slightly trenched to receive the cement. The distance which cement may be spread upon the aggregate ahead of the roadmixing operations will be determined by the Engineer.

The roadmixing machine shall have provisions for introducing water at the time of mixing, through a metering device or by other approved methods. The water shall be applied by means of controls that will supply the correct quantity of water to produce a completed mixture with a uniform moisture content. Leakage of water from equipment will not be permitted. Care shall be exercised to avoid the addition of any excessive water. The quantity of water added to the mixture will be determined by the Engineer.

Where the material is to be spread and compacted in two or more layers, material for each layer shall be mixed separately.

The resulting mixture shall be uniform and more than one pass of the mixer through the material may be required. If equipment is used that requires more than one pass of the mixer, at least one pass shall be made before any water is added to the material.

At the time mixing is completed the moisture content of the mixture shall not be in excess of one (1) percent over optimum as determined by Test Method No. Nev. T236.

The cement content of samples taken from time to time from the product of the roadmixing machine, or from mixtures spread on the roadbed shall not have a variation above or below the cement content designated by the Engineer or more than 0.6 of a percentage point based on the weight of the aggregate as determined by Test Method No. Nev. T239.

The lengths of treated sections shall be regulated to permit completion within the time requirements provided in subsection 304.03.07, "Time Requirements."

Should the Contractor elect to perform roadmixing operations off the roadbed, the provisions specified in this subsection for mixing on the roadbed shall apply.

304.03.03 Mixing—Plantmix Method. (a) General. Cement treated base shall be mixed at a central mixing

plant by either batch mixing using revolving blade or rotary drum mixers or continuous mixing at the option of the Contractor. The aggregate and cement may be proportioned either by weight or volume. Aggregate for cement treated base shall be separated into two sizes and each size shall be stockpiled separately. One stockpile shall contain aggregate retained on a No. 4 sieve of which not more than twenty (20) percent shall be finer than a No. 4 sieve. The other stockpile shall contain aggregate of which at least eighty (80) percent is finer than the No. 4 sieve. If aggregates are separated into more than two sizes, any combination of sizes approved by the Engineer that will meet the grading and other test requirements will be acceptable.

In all plants, the water shall be proportioned by weight or volume and there shall be means by which the Engineer may readily verify the amount of water per batch or the rate of flow for continuous mixing. The time of the addition of water or the points at which it is introduced into the mixer shall be determined by the Engineer. The quantity of water added to the mixture will be determined by the Engineer.

At the time mixing is completed the moisture content of the mixture shall not exceed optimum as determined by Test Method No. Nev. T236.

In all plants, cement shall be added in such a manner that is uniformly distributed throughout the aggregates during the mixing operation.

The charge in a batch mixer, or the rate of feed to a continuous mixer, shall not exceed that which will permit complete mixing of all of the material. Dead areas in the mixer, in which the material does not move or is not sufficiently agitated, shall be corrected by either a reduction in the volume of material or by other adjustment.

In all plants, the proportioning of materials designated by the Engineer shall be within the following tolerances:

Aggregate weights or rate of feed	±5.0%
Cement content of the complete dry mixture	±0.4%
Moisture content of the completed mixture	±1.0%

The Contractor shall furnish weighing equipment as

specified in subsection 109.01, "Measurement of Quantities."

(b) Batch Mixing. In batch type mixers the mixer shall be equipped with a timing device which will indicate by a definite audible or visual signal the expiration of the mixing period. The device shall be accurate to within two (2) seconds. The plant shall be equipped with a suitable automatic device for counting the number of batches.

Mixing shall continue until a homogeneous mixture of uniformly distributed and properly coated aggregates of unchanging appearance is produced.

Cement for each batch shall be weighed on scales separate and distinct from the aggregate batching scales.

If volumetric proportioning is used, means shall be provided for accurately calibrating the amount of material in each measuring bin.

(c) Continuous Mixing. If the continuous type mixer is used, the correct proportion of each aggregate size introduced into the mixer shall be drawn from the storage facility by an approved type of feeder, which will continuously supply the correct amount of aggregate in proportion to the cement, and so arranged that the proportion of each aggregate size can be separately adjusted. The plant shall be equipped with metering devices of an approved type that will introduce the cement and water into the mixer in specified proportions. The metering devices and feeder shall be interlocked and so synchronized as to maintain a constant rate of cement and water to the aggregate. When storage bins are used, they shall be equipped with overflow chutes for each compartment. A positive signal system shall be provided that will automatically close down the plant when the level of material in any bin approaches the strike-off capacity of the feed gate. The plant shall not be permitted to operate unless the signal system is in good working condition. The feeder for the aggregate shall be mechanically or electrically driven. Aggregate feeders that are mechanically driven shall be directly connected with the drive on the cement feeder. The plant shall be equipped with facilities satisfactoy to the Engineer for calibrating gate openings and metering devices by weighing check samples.

Aggregate feeders that are electrically driven shall be actuated from the same circuit that serves the motor driving the cement feeder.

Mixing shall continue until a homogeneous mixture of uniformly distributed and properly coated aggregates of unchanging appearance is produced.

The cement feeder shall be equipped with a device by which the rate of cement feed can be determined while the plant is in full operation.

The drive shaft of the cement feeder shall be equipped with a revolution counter reading to one-one hundredth (1/100) of a revolution, and of sufficient capacity to register the total number of revolutions in a day's run.

304.03.04 Spreading. (a) General. The area to be covered with cement treated base shall be prepared and compacted to the grade and cross section for the bottom surface of the cement treated base. Any material cut away in trimming for such grade and cross section shall be disposed of in a manner satisfactory to the Engineer.

Materials mixed at a location off the roadbed shall be protected against moisture loss while being transported to the spreading site, with a method approved by the Engineer, and shall be spread without segregation. Immediately prior to spreading, the area to be covered shall be moistened and kept moist, but not excessively wet.

Where the required thickness is six (6) inches or less, the mixture may be spread and compacted in one layer. Where the required thickness is more than six (6) inches, the mixture shall be spread and compacted in two or more layers of approximately equal thickness and the maximum compacted thickness of any one layer shall not exceed six (6) inches. Work on each layer shall be performed in a similar manner and the surface of the compacted material shall be kept moist or prevented from drying by some method approved by the Engineer until covered with the next layer.

Cement treated base to be placed in inaccessible areas may be spread by approved methods in one course. After spreading, the material shall be thoroughly compacted to the required lines, grades, and cross section by means of

pneumatic tampers or with other compacting equipment which consistently obtains equal or better compaction than that provided in subsection 304.03.05, "Compaction."

(b) Plantmix Method. The mixture shall be deposited on the roadbed at a uniform quantity per linear foot, which quantity will provide the required compacted thickness without resorting to spotting, picking up, or otherwise shifting the mixture.

The mixture shall be spread in one operation with a self-propelled mechanical spreader ready for compaction without further shipping. Segregation shall be avoided and the base shall be free from pockets of coarse or fine material. Equipment not propelled by the unloading vehicle will be considered self-propelled. The spreader shall be provided with a screed that strikes off and distributes the material to the required width and to the surface tolerances specified in subsection 304.03.06, "Finished Surface." The screed shall be adjustable to the required cross section. Screed action includes any cutting, oscillating or other practical motion that produces a finished surface texture of uniform appearance. If the spreader leaves ridges, indentations, or other objectionable marks in the surface that cannot be eliminated by rolling, or prevented by adjustments in operation, its use shall be discontinued.

Except as otherwise provided in this subsection, the use of motor graders will not be permitted during spreading and compacting operations, except that motor graders may be used to trim the edges and surface of the cement treated base after compaction in order to finish the base within the tolerances specified.

A motor grader will be considered to be a self-propelled mechanical spreader if it has been equipped with end wings on the blade, and with cross slope and automatic grade controls.

The mixed materials shall be spread for the full planned width, either by one spreader or by several spreaders operating in a staggered position across the subgrade, unless otherwise permitted by the Engineer or if traffic conditions require part width construction. Should permission be granted or part width construction be required for the use

of one spreader operating alternately on contiguous lanes, not more than one (1) hour shall elapse between the time of placing material in adjacent lanes at any location. If longitudinal construction joints are necessary, they shall fall on lane lines.

304.03.05 Compaction. The provisions contained in this subsection apply to both plantmix and roadmix methods.

Compacting equipment shall produce the required compaction within the operation time limit specified in subsection 304.03.07, "Time Requirements."

Initial rolling of cement treated bases shall be performed with steel-tired rollers.

Rolling shall be performed in such a manner that bumps and irregularities will be eliminated and the finished surface shall be true to the required grade and cross section within the surface tolerances specified in subsection 304.-03.06, "Finished Surface."

Water shall be applied without driving equipment over the uncompacted material.

Rolling shall commence by completely covering the outer edge of the material. Subsequent rolling shall lap at least twenty-five (25) percent of previously compacted material.

Pneumatic-tired rollers conforming to the provisions in subsection 401.03.04, "Rollers," shall be used following completion of initial rolling.

Areas inaccessible to rollers shall be compacted to the required compaction by other means.

The density of compacted cement treated bases shall not be less than ninety-two (92) percent of the maximum density as determined by Test Method No. Nev. T101. Test Method No. Nev. T102 or No. Nev. T103 may be used to determine the in-place density. Test method to be determined by the Engineer.

304.03.06 Finished Surface. The finished surface of cement treated base shall be uniform and shall not deviate

at any point more than 0.03 foot from the bottom of a twelve (12) foot straightedge laid in any direction.

The surface of the finished cement treated base at any point shall not vary more than 0.05 foot above or below the grade established by the Engineer, except that when Portland cement concrete pavement is to be placed on cement treated base, the surface of the finished cement treated base at any point shall not extend above the grade established by the Engineer.

When the finished surface of cement treated base is outside the specified tolerances and before placing any course of material thereon, all high spots on the finished surface shall be trimmed off to within the specified tolerance. The excess material shall be removed and disposed of in a manner approved by the Engineer immediately after trimming and no loose material shall be left on the base and the area shall then be rolled again. Full compensation for trimming high spots and disposing of the trimmed material shall be considered as included in the prices paid for the contract items involved in constructing the cement treated base and no additional compensation will be allowed therefor.

Cleated equipment shall not be allowed on new cement treated base unless street pads are used on cleats.

304.03.07 Time Requirements. Any mixture of aggregate, cement, and water that has not been compacted shall not be left undisturbed for more than thirty (30) minutes. Not more than two (2) hours shall elapse between the time water is added to the aggregate and cement and the time of completion of initial rolling. Not more than three (3) hours shall elapse between the time water is added to the aggregate and cement and the time of completion of final compaction after trimming.

304.03.08 Construction Joints. At the end of each day's work and when cement treated base operations are delayed or stopped for more than two (2) hours, a construction joint shall be made in thoroughly compacted

material, normal to the centerline of the roadbed with a vertical face. Additional mixture shall not be placed until the construction joint has been approved by the Engineer.

Where cement treated base has been finally compacted more than one (1) hour, longitudinal joints shall be constructed by cutting vertically into the existing edge for approximately three (3) inches and the material cut away may be disposed of in the adjacent lane to be constructed. The face of the cut joints shall be moistened in advance of placing the adjacent base.

304.03.09 Protection and Curing. The surface shall be kept moist at all times until the curing seal is applied. Water equipment shall be of a type which will apply moisture in a fog or mist type application free of pressure at the surface being treated.

The completed cement treated base shall be covered with a bituminous curing seal as protection against drying. Curing seal will be required only for the top layer of cement treated base. The curing seal shall be applied as soon as possible, but not later than eight (8) hours after the completion of final rolling. The surface shall be kept moist until the seal is applied. Curing seal shall be liquid asphalt, Type MC–250, unless otherwise specified, and shall be applied at a rate of between 0.15 gallon and 0.25 gallon per square yard of surface, the exact amount to be determined by the Engineer. The curing seal shall be applied in accordance with the requirements of Section 407, "Seal Coat," and in sufficient quantity to provide a continuous membrane over the base. At the time of application of the curing seal, the surface shall be tightly knit, free from all loose material and shall contain sufficient moisture to prevent excessive penetration of the asphalt. If necessary to insure this, sufficient water to fill the surface voids shall be applied immediately before the asphalt is applied.

The curing seal shall be applied as soon as possible, but not later than twenty-four (24) hours after the completion of final rolling.

Equipment or traffic shall not be permitted on the

cement treated base during the first three (3) days after applying the curing seal, unless otherwise permitted by the Engineer. After traffic is allowed on the cement treated base, and there is danger of excessive surface abrasion, sand blotter may be required as determined by the Engineer.

When equipment or traffic is permitted on the cement treated base and such permission is granted for the sole convenience of the Contractor, he shall protect the curing seal at his expense.

All loose sand shall be completely removed from the cement treated base before any surfacing material is placed thereon. Full compensation for furnishing, spreading, and removing sand as specified above shall be considered as included in the contract price paid for sand blotter and no additional allowance will be made therefor.

304.03.10 Weather Limitations. Cement treated base shall not be mixed or placed while the atmospheric temperature is below thirty-five (35) degrees Fahrenheit, or when conditions indicate that the temperature will fall below thirty-five (35) degrees Fahrenheit for a sustained period of four (4) hours. Cement treated base shall not be placed on frozen ground and all material shall be protected from freezing and frost for a period of five (5) days after placing.

METHOD OF MEASUREMENT

304.04.01 Roadmix Method Designated for Use. The quantity of cement treated base aggregate to be measured for payment will be the number of tons, conforming to all the requirements in the completed work. When aggregate and other materials are mixed at a central mixing plant, the quantity of aggregate will be determined by weighing the completed mixture of aggregate cement and water and deducting from this weight the weight of the cement and water. Water shall be metered and meters shall be calibrated for weight as prescribed in subsection 109.01, "Measurement of Quantities." Mixing, hauling, spreading, and compacting cement treated base will be measured for

payment by the square yard. Area will be determined from horizontal measurement of the finished surface of the base.

Portland cement will be measured for payment by the ton. A barrel of cement will be considered as weighing three hundred seventy-six (376) pounds. Weighing may be done by sack count (ninety-four (94) pounds to the sack) or by scale weights obtained by weighing the spreading equipment before and after spreading the cement when roadmixed, or by scale weights when the mixture is plantmixed.

304.04.02 Plantmix Method Designated for Use. The quantity of plantmix cement treated base aggregate to be measured for payment will be the number of tons, conforming to all the requirements, in the completed work, less the weight of cement. This will be determined by weighing the completed mixture of aggregate, cement and water (in the hauling vehicle prior to delivery), and by deducting from this weight the weight of cement.

Portland cement will be measured for payment by the ton. One barrel of cement will be considered as weighing three hundred seventy-six (376) pounds. Weighing may be done by sack count (ninety-four (94) pounds to the sack) or by scale weights.

304.04.03 General. For both roadmix and plantmix methods, the quantities of liquid asphalt used for curing seal and sand blotter to be measured for payment will be determined as provided in Section 407, "Seal Coat."

The quantity of Portland cement to be measured for payment may be determined from certified weight certificates indicating the truck and trailer number, tare weight, gross weight, net weight, and date. When the measurement of Portland cement is based on certified weight certificates, the following requirements shall apply:

(a) An occasional loaded transporting vehicle shall be weighed by project personnel prior to discharge of any material. The Engineer will determine the frequency in which the loaded vehicles are weighed.

(b) Every empty transporting vehicle shall be weighed by project personnel prior to the vehicle leaving the project.

(c) The Engineer will be the sole judge in determining the quantity of Portland cement used should a discrepancy arise between project weights of the loaded or unloaded vehicles or both and the certified weight certificates.

Due to possible variations in the specific gravity and voids of the aggregates, the tonnage used may vary from the proposed quantities and no adjustment in contract unit price will be made because of such variation.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

304.05.01 Roadmix Method Designated for Use. The accepted quantity of materials measured as provided in subsection 304.04.01, "Roadmix Method Designated for Use," will be paid for at the contract unit price bid per ton for "Portland Cement," per ton for "Roadmixed Cement Treated Base Aggregate," and per square yard for "Mixing Cement Treated Base."

The above prices shall be full compensation for furnishing all labor, materials, tools, equipment, and incidentals and for doing all the work involved in constructing roadmixed cement treated base, complete in place as shown on the plans and as directed by the Engineer.

The State reserves the right to increase or decrease the estimated amount of cement. Adjustment of unit price will not be made for such increase or decrease.

Payment will be made under:

Pay Item	Pay Unit
Roadmix Cement Treated Base Aggregate (dry)	Ton
Portland Cement for Cement Treated Base	Ton
Mixing Cement Treated Base	Square Yard

304.05.02 Plantmix Method Designated for Use. The accepted quantity of materials measured as provided in

subsection 304.04.02, "Plantmix Method Designated for Use," will be paid for at the contract unit price bid per ton for "Portland Cement" and per ton for "Plantmix Cement Treated Base Aggregate," which prices shall be full compensation for stripping the pit, crushing, screening, loading, hauling, furnishing water for the mix, mixing, placing, trimming, and compacting, complete in place as shown on the plans and as directed by the Engineer.

Payment will be made under:

Pay Item	Pay Unit
Plantmix Cement Treated Base Aggregate (wet)	Ton
Portland Cement for Cement Treated Base	Ton

304.05.03 General. The accepted quantities of "Liquid Asphalt" used for curing seal and "Sand Blotter," will be paid for in accordance with Section 407, "Seal Coat."

For both the roadmix and plantmix methods, all payments will be made in accordance with subsection 109.02, "Scope of Payment."

Partial payments for "Roadmix Cement Treated Base Aggregate" or "Plantmix Cement Treated Base Aggregate" may be as set forth under subsection 109.06, "Partial Payments."

SECTION 401

PLANTMIX BITUMINOUS PAVEMENTS—GENERAL

DESCRIPTION

401.01.01 General. These specifications include general requirements that are applicable to all types of bituminous pavements of the plantmix type irrespective of gradation of aggregate, kind and amount of bituminous material, or pavement use. Deviations from these general requirements will be indicated in the specific requirement for each type.

This work shall consist of one or more courses of bituminous mixture constructed on the prepared foundation in accordance with these specifications and the specific requirements of the type under contract, and in reasonably close conformity with the lines, grades, thicknesses, and typical cross sections shown on the plans or established by the Engineer.

MATERIALS

401.02.01 Composition of Mixtures. The bituminous plantmix shall be composed of a mixture of aggregate, filler if required, and bituminous material. The several aggregate fractions shall be sized, uniformly graded, and combined in such proportions that the resulting mixture meets the grading requirements of the job-mix formula.

Before starting work, the Contractor shall submit a proposed job-mix formula in writing, for use by the Engineer in setting the job-mix to be used. The formula submitted shall propose definite single values for:

(a) The percentage of aggregate passing each specified sieve.

(b) The percentage of bitumen to be added (to 0.1 percent).

(c) The temperature of the mixture leaving the mixer.

(d) The temperature of the mixture in the hopper of the paving machine.

The job-mix formula with the allowable tolerances shown herein shall conform to the requirements of Section 705, "Aggregates for Bituminous Courses," for plantmix bituminous base aggregate, plantmix bituminous surface aggregate, or plantmix bituminous open-graded aggregate, as the case may be.

The Engineer will determine a job-mix formula with single values for (a), (b), (c), and (d) above and so notify the Contractor in writing. This job-mix formula shall be in effect until modified in writing by the Engineer. The mixture furnished shall conform to this job-mix formula, within the following range of tolerances:

Aggregate passing the No. 4 and larger sieves	±7%
Aggregate passing the No. 8 to 100 sieves	±4%
Aggregate passing the No. 200 sieve	±2%
Bitumen content	±0.4% of volume or batch weight of aggregate
Temperature leaving the mixer	±20 deg. F.
Temperature in hopper of paving machine	±20 deg. F.

Should there be a change in sources of material, a new job-mix formula will be established before the new material is used. When unsatisfactory results make it necessary, the Engineer may establish a new job-mix formula and so notify the Contractor in writing.

The temperature of the bituminous material just prior to mixing, and completed mixture in the hauling vehicle just prior to leaving the plant shall conform to the following tables:

PLANTMIX BITUMINOUS MIXTURES WITH ASPHALT CEMENT

Grade of Asphalt Cement	Bituminous Material		Plantmix Bituminous Base or Surface Mixtures		Plantmix Bituminous Open-Graded Mixtures	
	Min. Temp.	Max. Temp.	Min. Temp.	Max. Temp.	Min. Temp.	Max. Temp.
AR 16,000	275°	350°	255°	350°	255°	290°
AR 8,000	265°	330°	245°	330°	245°	290°
AR 4,000	255°	325°	235°	325°	235°	290°
AR 2,000	245°	325°	225°	325°	225°	275°
AR 1,000	225°	300°	200°	300°	200°	275°

PLANTMIX BITUMINOUS MIXTURES WITH LIQUID ASPHALT

Grade and Type MC or SC	—Bituminous Material and Mixtures— Min. Temp.	Max. Temp.
70	95°	140°
250	135°	175°
800	165°	205°
3,000	200°	240°

The completed mixture of the above items at the hopper of the paver shall not be more than twenty (20) degrees below the specified completed mixing temperature in the hauling vehicle just prior to leaving the plant.

The type and grade of bituminous material will be specified in the contract. The grade may be changed one step by the Engineer at no change in unit price.

Attention is directed to subsection 106.04, "Samples and Tests."

401.02.02 Aggregates. Aggregates shall meet the applicable requirements of Section 705, "Aggregates for Bituminous Courses."

401.02.03 Commercial Mineral Filler. Commercial mineral filler shall meet the requirements of subsection 705.03.04, "Commercial Mineral Filler."

401.02.04 Bituminous Materials. The bituminous material shall meet the applicable requirements of Section 703, "Bituminous Materials." Bituminous material may be conditionally accepted at the source.

CONSTRUCTION

401.03.01 Bituminous Mixing Plant. Sufficient storage space shall be provided for the aggregate, or for each size aggregate when required. The storage yard shall be maintained neat and orderly and the stockpile, or separate stockpiles when required, shall be readily accessible for sampling.

Plants used for the preparation of bituminous mixtures shall conform to all requirements under (a). In addition,

batch mixing plants shall conform to the requirements under (b); continuous mixing plants (proportioned after drying) shall conform to the requirements under (c); continuous mixing plants (proportioned before drying) shall conform to the requirements under (d); and dryer drum mixing plants shall conform to the requirements under (e).

(a) Requirements for All Plants. Mixing plants shall be of sufficient capacity and coordinated to adequately handle the proposed bituminous construction.

1. Equipment for Preparation of Bituminous Material. Tanks for the storage of bituminous material shall be equipped to heat and hold the material at the required temperatures. The heating shall be accomplished by steam coils, electricity, or other approved means so that no flame shall be in contact with the tank. The circulating system for the bituminous material shall be designed to assure proper and continuous circulation during the operating period. Provision shall be made for measuring and sampling storage tanks.

2. Drier. The plant shall include a drier or driers which continuously agitate the aggregate during the heating and drying process.

3. Thermometric Equipment. An armored thermometer of adequate range in temperature reading shall be fixed in the bituminous feed line at a suitable location near the charging valve at the mixer unit.

The plant shall also be equipped with either an approved dial-scale, mercury-actuated thermometer, an electric pyrometer, or other approved thermometric instrument so placed at the discharge chute of the drier as to register automatically or indicate the temperature of the heated aggregates.

The Engineer may require replacement of any thermometer by an approved temperature-recording apparatus for better regulation of the temperature of aggregates.

4. Smoke and Dust Control. The Contractor will be required to install satisfactory precipitation devices, or use other methods which will meet local conditions, city, county, and state laws pertinent to air pollution.

5. Truck Scales. Except as allowed in subsection 401.04.01, "Measurement," bituminous mixture shall be weighed on approved scales furnished by the Contractor or on public scales at the Contractor's expense. Such scales shall be platform scales and conform to the provisions of subsection 109.01, "Measurement of Quantities."

6. 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 all 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 to enable the Engineer to obtain sampling and mixture temperature data. A hoist or pully system shall be provided to raise scale calibration equipment, sampling equipment, and other similar equipment from the ground to the mixer platform and return. All gears, pulleys, chains, sprockets, and other dangerous moving parts shall be thoroughly guarded and protected. Ample 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.

(b) Requirements for Batching Plants.

1. Plant Scales. Scales shall be accurate to 0.5 percent of the maximum load that may be required. Poises shall be designed to be locked in any position to prevent unauthorized change or position. In lieu of truck scales, the Contractor may provide an approved automatic printer system which will print the weights of the material delivered, provided the system is used in conjunction with an approved automatic batching and mixing control system. Such weights shall be evidenced by a weigh ticket for each load.

The amount of filler material shall be determined by weighing on springless dial scales separate from the plant weigh hopper or by some method that uniformly feeds the mixer within ten (10) percent of the required amount.

2. Feeder for Drier. The plant shall be provided with accurate mechanical means for uniformly feeding the

aggregate into the drier so that uniform production and uniform temperature will be obtained.

3. Screens. Plant screens capable of screening all aggregates to the specified sizes and proportions will be required when the aggregate is proportioned after the drying operations. Plant screens may be eliminated when proportioning is done prior to the drying process and the aggregate is proportioned in accordance with subsection (d)(2), "Aggregate Proportioning" of this subsection and prepared in accordance with the first paragraph of subsection 401.03.08, "Preparation of Aggregates."

4. Bins. The plant shall include storage bins of sufficient capacity to supply the mixer when it is operating at full capacity. Bins shall be arranged to assure separate and adequate storage of appropriate fractions of the mineral aggregates. Separate dry storage shall be provided for mineral filler when used and the plant shall be equipped to feed such material into the mixer. Each bin shall be provided with overflow pipes, of such size and at such locations as to prevent backing up of material into other compartments or bins. Each compartment shall be provided with its individual outlet gate, constructed so that when closed there shall be no leakage. The gates shall cut off quickly and completely. Bins shall be so constructed that samples can be readily obtained.

5. Weigh Box or Hopper. The 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 is allowed to leak into the mixer while a batch is being weighed.

6. Bituminous Control Unit. Satisfactory means, either by weighing or metering, shall be provided to obtain the proper amount of bituminous material in the mix within the tolerance specified. Means shall be provided for checking the quantity or rate of flow of bituminous material into the mixer.

7. Bituminous Control. The equipment used to measure the bituminous material shall be accurate to plus

or minus 0.5 percent. The bituminous material bucket shall be a nontilting type with a loose sheet metal cover. The length of the discharge opening or spray bar shall be not less than three-fourths (¾) the length of the mixer and it shall discharge directly into the mixer. The bituminous material bucket, its discharge valve or valves, and spray bar shall be adequately heated. Steam jackets, if used, shall be efficiently drained and all connections shall be so constructed that they will not interfere with the efficient operation of the bituminous scales. The capacity of the bituminous material bucket shall be at least fifteen (15) percent in excess of the weight of bituminous material required in any batch. The plant shall have an adequately heated quick-acting, nondrip, charging valve located directly over the bituminous material bucket.

Bituminous material shall be measured by means of springless dial scales or metering devices. Springless dial scales shall have a capacity of not more than one thousand (1,000) pounds in two (2) pound gradations.

The indicator dial shall have a capacity of at least fifteen (15) percent in excess of the quantity of bituminous material used in a batch. The controls shall be constructed so that they may be locked at any dial setting and will automatically reset to that reading after the addition of bituminous material to each batch. The dial shall be in full view of the mixer operator. The flow of bituminous material shall be automatically controlled so that it will begin when the dry mixing period is over. All of the bituminous material required for one batch shall be discharged in not more than fifteen (15) seconds after the flow has started. The size and spacing of the spray bar openings shall provide a uniform application of bituminous material the full length of the mixer. 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.

8. Mixer. The batch mixer shall be of a twin pugmill type, steam jackets, or heated by other approved means and capable of producing uniform mixtures within

the specified tolerances. It shall be equipped with a sufficient number of paddles or blades set in proper order and operated at such speed as to produce a properly and uniformly mixed batch. The clearance of the paddles or blades from all fixed and moving parts shall not exceed one (1) inch. Badly worn or defective paddles or blades shall not be used in mixing operations.

9. Control of Mixing Time. The mixer shall be equipped with an accurate time lock to control the operations of a complete mixing cycle. It shall lock the weigh box gate after the charging of the mixer until the closing of the mixer gate at the completion of the cycle. It shall lock the bituminous material bucket throughout the dry mixing period and shall lock the mixer gates throughout the dry and wet mixing periods. 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 the interval of time between the start of introduction of bituminous material and the opening of the mixer gate.

The mixer shall be equipped with a timing device which will indicate by a definite audible or visual signal the expiration of the mixing period. The device shall measure the time of mixing within an accuracy of two (2) seconds. A suitable automatic device for counting the number of batches shall be provided and maintained in proper working condition.

When the aggregate and the bituminous material have been combined, the entire mass shall be mixed in an approved mixer. The mixing shall continue until homogeneity and a uniform coating are achieved. The output rate shall not exceed the manufacturer's capacity rating.

(c) Requirements for Continuous Mixing Plants (Proportioned After Drying).

1. Feeder for Drier. The plant shall be provided with accurate mechanical means for uniformly feeding the aggregate into the drier so that uniform production and uniform temperature will be obtained.

2. Screens. Plant screens capable of screening all

aggregates to the specified sizes and proportions will be required.

3. Bins. The plant shall include storage bins of sufficient capacity to supply the mixer when it is operating at full capacity. Bins shall be arranged to assure separate and adequate storage of appropriate fractions of the mineral aggregates. Separate dry storage shall be provided for mineral filler when used and the plant shall be equipped to feed such material into the mixer. Each bin shall be provided with overflow pipes, of such size and at such locations as to prevent backing up of material into other compartments or bins. Each compartment shall be provided with its individual outlet gate. Bins shall be so constructed that samples can be readily obtained. Bins shall be equipped with adequate telltale devices to indicate the position of the aggregates in the bins at the lower quarter points.

4. Aggregate Proportioning. The plant shall include a means for accurately proportioning each size of aggregate after the drying operation.

The plant shall have a mechanical feeder mounted under each compartment bin. Each compartment bin shall have an accurately controlled individual gate for volumetrically measuring the material drawn from each compartment. The feeding orifice shall be rectangular with one dimension adjustable by positive means. Indicators shall be provided for each gate to show the respective gate opening.

A meter for determining the rate of each feeder, or a revolution counter, shall be provided.

Commercial filler material introduced into the mixer shall be drawn from storage bins by a continuous mechanical feeder which will uniformly feed the mixer within ten (10) percent of the required amount.

5. Weight Calibration of Aggregate. The plant shall include a means for calibration of each aggregate feeder by weighing test samples. Contractor shall provide accurate scales and test boxes for this weight calibration.

6. Bitumen Metering Device. The bituminous

material shall be introduced into the mixer through a gallonage meter by a positive displacement metering device. This metering device shall be equipped with a ready means of varying the bituminous material delivery rate.

7. Synchronization of Aggregate Feed and Bituminous Material Feed. Satisfactory means shall be provided to afford a positive interlocking control between the flow of each feeder and the flow of bituminous material. The interlocking control shall indicate a visible or audible signal when the level of material in any one feeder approaches the strike off capacity of the feed gate, or shut the plant down.

8. Mixer. The plant shall include a continuous mixer of an approved type, adequately heated and capable of producing a uniform mixture within the job-mix tolerances. The paddles shall be adjustable for angular position on the shafts and reversible to retard the flow of the mix. The mixer shall have a manufacturer's plate giving the net volumetric contents of the mixer at the several heights inscribed on a permanent gage. Charts shall be provided showing the rate of feed of aggregate per minute for the aggregate being used.

9. Surge Bins. The plant will be equipped with an approved surge bin at the discharge. This surge bin will be in excess of twenty (20) tons, and shall be equipped with an approved surge batcher or other approved method satisfactory to the Engineer that will prevent segregation of the bituminous mixture as it is being discharged into the hauling vehicle.

(d) Requirements for Continuous Mixing Plants (Proportioned Before Drying).

1. Aggregate Stockpiles. The first paragraph of subsection 401.03.08, "Preparation of Aggregates," shall apply.

2. Aggregate Proportioning. The plant shall include a means for accurately proportioning each size of aggregate prior to the drying operation.

The plant shall have a mechanical feeder mounted under each compartment bin. Each compartment bin shall

have an accurately controlled individual gate for volumetrically measuring the material drawn from each compartment. The feeding orifice shall be rectangular with one dimension adjustable by positive means. Indicators shall be provided for each gate to show the respective gate opening.

A meter for determining the rate of each feeder, or a revolution counter, shall be provided.

Commercial filler material introduced into the mixer shall be drawn from storage bins by a continuous mechanical feeder which will uniformly feed the mixer with ten (10) percent of the required amount.

3. Weight Calibration of Aggregate. The plant shall include a means for calibration of each aggregate feeder by weighing test samples.

4. Bitumen Metering Device. The bituminous material shall be introduced into the mixer through a gallonage meter by a positive displacement metering device. This metering device shall be equipped with a ready means of varying the bituminous material delivery rate.

5. Synchronization of Aggregate Feed and Bituminous Material Feed. Satisfactory means shall be provided to afford a positive interlocking control between the flow of each feeder and the flow of bituminous material. The interlocking control shall indicate a visible or audible signal when the level of material in any one feeder approaches the strike off capacity of the feed gate, or shut the plant down.

6. Mixer. The plant shall include a continuous mixer of an approved type, adequately heated and capable of producing a uniform mixture within the job-mix tolerances. The paddles shall be adjustable for angular position on the shafts and reversible to retard the flow of the mix. The mixer shall have a manufacturer's plate giving the net volumetric contents of the mixer at the several heights inscribed on a permanent gage. Charts shall be provided showing the rate of feed of aggregate per minute for the aggregate being used.

7. Surge Bins. The plant will be equipped with an approved surge bin at the discharge. This surge bin will be in excess of twenty (20) tons, and shall be equipped with an approved surge batcher or other approved method satisfactory to the Engineer that will prevent segregation of the bituminous mixture as it is being discharged into the hauling vehicle.

(e) Requirements for Dryer Drum Mixing Plants.

1. Aggregate Stockpiles. The first paragraph of subsection 401.03.08, "Preparation of Aggregates," shall apply.

2. Aggregate Proportioning. The plant shall include a means for accurately proportioning each size of aggregate prior to the drying operation.

The plant shall have a mechanical feeder mounted under each compartment bin. Each compartment bin shall have an accurately controlled individual gate for volumetrically measuring the material drawn from each compartment. The feeding orifice shall be rectangular with one dimension adjustable by positive means. Indicators shall be provided for each gate to show the respective gate opening.

A meter for determining the rate of each feeder, or a revolution counter, shall be provided.

Commercial filler material introduced into the mixer shall be drawn from storage bins by a continuous mechanical feeder which will uniformly feed the mixer within ten (10) percent of the required amount.

3. Weight Calibration of Aggregate. The plant shall include a means for calibration of each aggregate feeder by weighing test samples.

4. Bitumen Metering Device. The bituminous material shall be introduced into the mixer through a gallonage meter by a positive displacement metering device. This metering device shall be equipped with a ready means of varying the bituminous material delivery rate.

5. Synchronization of Aggregate Feed and Bituminous Material Feed. Satisfactory means shall be provided to afford a positive interlocking control between the

flow of each feeder and the flow of bituminous material. The interlocking control shall indicate a visible or audible signal when the level of material in any one feeder approaches the strike off capacity of the feed gate, or shut the plant down.

6. Mixer. The plant shall include a mixing device which will obtain homogeneity and a uniform coating. The mixing output shall not exceed the manufacturer's capacity rating.

7. Surge Bins. The plant will be equipped with an approved surge bin at the discharge. This surge bin will be in excess of twenty (20) tons, and shall be equipped with an approved surge batcher or other approved method satisfactory to the Engineer that will prevent segregation of the bituminous mixture as it is being discharged into the hauling vehicle.

401.03.02 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 paraffin oil, lime solution, or other approved material to prevent the mixture from adhering to the beds.

401.03.03 Pavers. Bituminous pavers shall be self-contained, power-propelled units, provided with an activated screed or strike-off assembly, heated if necessary, and capable of spreading and finishing courses of bituminous plantmix material in lane widths applicable 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 plantmix material in widths shown on the plans.

Pavers shall be equipped with a receiving hopper having sufficient capacity for a uniform spreading operation. The hopper shall be equipped with a distribution system to place the mixture uniformly in front of the screed.

The screed or strike-off assembly shall effectively produce a finished surface of the required evenness and texture without tearing, shoving, or gouging the mixture.

The screed shall be equipped with automatic controls which will make adjustments in both transverse and longitudinal direction. The external longitudinal reference devices used to pick up grade information for the automatic sensing control shall conform to the following requirements:

(a) When picking up grade information from an underlying base, the external longitudinal reference device shall not be less than thirty (30) feet in length. The devices for averaging the high and low spots over a minimum thirty (30) foot span shall be a floating beam or a long ski.

(b) When picking up grade information from an adjacent compacted pavement course or a concrete surface, the external longitudinal reference device shall not be less than ten (10) feet in length.

Sensing grids or shoes for monitoring the grade information from these longitudinal reference devices shall ride approximately in the middle portion. The pathways for the external reference devices shall be kept clear of pebbles, debris and any other obstruction that might affect the pavement surface.

Should the automatic controls fail to function properly, the Engineer may permit the Contractor to finish the half shift with manual controls. Operations shall not resume until the controls are repaired.

401.03.04 Rollers. Rollers shall meet the following requirements:

(a) Breakdown rollers shall be either a three (3) wheeled steel roller or a two-axle tandem or a three-axle tandem weighing not less than ten (10) tons.

(b) Except as hereinafter permitted, pneumatic-tired rollers shall consist of not less than nine (9) wheels equipped with pneumatic tires of equal size and diameter mounted on two axles attached to a rigid frame equipped with a loading platform or body suitable for ballast loading; so that the total weight of the roller can be varied to produce an operating weight per tire of between one thousand (1,000) and two thousand (2,000) pounds. The tires shall have treads satisfactory to the Engineer. The

tires on the rear axle shall be so spaced that the entire gap between adjacent tires on the front axle will be covered by one tread of the following tires. The tires shall be uniformly inflated so that the air pressure in the several tires will not vary more than five (5) pounds per square inch. Inflation pressure in pounds per square inch shall be the tire manufacturer's recommendation. Minimum tire size shall be 7.50 x 15 inches, four (4) ply. The use of pneumatic-tired rollers with a lesser number of wheels and a greater maximum operating weight per tire than that specified herein will be permitted subject to the following requirements:

1. The minimum width between the outer edge of the outside tires on a given axle shall be sixty (60) inches.
2. The weight of the roller and the tire pressure can be varied to produce a ground contact pressure between 50–70 p.s.i.

(c) The finish roller shall be a two-axle tandem weighing not less than eight (8) tons.

Attention is directed to subsection 401.03.11, "Rolling."

401.03.05 Weather Limitations. Plantmix bituminous base or surface shall not be placed on any wet surface or when the air temperature is below forty (40) degrees Fahrenheit or when weather conditions otherwise prevent the proper handling or finishing of the bituminous mixtures.

The open-graded plantmix surface shall be placed only when the pavement surface temperature in the shade is above sixty (60) degrees Fahrenheit.

401.03.06 Preparation of Existing Surface. When the surface of the existing pavement or old base is irregular, it shall be brought to uniform grade and cross section as directed.

When specified in the contract, all longitudinal and transverse joints and all cracks shall be sealed by the application of an approved joint sealing compound before spreading the mixture upon a Portland cement concrete

surface. All excess bituminous material shall be removed from joints and cracks prior to spreading the mixture.

Contact surface of curbing, gutters, manholes, and other structures shall be painted with a thin, uniform coating of asphaltic emulsion prior to the bituminous mixture being placed against them.

401.03.07 Preparation of Bituminous Materials. The bituminous material shall be heated to the specified temperature in a manner that will avoid local overheating and provide a continuous supply of the bituminous material to the mixer at a uniform temperature at all times.

401.03.08 Preparation of Aggregates. Aggregates proportioned prior to the heating and drying process, shall be separated into two general sizes: (1) that portion of the material having a minimum of eighty (80) percent *passing* a No. 4 sieve, and (2) that portion of the material having a minimum of eighty (80) percent *retained* on a No. 4 sieve. The material shall be maintained within these limits with a uniformity of plus or minus five (5) percent. Each portion of the material shall be stored separately. When moving the aggregate from storage to compartment bins, any method may be used which will not cause segregation, degradation, or combinations of aggregate which fail to meet the specified gradation requirements. Plantmix operations shall not commence until a minimum of five thousand (5,000) tons combined has been separated and stockpiled, unless the tonnage required is less than five thousand (5,000) tons.

Aggregates proportioned immediately after the heating and drying process shall be screened into a minimum of two fractions in the case minus one-half (½) inch aggregate is used, and into a minimum of three fractions when larger sized aggregate is used. The screened material shall be conveyed to separate compartments ready for proportioning and mixing with bituminous material. Plantmix operations shall not commence until a minimum of five thousand (5,000) tons has been stockpiled, unless the tonnage required is less than five thousand (5,000) tons.

401.03.09 Mixing. The permissible moisture content of the bituminous mixture just behind the paver shall not exceed one and one-half (1½) percent as determined by Test Method No. Nev. T112B. Should the aggregate contain excessive moisture when heated within the temperature limits, the Contractor will be required to take satisfactory corrective action before resuming plantmix operations.

The dried aggregate shall be combined in the mixer in the amount of each fraction of aggregates required to meet the job-mix formula. The bituminous mixture shall be measured or gaged and introduced into the mixer in the amount specified by the job-mix formula.

Commercial filler material, when required, shall be added to the mixer separately and shall be thoroughly dry. If the materials are mixed in a batching plant, the filler material shall be fed directly into the mixer as near the center as possible.

When the aggregates and the bituminous material have been combined, the entire mass shall be mixed in an approved mixer. The mixing shall continue until homogeneity and a uniform coating are achieved. The output rate shall not exceed the manufacturer's capacity rating.

Should the mixture, at the plant or in place, show an excess or deficiency of bitumin, show injury or damage due to burning or overheating, or show an improper combination of aggregate, due to the Contractor's failure to conform to specification requirements, it shall be rejected and if still in the truck shall be disposed of as directed. If an unsatisfactory mix, as referred to above, has been placed, it shall be disposed of and replaced as directed. No compensation will be allowed for rejected material.

401.03.10 Spreading and Finishing. The mixture shall be laid upon an approved surface, spread and struck off to 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.

The forward rate of travel of the paving machine(s)

shall be regulated to a speed dependent upon the capacity of the mixing plant to furnish the mixture. The machine(s) shall move at a uniform rate with a minimum amount of stopping.

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 by hand tools. For such areas, the mixture shall be dumped, spread, and screeded to give the required compacted thickness.

The Contractor may windrow plantmixed bituminous base or surface material in front of the spreading and finishing machine, provided that the following conditions and requirements are strictly adhered to:

(a) The windrow is properly sized, thereby insuring the delivery of the correct amount of material to the spreading and finishing machine at all times.

(b) The bituminous mixture shall be transferred from the windrow to the spreading and finishing machine in such a manner that the materials in the spreading machine will be a uniform mixture. The base, upon which the windrow was formed, shall not be disturbed and there shall be no excess paving material remaining on this base between the pickup device and the spreading and finishing machine.

(c) The minimum temperature requirements pertain to the material in the hopper of the spreading and finishing machine. Plantmix bituminous mixture that does not meet the minimum temperature specified shall not be incorporated in the work but shall be wasted in a manner satisfactory to the Engineer.

Should any course of bituminous mixture placed by utilizing a windrow be inferior, as determined by the Engineer, to that placed by transferring the bituminous mixture directly from the hauling vehicle to the spreading machine, the use of a windrow shall be discontinued.

401.03.11 Rolling. Rolling patterns shall be as directed by the Engineer. The initial or breakdown rolling shall consist of one complete coverage of the bituminous mixture. Initial rolling shall commence at the lower

edge and shall progress toward the highest portion of the roadbed. Under no circumstances shall the center be rolled first. The initial or breakdown rolling shall be followed by three complete coverages with a pneumatic-tired roller while the temperature of the mixture is at or above one hundred forty (140) degrees Fahrenheit. The final rolling of the bituminous mixture shall be performed with a two-axle tandem roller. The sequence of rolling may be modified to provide breakdown rolling with a two-axle tandem or pneumatic-tired roller and final rolling with a three-axle when directed. Rolling shall be performed in such a manner that cracking, shoving, or displacement will be avoided. All rollers shall be in good condition, and the reversing mechanism so maintained that the roller is capable of changing directions smoothly. The roller shall be kept in continuous motion while rolling so that all parts of the pavement shall receive equal compression. The motion of the roller shall be slow enough at all times to avoid displacement of the pavement. Any displacement occurring as a result of reversing the direction of the roller, or from any other cause, shall be corrected immediately by the use of rakes and fresh mixture when required. To prevent adhesion of the mixture to the roller, the wheels shall be kept properly moistened.

401.03.12 Joints. Placing of the bituminous paving shall be as continuous as possible. Rollers shall not pass over the unprotected end of a freshly laid mixture unless authorized by the Engineer. Transverse joints shall be formed by cutting back on the previous run to expose the full depth of the course. A brush coat of asphaltic emulsion shall be used on contact surface of transverse joints just before additional mixture is placed against the previously rolled material.

Longitudinal joints shall be spaced in such a manner that joints in succeeding courses will be at least six (6) inches horizontally from joints in any preceding course.

Attention is directed to subsection 401.03.10, "Spreading and Finishing."

401.03.13 Surface Tolerances. Surface tolerances will be specified under the respective sections of bituminous pavement.

401.03.14 Surfacing Miscellaneous Areas. Surfacing of road approaches and connections, street intersection areas, frontage roads, median strip areas, island areas, sidewalks, dikes, gutters, guttter flares, ditches, downdrains, spillways, aprons at the ends of drainage structures, and other designated areas outside the traveled way shall conform to the provisions specified in these specifications.

The combined aggregate grading for bituminous mixtures placed on miscellaneous areas shall conform to that specified for the bituminous mixture placed on the traveled way, except the aggregate used in the construction of median strip areas, island areas and dikes shall be constructed of aggregate conforming to the requirements of Plantmix Surface Aggregate, Type 3. The amount of bituminous material used in the bituminous mixture placed in dikes, gutters, gutter flares, downdrains, spillways, aprons at the end of drainage structures, and other designated areas outside the traveled way shall be increased not less than one (1) percent by weight of the aggregate over the amount of bituminous material used in the bituminous mixture placed on the traveled way. Submittal of a revised job-mix formula will not be necessary.

The bituminous mixture placed in median strip areas, island areas, sidewalks, dikes, gutters, gutter flares, ditches, downdrains, spillways, aprons at the ends of drainage structures, and other designated areas outside the traveled way may be spread in one layer. The material shall be compacted to the required lines, grades, and cross section.

Dikes shall be shaped and compacted with an extrusion machine or other equipment capable of shaping and compacting the material to the required cross section.

METHOD OF MEASUREMENT

401.04.01 Measurement. The quantity of plantmix bituminous aggregate to be measured for payment will be

the number of tons conforming to all the requirements in the completed work, and will be determined by weighing the completed mixture of aggregate, mineral filler if required, and bituminous material, and deducting from this weight the weight of the mineral filler and bituminous material.

The quantity of bituminous material to be measured for payment will be the number of tons used in the completed work and shall conform to the requirements herein.

The quantity of shoulder dikes constructed of bituminous mixture, the placing of which is to be paid for as a contract item on a linear foot basis, will be determined from measurements taken along the top of the completed dikes to the nearest one (1) foot length. The quantities of bituminous mixture used to construct the dikes shall be measured as set forth above.

The quantities of bituminous mixture, the placing of which is to be paid for as a contract item on an area basis in addition to the contract prices paid for the bituminous mixture, will be determined from measurements of the bituminous mixture compacted in place.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities." Batch weights will not be permitted as a method of measurement unless the alternate provisions of subsection 401.03.01(a)1, "Plant Scales," are met, in which case the cumulative weight of all the acceptable batches will be used for payment.

Due to possible variations in the specific gravity and voids of the aggregate, the tonnage used may vary from the proposal quantities and no adjustment in contract unit price will be made because of such variation.

BASIS OF PAYMENT

401.05.01 Payment. All accepted work and materials measured as prescribed above will be paid for as provided in the respective sections for each type specified.

Full compensation for furnishing and applying bituminous material or asphaltic emulsion as provided for in subsections 401.03.06, "Preparation of Existing Surface," and

401.03.12, "Joints," shall be considered as included in the contract price paid for the principal items involved and no further compensation will be allowed therefor.

When Plantmix Surface Aggregate, Type 3, is used in the construction of median strip areas, island areas or dikes and there is no separate payment for said aggregate, this bituminous mixture shall be included in the payment for Plantmix Bituminous Surface Aggregate of the major type shown in the list of bid items and the proposal.

SECTION 402

PLANTMIX BITUMINOUS SURFACE

DESCRIPTION

402.01.01 General. This work shall consist of constructing one or more courses of bituminous pavement on a prepared 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 by the Engineer.

The requirements of Section 401, "Plantmix Bituminous Pavements—General," shall be applicable to this work, except as hereinafter specified.

MATERIALS

402.02.01 General. The materials shall conform to the requirements as specified in subsections 401.02.01 through 401.02.04, inclusive, of Section 401, "Plantmix Bituminous Pavements—General."

CONSTRUCTION

402.03.01 General. The construction requirements shall conform to the requirements as specified in subsections 401.03.01 through 401.03.14, inclusive, of Section 401, "Plantmix Bituminous Pavements—General," with the exceptions contained in the following three subsections.

402.03.02 Rollers. There shall be operating with each paver, three rollers meeting the requirements of (a), (b), and (c) in subsection 401.03.04, "Rollers," except as hereinafter noted.

When two (2) pavers are paving in echelon within four hundred (400) feet of each other and each paver is placing not more than one hundred fifty (150) tons of bituminous mixture per hour, then three (3) rollers meeting the requirements of (a), (b), and (c) in subsection 401.03.04, "Rollers," may be used to roll for both pavers.

402.03.03 Spreading and Finishing. Unless otherwise specified, bituminous plantmix surface shall be placed in courses not exceeding three (3) inches in compacted thickness. When more than one course is placed, the courses shall be of approximately equal thickness.

Bituminous plantmix surface to be placed on shoulders and other areas of the traveled way having a width of eight (8) feet or more shall be spread as specified in subsection 401.03.10, "Spreading and Finishing." When the areas are less than eight (8) feet in width the material may be deposited and spread in one or more layers by other mechanical means that will provide a uniform smoothness and texture. Placing bituminous mixture on any pavement that would be stained thereby will not be permitted.

402.03.04 Surface Tolerances. The completed surfacing shall be thoroughly compacted, smooth and free from ruts, humps, depressions, or irregularities. When a straightedge twelve (12) feet long is laid on the finished surface and parallel with the centerline of the highway, the surface shall not vary more than 0.02 foot from the lower edge of the straightedge. The transverse slope of the finished surface shall be uniform to a degree such that no depressions greater than 0.02 foot are present when tested with a straightedge twelve (12) feet long laid in a direction transverse to the centerline and extending from edge to edge of a twelve (12) foot traffic lane.

Any ridges, indentations, or other objectionable marks left in the surface of the bituminous mixture by blading or other equipment shall be eliminated by rolling or other means. The use of any equipment that leaves ridges, indentations, or other objectionable marks in the bituminous mixture shall be discontinued and other acceptable equipment shall be furnished by the Contractor.

METHOD OF MEASUREMENT

402.04.01 Measurement. Plantmix bituminous surface aggregate will be measured as specified in subsection 401.04.01, "Measurement."

BASIS OF PAYMENT

402.05.01 Payment. The accepted quantity of materials measured as provided in subsection 402.04.01, "Measurement," will be paid for at the contract unit price bid per ton for plantmix bituminous surface aggregate, per ton for mineral filler (type), and per ton for bituminous material (asphalt cement or liquid asphalt).

The above prices shall be full compensation for furnishing all the material, mixing, loading, hauling, placing, compacting, and incidentals necessary for doing all the work involved in constructing plantmix bituminous surface as shown on the plans or established by the Engineer.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Partial payments for plantmix bituminous surface aggregate may be made as set forth under subsection 109.06, "Partial Payments."

Payment will be made under:

Pay Item	Pay Unit
Plantmix Bituminous Surface Aggregate (type .....)	Ton
Mineral Filler (type)	Ton
Asphalt Cement (grade)	Ton
Liquid Asphalt (grade)	Ton
Plantmixing Miscellaneous Areas (type)	Square Yard
Plantmix Bituminous Shoulder Dikes	Linear Foot

SECTION 403

PLANTMIX BITUMINOUS OPEN-GRADED SURFACE

DESCRIPTION

403.01.01 General. This work shall consist of placing plantmix bituminous open-graded surface in one course for surface in accordance with these specifications and in reasonably close conformity with the lines, grades, thickness, and the typical cross sections shown on the plans or established by the Engineer.

The requirements of Section 401, "Plantmix Bituminous Pavements—General," shall be applicable to this work, except as hereinafter specified.

MATERIALS

403.02.01 General. The materials shall conform to the requirements as specified in subsections 401.02.01 through 401.02.04, inclusive, of Section 401, "Plantmix Bituminous Pavements—General."

CONSTRUCTION

403.03.01 General. The construction requirements shall conform to the requirements as specified in subsections 401.03.01 through 401.03.13, inclusive, of Section 401, "Plantmix Bituminous Pavements—General," with the exceptions contained in the following three subsections.

403.03.02 Rollers. There shall be operating with each paver one (1) tandem roller weighing not less than eight (8) nor more than ten (10) tons. When two (2) pavers are paving in echelon, within four hundred (400) feet of each other, then one (1) roller may be used for both pavers.

403.03.03 Joints. Longitudinal joints shall be constructed only on the shoulders, or at the edge of travel lanes.

403.03.04 Surface Tolerances. The completed surfacing shall be thoroughly compacted, smooth and free from ruts, humps, depressions, or irregularities. When a straightedge twelve (12) feet long is laid on the finished surface and parallel with the centerline of the highway, the surface shall not vary more than 0.02 foot from the lower edge of the straightedge. The transverse slope of the finished surface shall be uniform to a degree such that no depressions greater than 0.02 foot are present when tested with a straightedge twelve (12) feet long laid in a direction transverse to the centerline and extending from edge to edge of a twelve (12) foot traffic lane.

Any ridges, identations, or other objectionable marks left in the surface of the bituminous mixture by blading or other equipment shall be eliminated by rolling or other means. The use of any equipment that leaves ridges, indentations, or other objectionable marks in the bituminous mixture shall be discontinued and other acceptable equipment shall be furnished by the Contractor.

METHOD OF MEASUREMENT

403.04.01 Measurement. Plantmix bituminous open-graded surface aggregate will be measured as specified in subsection 401.04.01, "Measurement."

BASIS OF PAYMENT

403.05.01 Payment. The accepted quantity of materials measured as provided in subsection 403.04.01, "Measurement," will be paid for at the contract unit price bid per ton for plantmix bituminous open-graded surface aggregate and per ton for bituminous material (asphalt cement).

The above prices shall be full compensation for furnishing all the materials, mixing, loading, hauling, placing,

compacting, and incidentals necessary for doing all the work involved in constructing plantmix bituminous open-graded surface as shown on the plans or established by the Engineer.

All payments will be made in accordance with subsection 109.01, "Scope of Payment."

Partial payments for plantmix bituminous open-graded surface aggregate may be made as set forth under subsection 109.06, "Partial Payments."

Payment will be made under:

Pay Item	Pay Unit
Plantmix Bituminous Open-Graded Surface Aggregate	Ton
Asphalt Cement	Ton

SECTION 404

ROADMIX BITUMINOUS SURFACE

DESCRIPTION

404.01.01 General. This work shall consist of constructing one or more courses of roadmix bituminous pavement on a prepared base or road 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 by the Engineer.

The mineral aggregate and bituminous material may be mixed in place in the prepared roadbed, or mixed off of the roadbed by either roadmix or plantmix methods.

MATERIALS

404.02.01 Aggregates. Aggregates shall meet the requirements of Section 705, "Aggregates for Bituminous Courses," for the grading size and type specified. The aggregate will be accepted immediately preceding addition of bituminous material to the mix. This acceptance will be based on periodic samples of the windrow after all aggregates have been blended for each layer. When plantmix method is used, aggregates will be tested for acceptance at the bins. Attention is directed to subsection 106.04, "Samples and Tests."

When the mineral aggregate consists of material in place on the roadbed, which was not placed under the contract providing for the placing of the roadmix surfacing, all rock or lumps of materials larger in greatest dimension than the planned surface thickness shall be removed and disposed of along the roadway and such work shall be paid for as extra work as provided in subsection 104.03, "Extra Work."

404.02.02 Bituminous Material. The type and grade of bituminous material will be specified in the contract. The grade may be changed one step by the Engineer during construction at no change in unit price.

The bituminous material shall meet the applicable requirements of Section 703, "Bituminous Materials."

Bituminous material may be conditionally accepted at the source.

CONSTRUCTION

404.03.01 Motor Graders. Motor graders for spreading, shaping, and finishing mixture shall be of the self-powered type with blades not less than twelve (12) feet long and wheel bases of not less than seventeen (17) feet.

404.03.02 Distributors. The distributor shall be so designed, equipped, maintained, and operated that bituminous material at even heat may be applied uniformly on variable widths of surface up to fourteen (14) feet at readily determined and controlled rates from 0.05 to 2.0 gallons per square yard, with uniform pressure, and with an allowable variation from any specified rate not to exceed 0.02 gallon per square yard. Distributor equipment shall include a tachometer, pressure gages, 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.

404.03.03 Mixing Plants. Traveling or stationary mixing plants or other equipment of proven performance may be used by the Contractor in lieu of the specified equipment if approved. Traveling mixing plant shall have positive controls for applying asphalt.

404.03.04 Rollers. Rollers used shall conform to the requirements of subsection 401.03.04, "Rollers."

404.03.05 Weather Limitations. The mixing, spreading, and compacting of roadmix bituminous pavement shall be carried on only when the surface on which the material is to be placed is dry and when the atmospheric temperature is above fifty (50) degrees Fahrenheit, and has not been below forty (40) degrees Fahrenheit during the preceding twenty-four (24) hours.

404.03.06 Preparation of Existing Surface. Before spreading materials for roadmixing, the surface of the base or road surface on which the roadmix is to be placed shall be conditioned as specified in subsection 401.03.06, "Preparation of Existing Surface."

After a prime coat is applied, it shall be left undisturbed not less than twenty-four (24) hours. The Contractor shall maintain the primed surface until the roadmix material has been placed. This maintenance shall include the spreading of sand or other material, if necessary to prevent adherence of the prime coat to the tires of vehicles using the primed surface, and patching any breaks in the primed surface with additional bituminous material. Any area of primed surface that has become damaged shall be repaired before the roadmix material is placed.

404.03.07 Placing Aggregates. Mineral aggregate shall be deposited upon the prepared subgrade, or mixing area, by the use of spreader boxes, or from the vehicles equipped or supplemented with suitable spreading devices.

The mineral aggregate shall contain sufficient material to construct the roadmix surfacing as planned, including sufficient material for surfacing special features off the traveled way. The aggregate shall not be mixed with earth or other deleterious matter.

If the surface moisture of the aggregate is more than two (2) percent of the dry weight of the aggregate, except when the bituminous material is emulsified asphalt, the aggregate shall be turned by blades or disc harrows or otherwise aerated until the moisture content is reduced to two (2) percent or less. The aggregate shall then be spread smoothly and uniformly over half the road or other convenient width of the surface ready for the application of bituminous material, except that when a traveling mixing plant is used the aggregate shall be formed into a uniform cross section.

In lieu of aerating and drying the aggregate, the Contractor may use an approved additive. The additive shall permit suitable coating of the wet aggregate and shall prevent the bituminous coating from stripping in the presence of water.

404.03.08 Application of Bituminous Material. The bituminous material shall be uniformly distributed in successive application, in such amounts and at such intervals as directed. The temperature of the bituminous material shall conform to the applicable requirements of subsection 406.03.04 of Section 406, "Prime Coat." The mixing equipment shall follow immediately behind the distributor after each application of bituminous material to partially mix the aggregate and the bituminous material. No more bituminous material shall be applied per day than can be mixed with the aggregate on the same day it is applied.

404.03.09 Mixing. The materials may be mixed upon the roadbed, or upon some other approved area off the roadbed by roadmixing methods, or the material may be mixed at a central mixing plant by plantmix methods as specified below, whichever the Contractor elects.

(a) Roadmixing Methods. Prior to applying the bituminous material the prepared aggregate shall be spread smoothly and uniformly over one-half the mixing area or some other convenient width. The first application of bituminous material shall then be applied and partially mixed with the aggregate. The remaining applications of bituminous material with a partial mixing after each application shall follow in like manner. After the last application of bituminous material and partial mixing, the entire mass of bituminous material and aggregate shall be windrowed on the mixing surface and then thoroughly mixed and combined by the mixing units specified, by blading the mix from side to side of the mixing surface, or by a manipulation producing equivalent results, until all particles are coated with bituminous material and the whole mass has uniform color and the mixture is free from spots containing an excess or deficiency of bituminous material, balls, or uncoated particles. During the mixing operations, care shall be taken to avoid cutting into the underlying course or contaminating the mixture with earth or other extraneous matter. When so directed by the Engineer, the mixing process shall be confined to part of the width or area of the roadbed so as to allow a convenient passage for traffic.

Prior to spreading and compacting, should the mixture show an excess or deficiency of bituminous material, or an uneven distribution thereof, the condition shall be corrected by adding mineral aggregate or bituminous material, as the case may be, and then remixing to produce a satisfactory mixture. If necessary, all compressed masses of mixed materials shall be broken up.

When the mineral aggregate consists of the existing material on the roadbed and an allowance for additional mineral aggregate has not been provided for on the plans, additional mineral aggregate may be obtained by scarifying material from the roadbed as directed by the Engineer or, in lieu thereof, the Contractor may import suitable material. No additional compensation will be allowed for conforming to the above requirements, except that additional materials imported and added to that in place will be paid for as extra work as provided in subsection 104.03, "Extra Work."

The amount of material mixed in any one day shall not be more than can be spread and compacted on the following day, provided, however, that when directed by the Engineer, mixed material may remain in the windrow for a longer period.

In lieu of mixing the material as above specified, a roadmixing machine or any equipment other than that required above may be employed which will produce the completed mixture equal to that which would be produced by the means above specified. The Department reserves the right to order the use of any equipment discontinued which, in the opinion of the Engineer, fails to produce a satisfactory mixture.

The roadmixing machine shall be of the pugmill or auger type which picks up the loose material from the mixing area or it may be of the type which cuts a true plane in material at a specified depth, leaving no loose material in either case. Either type shall introduce the bituminous material through a metering device at the time of mixing. The machine shall be equipped to provide for a positive control of the amount of bituminous material introduced

into the mix, which can be readily adjusted to the changes required.

The rate of movement of the roadmixing machine, the amount of the material mixed and the amount of mixing shall be so regulated that a mix satisfactory to the Engineer will result. The materials shall be mixed until a uniform mixture of unchanging appearance is obtained and all particles of aggregate are thoroughly coated with bituminous materials. Before mixing, the loose materials shall be placed in windrows or in a blanket of uniform cross section and of such size that all the material in the windrow or blanket can be passed through the mixing machine at each mixing operation.

Materials mixed off the roadbed shall be uniform in character and equal in all respects to that which would be produced by mixing on the roadbed as above specified.

(b) Plantmixing Method. Should the Contractor elect to mix the materials at a central mixing plant by the plant-mix method, the mineral aggregate shall be dried, proportioned, and mixed with the bituminous material in accordance with the applicable requirements of Section 401 of these specifications with the following modifications: When the moisture content of the mineral aggregate does not exceed two (2) percent by weight of the dry aggregate and laboratory tests indicate that such increased moisture content will not produce an unstable mixture, mixing of the materials without passing the aggregate through a dryer will be permitted.

Unless otherwise specified in the special provisions, separation of the mineral aggregate into required sizes and storing in separate bins will not be required.

404.03.10 Spreading, Compacting, and Finishing. Before the finished mixture is spread for compaction, a triangular cut shall be made with a motor grader at each edge of the base course to provide for a thickened edge of bituminous mixture. The cut shall be approximately two (2) inches deep at the outer edge and slope to zero, two (2) feet in toward the center. In making a cut the excavated

material shall be thrown to the edge of the roadbed in a small windrow against which the mixture shall then be spread.

After roadmixing operations have been completed and the mixture has been approved by the Engineer, the mixture shall be uniformly spread over the area to be surfaced to the proper width and to such depth as will compact to the required thickness. The mixture shall be spread by means of a motor grader meeting the requirements of subsection 404.03.01, "Motor Graders."

Segregation of coarse or fine particles shall be avoided and the mixture shall be free from lumps or pockets of coarse and fine material after spreading.

After the mixture has been spread as above specified, approximately the top half of the material shall be removed by motor graders and placed into a windrow on one side. The windrow shall be so placed that earth or other extraneous materials will not become intermixed with the windrowed material, shall then be respread over the entire surface by alternating the windrow from one side of the roadbed to the other and to the center and gradually decreasing the amount of material moved, until the entire surface has uniform texture and is smooth and true to cross section and grade and is uniformly compacted. During blading and rolling, all lumps and loose stones shall be moved to the outside of the surface area and disposed of.

All rolling, except the final finish rolling, shall be done with pneumatic-tired rollers. The finish rolling shall be done with steel-tired tandem or three-wheeled rollers commencing at the lower edge, progressing toward the highest portion. Under no circumstances shall the highest portion be rolled first.

404.03.11 Miscellaneous Areas. Surfacing of road approaches and connections, street intersection areas, frontage roads, median strip areas, island areas, sidewalks, dikes, gutters, gutter flares, ditches, overside drains, spillways, aprons at the ends of drainage structures, and other designated areas outside the traveled way shall conform to the provisions specified in these specifications.

The combined aggregate grading for bituminous mixtures placed on miscellaneous areas shall conform to that specified for the bituminous mixture placed on the traveled way. The amount of bituminous material used in the bituminous mixture placed in dikes, gutters, gutter flares, overside drains, spillways, aprons at the ends of drainage structures, and other designated areas outside the traveled way shall be increased not less than one (1) percent by weight of the aggregate over the amount of bituminous material used in the bituminous mixture placed on the traveled way.

404.03.12 Surface Tolerances. The surface will be tested by the Engineer using a twelve (12) foot straightedge at selected locations. The variation of the surface from the testing edge of the straightedge between any two contacts with the surface shall at no point exceed 0.03 foot. All humps or depressions exceeding the specified tolerance shall be corrected by removing defective work and replacing it with new material as specified.

METHOD OF MEASUREMENT

404.04.01 Measurement. The quantity of roadmix bituminous surface aggregate to be measured for payment will be the number of tons or cubic yards as indicated in the proposal, conforming to all the requirements in the completed work. When the mixture is mixed at a central mixing plant by the plantmix method, the number of tons will be determined by weighing the completed mixture of aggregate and bituminous material and deducting from this weight the weight of the bituminous material.

Mineral aggregate consisting of material in place on the roadbed will not be measured and paid for, except for the removal of rocks and lumps as provided in subsection 404.02.01, "Aggregates," of this section. All other work involved in scarifying and preparing the material as herein specified shall be considered as included in the contract unit price paid for mixing the roadmix surfacing.

Mixing and compacting shall be measured in miles along the centerline of the roadway and no extra allowance will be made for mixing widened sections and shoulder dikes, unless otherwise provided in the special provisions.

The quantity of shoulder dikes constructed of bituminous mixture, the placing of which is to be paid for as a contract item on a linear foot basis, will be determined from measurements taken along the top of the completed dikes to the nearest one (1) foot length. The quantities of bituminous mixture used to construct the dikes shall be measured as set forth above.

The quantities of bituminous mixture, the placing of which is to be paid for as a contract item on an area basis in addition to the contract prices paid for the bituminous mixture, will be determined from measurements of the bituminous mixture compacted in place.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities." Batch weights will not be permitted as a method of measurement unless the alternate provisions of subsection 401.03.01(a)1, "Plant Scales," are met, in which case the cumulative weight of all the acceptable batches will be used for payment.

Tonnage shall conform reasonably close to that shown on the plans, unless otherwise directed. Due to possible variations in the specific gravity and voids of the aggregates, the thickness may vary from that shown on the plans.

BASIS OF PAYMENT

404.05.01 Payment. The accepted quantity of materials measured as provided in subsection 404.04.01, "Measment," will be paid for at the contract unit price bid per ton or cubic yard for roadmix bituminous surface aggregate, per ton for bituminous material (liquid asphalt), and per mile for mixing the roadmix bituminous pavement.

The above prices shall be full compensation for furnishing all the material, mixing, loading, hauling, placing, compacting, and incidentals necessary for doing all the work

involved in constructing roadmix bituminous surface, as shown on the plans or established by the Engineer.

Full compensation for furnishing and applying bituminous material or asphaltic emulsion as provided for in subsection 404.03.06, "Preparation of Existing Surface," shall be considered as included in the contract price paid for the principal items involved and no further compensation will be allowed therefor.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Partial payments for roadmix bituminous surface aggregate may be made in accordance with subsection 109.06, "Partial Payments."

Payment will be made under:

Pay Item	Pay Unit
Roadmix Bituminous Surface Aggregate	Ton or Cubic Yard
Liquid Asphalt (grade)	Ton
Mixing Roadmix Bituminous Surface (width)	Mile
Roadmixing Miscellaneous Areas (type)	Square Yard
Roadmix Bituminous Shoulder Dikes	Linear Foot

SECTION 405

TACK COAT

DESCRIPTION

405.01.01 General. This work shall consist of preparing and treating an existing bituminous or concrete surface with bituminous material in accordance with these specifications and in reasonably close conformity with the lines shown on the plans or established by the Engineer.

MATERIALS

405.02.01 Bituminous Material. The type and grade of bituminous material will be specified in the contract. The grade may be changed one step by the Engineer during construction at no change in unit price.

The bituminous material shall meet the applicable requirements of Section 703, "Bituminous Materials." The bituminous material may be conditionally accepted at the source.

Asphaltic emulsion used as a tack coat between the courses of plantmix surface or over an existing surface shall be of the type and grade specified and prepared for application as follows:

The emulsion shall be cut back by water. Water shall be added in the quantity of forty (40) percent of the emulsion by weight. To accomplish this mixing, the distributor shall be partly filled with water, and the correct proportion of emulsified asphalt shall then be added, and the remaining water to be added shall be sprayed into the tank under pressure and then thoroughly circulated within the distributor.

CONSTRUCTION

405.03.01 Equipment. The Contractor shall provide equipment for heating and applying the bituminous material. This equipment shall meet the requirements of subsection 404.03.02, "Distributors."

405.03.02 Weather Limitations. Application of bituminous material will not be permitted when the surface to be treated is damp or wet or when weather conditions are unsuitable or when the atmospheric temperature or aggregate temperature is below forty (40) degrees Fahrenheit.

405.03.03 Preparation of Surface. The existing surface shall be patched and cleaned and be free of irregularities to provide a reasonably smooth and uniform surface to receive the treatment. The edges of existing pavements, which are to be adjacent to new pavement, shall be cleaned to permit the adhesion of bituminous materials.

Where the Contractor is applying tack upon a previously constructed course under the contract, patching, cleaning, repairing, etc., will be at the Contractor's expense, unless otherwise provided. Attention is directed to subsection 104.04, "Maintenance of Traffic," and subsection 105.14, "Maintenance During Construction."

Where the Contractor is applying tack upon a previously constructed course not a part of the contract, and when there are no items or provisions to pay for preparing the existing surface, the Contractor shall be paid for such preparation under the provisions of subsection 104.03, "Extra Work."

450.03.04 Application of Bituminous Materials. The bituminous material shall be uniformly applied at the rate called for on the plans or ordered by the Engineer. When asphaltic emulsion or liquid asphalt is used, the temperature at the time of application shall conform to the applicable requirements in Table I of subsection 406.03.04.

The tack coat shall be applied in such manner as to offer the least inconvenience to traffic and to permit one-way traffic without pickup or tracking of the bituminous material. Tack coat shall be applied only so far in advance that it will be covered during the following thirty-six (36) hours.

METHOD OF MEASUREMENT

405.04.01 Measurement. The quantity of bituminous material to be measured for payment will be the number of tons conforming to all the requirements in the completed work.

Bituminous material diluted as prescribed shall be measured in tons of the diluted mixture acceptably applied to the surface.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

405.05.01 Payment. The accepted quantity of bituminous material measured as provided in subsection 405.-04.01, "Measurement," will be paid for at the contract unit price bid per ton.

The above prices shall be full compensation for furnishing the material, mixing, loading, hauling, placing, and incidentals necessary for doing all the work involved in placing tack coat, as shown on the plans or established by the Engineer, all in accordance with subsection 109.02, "Scope of Payment."

The Department reserves the right to increase or to omit all or any part of the estimated amount of bituminous material to be used and no additional compensation shall be allowed by reason of such increase or decrease.

Payment will be made under:

Pay Item	Pay Unit
Liquid Asphalt (type)	Ton
Emulsified Asphalt (type)	Ton

SECTION 406

PRIME COAT

DESCRIPTION

406.01.01 General. This work shall consist of preparing and treating an existing surface with bituminous material, and blotter material, if required, in accordance with these specifications and in reasonably close conformity with the lines shown on the plans or established by the Engineer.

MATERIALS

406.02.01 Bituminous Material. The type and grade of bituminous material will be specified in the contract. The grade may be changed one step by the Engineer during construction at no change in unit price.

The bituminous material shall meet the applicable requirements of Section 703, "Bituminous Materials." The bituminous material may be conditionally accepted at the source.

406.02.02 Sand Blotter. Sand blotter shall meet the requirements of subsection 705.03.06, "Sand Blotter." The material may be accepted in stockpile at the source.

CONSTRUCTION

406.03.01 Equipment. The Contractor shall provide equipment for heating and applying the bituminous material and for applying blotter material. The equipment shall meet the requirements of subsection 404.03.02, "Distributors."

406.03.02 Weather Limitations. Bituminous material shall not be applied on a wet surface; when the atmospheric temperature is below fifty (50) degrees Fahrenheit

or when weather conditions, in the opinion of the Engineer, would prevent the proper construction of the prime coat.

406.03.03 Preparation of Surface. The surface upon which the bituminous prime coat is to be placed shall conform to the established lines and grades, shall be reasonably smooth and uniform and shall be compacted to the required density. If the required density deteriorates from the time the gravel course was compacted originally and the time the prime coat is placed, for any reason whatsoever, then the surface shall be recompacted to the required density at the expense of the Contractor. When required by the Engineer, an application of water shall be applied immediately before bituminous application.

406.03.04 Application of Bituminous Material. Bituminous material shall be applied to the width of the section to be primed by means of a pressure distributor in a uniform, continuous spread. When traffic is maintained, not more than one-half (½) of the width of the section shall be treated in one application. Care shall be taken that the application of bituminous material at the junctions of spreads is not in excess of the specified amount. Excess bituminous material shall be squeegeed from the surface. Skipped areas or deficiencies shall be corrected.

When traffic is maintained, one-way traffic shall be permitted on the untreated portion of the roadbed. As soon as the bituminous material has been absorbed by the surface and will not pick up, traffic shall be transferred to the treated portion and the remaining width of the section shall be primed.

The bituminous material shall be uniformly applied at the rate called for on the plans or ordered by the Engineer.

The temperature requirements pertaining to the application of liquid asphalts and asphaltic emulsions shall conform to the requirements of the following Table I:

TABLE I

Spraying and Mixing Temperatures of Liquid Asphalts and Asphaltic Emulsions

Grade and Type RC, MC and SC	Distributor —Spraying Temp. °F.— Minimum	Maximum	*Pugmill Mixing Temp. °F. of Liquid Asphalts —MC and SC— Minimum	Maximum
70	120	180	95	140
250	165	220	135	175
800	200	255	165	205
3,000	235	290	200	240

*The maximum spraying temperature may be used if the aggregate is not heated.

Grade of Asphalt Emulsion	Distributor —Spraying Temp. °F.— Minimum	Maximum	*Pugmill Mixing Temp. °F. of Emulsion and —Aggregates— Minimum	Maximum
RS–1, CRS–1	75	130	(Not used for Mixing)	
RS–2, CRS–2	110	160	(Not used for Mixing)	
SS–1, CSS–1	75	130	50	130
SS–1h, CSS–1h	75	130	50	130
CMS–2S	100	160	60	140

*The maximum spraying temperature may be used if the aggregate is not heated.

406.03.05 Application of Blotter Material. If, after the application of the prime coat, the bituminous material fails to penetrate within three (3) to six (6) days and the roadway must be used by traffic, blotter material shall be spread in the amounts required to absorb any excess bituminous material. When necessary for traffic, blotter material may be spread prior to three (3) days' penetrating time.

METHOD OF MEASUREMENT

406.04.01 Measurement. The quantity of bituminous material to be measured for payment will be the number of tons conforming to all the requirements in the completed work. The quantity of blotter sand measured for payment will be the number of tons or cubic yards conforming to all the requirements in the completed work.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

406.05.01 Payment. The accepted quantity of materials measured as provided in subsection 406.04.01, "Measurement," will be paid for at the contract unit price bid per ton for bituminous material and per ton or cubic yard for blotter sand.

When sand blotter is not included in the proposal and it is needed to protect the work or public traffic, it shall be furnished and spread as herein described, and payment therefor will be in accordance with subsection 104.03, "Extra Work."

The above prices shall be full compensation for furnishing the material, mixing, loading, hauling, placing, and incidentals necessary for doing all the work involved in placing prime coat and sand blotter, as shown on the plans or established by the Engineer.

The Department reserves the right to increase or to omit all or any part of the estimated amount of blotter material or bituminous material to be used and no additional compensation shall be allowed by reason of such increase or decrease.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Liquid Asphalt (type)	Ton
Emulsified Asphalt (type)	Ton
Sand Blotter	Ton or Cubic Yard

SECTION 407

SEAL COAT

DESCRIPTION

407.01.01 General. This work shall consist of an application of bituminous material on a compacted and bonded bituminous surface, and blotter material, if required, in accordance with these specifications and in reasonably close conformity with the lines shown on the plans or established by the Engineer.

MATERIALS

407.02.01 Bituminous Material. The type and grade of bituminous material will be specified in the contract. The grade may be changed one step by the Engineer during construction at no change in unit price.

The bituminous material shall meet the applicable requirements of Section 703, "Bituminous Materials." The bituminous material may be conditionally accepted at the source.

407.02.02 Sand Blotter. Sand blotter shall meet the requirements of subsection 705.03.06, "Sand Blotter." The material may be accepted in stockpile at the source.

CONSTRUCTION

407.03.01 Equipment. The Contractor shall provide equipment for heating and applying the bituminous material and for applying blotter material. The equipment shall meet the requirements of subsection 404.03.02, "Distributors."

407.03.02 Weather Limitations. Bituminous material shall not be applied on a wet surface, when the temperature is below fifty (50) degrees Fahrenheit or when weather conditions, in the opinion of the Engineer, would prevent the proper construction of the seal coat.

407.03.03 Preparation of Surface. Immediately before applying the bituminous material the surface to be sealed shall be thoroughly cleaned of all dirt and loose material by sweeping with power brooms supplemented by hand brooms if necessary. The process of cleaning shall continue until dirt and loose material is removed from the entire width of the surfacing.

407.03.04 Application of Bituminous Material. Bituminous material shall not be spread later in the day than will permit the stopping of traffic control prior to darkness. Bituminous material shall be applied to only one designated traffic lane at a time and the entire width of the lane shall be covered in one operation.

The bituminous material shall be uniformly applied at the rate called for on the plans or ordered by the Engineer. The temperature of the bituminous material shall conform to the applicable requirements of subsection 406.03.04 of Section 406, "Prime Coat."

The seal coat shall be applied in such manner as to offer the least inconvenience to traffic and to permit one-way traffic without pickup or tracking of the bituminous material.

When a surface treatment is to be applied to the central portion of the pavement, the seal coat shall be applied to the shoulder at least four (4) days in advance of the application of the adjacent surface treatment requiring screenings, and the seal coats shall be applied in such a manner that the joint between the two types will present a neat and uniform appearance true to the line shown on the typical cross section and as established by the Engineer.

407.03.05 Application of Blotter Material. The applicable requirements of Section 406, "Prime Coat," shall apply to this Section 407, "Seal Coat," when sand blotter is required.

METHOD OF MEASUREMENT

407.04.01 Measurement. The quantity of bituminous material to be measured for payment will be the number of

tons conforming to all the requirements in the completed work.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

407.05.01 Payment. The accepted quantity of materials measured as provided in subsection 407.04.01, "Measurement," will be paid for at the contract unit price bid per ton for bituminous material.

The above price shall be full compensation for furnishing the material, mixing, loading, hauling, placing, and incidentals necessary for doing all the work involved in placing seal coat as shown on the plans or established by the Engineer.

The Department reserves the right to increase or to omit all or any part of the estimated amount of bituminous material to be used and no additional compensation shall be allowed by reason of such increase or decrease.

Sand blotter will be paid for in accordance with Section 406, "Prime Coat."

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Liquid Asphalt (type)	Ton
Emulsified Asphalt (type)	Ton

SECTION 408

SURFACE TREATMENT

DESCRIPTION

408.01.01 General. This work shall consist of an application of bituminous material and cover of screenings applied on a previously compacted and bonded bituminous surface, all in accordance with these specifications and in reasonably close conformity with the lines shown on the plans or established by the Engineer.

MATERIALS

408.02.01 Bituminous Material. The type and grade of bituminous material will be specified in the contract. The grade may be changed one step by the Engineer during construction at no change in unit price.

The bituminous material shall meet the applicable requirements of Section 703, "Bituminous Materials." The bituminous material may be conditionally accepted at the source.

408.02.02 Screenings. Screenings shall meet the requirements of subsection 705.03.05, "Screenings," for the size specified. Attention is directed to subsection 106.04, "Samples and Tests."

CONSTRUCTION

408.03.01 Distributors. The distributor shall meet the requirements of subsection 404.03.02, "Distributors."

408.03.02 Aggregate Spreader. The aggregate spreader shall be self-propelled and supported by at least four (4) wheels equipped with pneumatic tires on two (2) axles. The aggregate spreader shall be equipped with positive control so that the required amount of material will be deposited uniformly over the full width of the bituminous material.

408.03.03 Rollers. There shall be operating with each aggregate spreader, one (1) pneumatic-tired roller and one (1) steel-wheel roller. The pneumatic-tired roller shall meet the requirements of subsection 401.03.04, "Rollers" (b). The steel-wheel roller shall meet the requirements of the same subsection, (a) or (c).

408.03.04 Weather Limitations. Bituminous material shall not be spread when weather conditions are unsuitable, or when the atmospheric temperature is below sixty-five (65) degrees Fahrenheit or the pavement temperature is below eighty (80) degrees Fahrenheit.

408.03.05 Maintaining Traffic. Where public traffic is being routed over a surface upon which a surface treatment is to be applied, the surface treatment shall not be applied to more than one-half the width of the traveled way at a time, and the remaining half width shall be kept free of obstructions and open for use by public traffic at all times until the surface treatment first applied is ready for use by traffic.

Traffic will not be allowed on the newly placed bituminous material and screenings until, in the opinion of the Engineer, the screenings and bituminous material have sufficiently set and bonded to prevent displacement by such traffic.

When the newly completed surface treatment is open to traffic, the traffic shall be controlled by use of flagmen and a pilot car for a period of six (6) hours or for such time as deemed necessary by the Engineer as follows:

(a) A flagman shall be stationed at the beginning of each newly completed section open to traffic, to stop oncoming traffic preparatory to piloting operations and shall be kept on duty during the entire control period.

(b) Traffic control as described above shall be moved ahead progressively as the newly completed surface is open to traffic.

408.03.06 Preparation of Surface. Immediately before applying the bituminous material, the surface to be

treated shall be thoroughly cleaned of all dirt and loose material by sweeping with power brooms supplemented by hand brooms if necessary. The process of cleaning shall continue until the surfacing is exposed and all dirt and loose material is removed from the entire width of surfacing.

408.03.07 Application of Bituminous Material. Bituminous material shall be applied by means of a pressure distributor in a uniform, continuous spread over the section to be treated. The temperature of the bituminous material shall conform to the applicable requirements of subsection 406.03.04 of Section 406, "Prime Coat." The quantity of bituminous material to be used per square yard shall be as directed. If the texture of the surface is such that bituminous material penetrates too rapidly, a preliminary application of from 0.05 to 0.10 gallon per square yard of surface may be required. A strip of building paper at least three (3) feet in width and with a length equal to that of the spray bar of the distributor plus one (1) foot, shall be used at the beginning of each spread. If the cutoff is not positive, the use of paper may be required at the end of each spread. The paper shall be removed and disposed of in a satisfactory manner. The distributor shall be moving forward at proper application speed at the time the spray bar is opened. Any skipped areas or deficiencies shall be corrected. Junctions of spreads shall be carefully made to assure a smooth riding surface.

The length of spread of bituminous material shall not be in excess of that which trucks loaded with screenings can immediately cover.

The spread of bituminous material shall not be more than six (6) inches wider than the width covered by the screenings from the spreading device. Under no circumstances shall operations proceed in such manner that bituminous material will be allowed to chill, set up, dry, or otherwise impair retention of the screenings.

The distributor, when not spreading, shall be parked so that the spray bar or mechanism will not drip bituminous materials on the surface of the traveled way.

408.03.08 Application of Screenings. Immediately following the application of the bituminous material, screenings shall be spread at the required rate per square yard.

In order to avoid building a longitudinal joint, when spreading screenings on the first width of bituminous materterial, no screening shall be applied within six (6) inches of the edge adjacent to the next application of bituminous material.

Bituminous material and screenings shall not be spread over a greater distance than can be rolled and finished within one (1) day's operation.

In order to eliminate dust film, screenings shall be moistened with water before being applied. In spreading the screenings, the equipment used shall be so operated that the fresh bituminous material will be covered before equipment wheels come upon it.

Asphaltic emulsion applied to the road surface shall be covered with screenings before setting or breaking occurs.

After the screenings have been spread upon the bituminous material, any piles, ridges, or uneven distribution shall be carefully removed with flat bottom shovels, or other approved methods to insure against permanent ridges or bumps in the completed surface. Additional screenings shall be spread by hand in whatever quantities required to prevent picking up by the rollers or traffic.

After the application of the screenings the surface where specified shall be lightly broomed or otherwise maintained as directed for a period of four (4) days or as directed. Maintenance of the surface shall include the distribution of screenings over the surface to absorb any free bituminous material and cover any area deficient in screenings. The maintenance shall be conducted so as not to displace imbedded material. Excess material shall be swept at the time determined by the Engineer.

408.03.09 Rolling. Rolling shall follow immediately behind spreading screenings to properly embed the screenings in the soft bituminous material and rolling shall commence at the outer edges and proceed toward the inner

edge of each spread of bituminous material and screenings, and shall be continued until the screenings are thoroughly set.

The sequence of rollers and roller patterns will be established by the Engineer.

METHOD OF MEASUREMENT

408.04.01 Measurement. The quantity of bituminous material to be measured for payment will be the number of tons conforming to all the requirements in the completed work. The quantity of screenings measured for payment will be the number of tons or cubic yards conforming to all the requirements in the completed work.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

408.05.01 Payment. The accepted quantity of materials measured as provided in subsection 408.04.01, "Measurement," will be paid for at the contract unit price bid per ton for bituminous material and per ton or cubic yard for screenings.

The above prices shall be full compensation for furnishing the material, mixing, loading, hauling, placing, rolling, sweeping, and incidentals necessary for doing all the work involved in placing bituminous material and screenings, as shown on the plans or established by the Engineer.

The Department reserves the right to increase or to omit all or any part of the estimated amount of screening material or bituminous material to be used and no additional compensation shall be allowed by reason of such increase or decrease.

Flagmen and pilot cars will be paid for in accordance with Section 624, "Accommodations for Public Traffic."

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Liquid Asphalt (type)	Ton
Emulsified Asphalt (type)	Ton
Screenings	Ton or Cubic Yard

SECTION 409

PORTLAND CEMENT CONCRETE PAVEMENT

DESCRIPTION

409.01.01 General. This work shall consist of a pavement composed of Portland cement concrete, with or without reinforcement as specified, constructed on a prepared subgrade or base course in accordance with these specifications and in reasonably close conformity with the lines, grades, thicknesses, and typical cross sections shown on the plans or established by the Engineer.

At the option of the Contractor, concrete pavement may be constructed with equipment utilizing stationary side forms or by the use of slip-form paving equipment.

MATERIALS

409.02.01 General. Materials shall conform to the requirements of the following sections and subsections:

Fine Aggregate	Subsection 706.03.03
Course Aggregate	Subsection 706.03.01
Portland Cement	Section 701
Water	Section 722
Air-Entraining Admixtures	Subsection 702.03.03
Joint Filler	Subsection 707.03.01
Curing Materials	Subsection 702.03.01
Subgrade Paper	Subsection 702.03.02
Reinforcement	Section 713

An inadequate water supply shall be concluded sufficient cause for delaying or stopping mixing operations. In case of a deficiency of water, the requirements for subgrade and curing concrete previously placed shall have priority over mixing.

409.02.02 Gradation Requirements. Gradation requirements shall conform to the requirements as specified in subsection 501.02.02, "Gradation Requirements."

409.02.03 Concrete Properties and Tests. Portland cement concrete pavement shall be subject to the following requirements and test methods:

Test	Test Designation	Requirements
Flexural Strength of Concrete	Nev. T442	Subsection 409.03.13, "Protection of Pavement"
Length of Drilled Cores	Nev. T452	Subsection 409.04.02, "Pavement Thickness"
Proportions of Coarse Aggregate In Fresh Concrete	Nev. T449*	Compliance with uniformity specified in test method
Slump	Nev. T439 or Nev. T438	Table I
Evaluation of Profiles	Nev. T446	Subsection 409.03.11, "Riding Tolerances"
12 foot Straightedge Tolerances	Nev. T380	0.01 ft. max. longitudinal —0.02 ft. max. transverse
Method of Test for Specific Gravity and Absorption of Coarse Aggregate	Nev. T492	Min. saturated surface dry condition
Method of Test for Specific Gravity and Absorption of Coarse Aggregate	Nev. T493	Min. saturated surface dry condition

*Referee Test Method.

CONSTRUCTION

409.03.01 Classification and Proportions. The Contractor shall notify the Engineer not less than thirty-two (32) calendar days in advance of use of the proposed sources of materials and shall make arrangements for the Engineer to obtain samples as required for testing purposes.

When requested by the Contractor and allowed in writing by the Engineer, samples will not be required from aggregate sources previously tested within the past one (1) year.

Samples will not exceed five hundred (500) pounds for each separate grading. The Contractor shall furnish a written statement giving the cement factor in sacks per cubic yard, the proportions of cement, water, and each size of

aggregate in S.S.D. condition, and the percentage of air in the concrete proposed for use in the work. If the Contractor proposes to use an admixture other than an air-entraining agent, he shall state its complete brand name and the quantity proposed to be used per sack of cement. The Engineer, after making such tests as he deems advisable, will either accept the proposed materials and proportions or suggest modifications needed for acceptance. After acceptance by the Engineer of batch proportions and materials, they shall not be altered during the course of the work except as found necessary to maintain yield, cement factor, and unit weight within specification requirements.

Portland cement concrete shall be proportioned, using the aggregates tested, such that the requirements in Table I will be satisfied without falling below the minimum, or exceeding the maximum values given.

The cement factor of any individual batch placed in the work shall not be more than 0.15 sack per cubic yard less, nor more than 0.25 sack per cubic yard greater than the designated factor (sacks of cement per cubic yard). Aggregates shall be batched and reported to the resident engineer. The weights used may be varied as necessary to comply with the above tolerances in cement factor and unit weight.

Coarse and fine aggregate in each batch of concrete shall be combined in proportions that will produce a mixture within the grading limits for combined aggregates specified as follows:

Grading Limits of Combined Aggregates

Sieve Sizes	Percentage Passing
2″	100
1½″	90–100
1″	50–86
¾″	45–75
⅜″	38–55
No. 4	30–45
No. 8	23–38
No. 16	15–33
No. 30	8–22
No. 50	4–13
No. 100	1–5
No. 200	0–3

TABLE I

Class of Concrete	Sacks Cem. Per Cu. Yd., Min.–Max.	Coarse Agg. Size No.	Max. Water, Gal. Per Sack Cem.*	Slump Range, Inches	Air Range, Percent	Unit Weight Variation
P.C.A.	5.5–7.0	467	5.5	0–3.0†	4±1	±3 lbs.
P.C.A.A.	6.0–7.5	467	5.5	0–3.0†	5±1	±3 lbs.

*Based on aggregate in a saturated surface dry condition.

†The nominal slump in inches shall be three (3.0)—the maximum slump shall be three and one-half (3.5). When the slump of concrete is found to exceed the nominal slump, the mixture shall be adjusted as directed by the Engineer to reduce slump to a value within the nominal range. Four slump tests will be considered sufficient to determine nominal slump. The difference in slump, determined by comparing slump tests on two samples of mixed concrete for each individual batch tested, shall not exceed one (1) inch. When the difference in slump does exceed one (1) inch, procedure and equipment used in producing the concrete shall be adjusted to reduce the difference in slump to not more than one (1) inch.

409.03.02 Equipment. (a) General. Equipment and tools necessary for handling materials and performing all parts of the work must meet the approval of the Engineer as to design, capacity, and mechanical condition. This equipment shall be on the site, available for inspection, testing, and approval before paving operations are started. All equipment, tools, and machinery shall be maintained in a satisfactory working condition.

The Contractor shall provide equipment of such capacity that the paver will operate continuously or at a constant rate of production insofar as feasible. In the event that any piece of equipment does not have sufficient capacity to keep pace with the other operations, the Engineer may limit the size of the batch or otherwise limit the rate of production to prevent poor workmanship, overloading of equipment, or frequent delays.

Any equipment operating entirely or partially on the pavement, regardless of the age of the pavement, shall be equipped so that only rubber-tired wheels will come in contact with the pavement.

(b) Batch Plant and Equipment. When the size of the batch of concrete aggregates to be mixed exceeds one (1) cubic yard, the Contractor shall install and maintain in operating condition, an electrically actuated moisture meter that will indicate on a readily visible scale the percentage of moisture in the fine aggregate as it is batched within a sensitivity of one-half (½) percent by weight of the fine aggregate.

For all batches with a volume of one (1) cubic yard or more, the batching equipment shall conform to one of the following combinations:

1. Separate boxes and separate dial or beam scales for weighing each size of aggregate.
2. Single box and dial or multiple beam type scales for all aggregates.
3. Single box or separate boxes and automatic weighing mechanism for all aggregates.

In order to check the accuracy of batch weights, the gross weight and tare weight of batch trucks, truck mixers, and truck agitators shall be determined when ordered

by the Engineer. The equipment shall be weighed at the Contractor's expense on scales approved by the Engineer.

Aggregates and bulk cement for use in pavement shall be proportioned by weight by means of automatic proportioning devices of approved type conforming to the requirements specified herein.

Bulk cement shall be weighed on scales separate and distinct from the aggregate hopper or hoppers. The discharge mechanism of the bulk cement hopper shall be interlocked against opening before the full amount of cement is in the hopper, against closing before the contents of the hopper are entirely discharged and the scales are back in balance, and against opening when the amount of cement in the hopper is either over or under weight by more than one (1) percent of the amount specified.

The bulk cement batcher and aggregate batched shall be so interlocked that a new batch of cement cannot be started until all weigh hoppers are empty, the scale at zero, and the discharge gates closed. The interlock shall permit no part of the batch to be discharged until all aggregate hoppers and the cement hopper are charged with the correct weight.

The discharge gate on the cement hopper shall be so designed to permit regulating the flow of cement into the aggregate as approved by the Engineer.

Material discharged from the several bins shall be controlled by gates or by mechanical conveyors. The means of withdrawal from the several bins, and of discharge from the weigh box, shall be so interlocked that not more than one bin can discharge at a time; that the order of discharge can be changed; and that the weigh box cannot be tripped until the required quantity from each of the several bins has been deposited therein. Should a separate weigh box be used for each size of aggregate, all may be operated and discharged simultaneously.

When the discharge from the several bins is controlled by gates, each gate shall be actuated automatically so that the required weight is discharged into a weigh box, after which the gate shall automatically close and lock.

The automatic weighing device of the dial or multiple

beam scale shall be so designed that the number of proportions required may be set on the dial or dial control and beams at the same time, and that proportions and the sequence of weighing individual sizes may be changed without delay.

It is the intention of this specification that the device shall be automatic to the extent that the only manual operation required for proportioning the aggregates and cement for one batch shall be a single operation of a switch or a starter.

(c) Mixers. All mixing equipment shall meet the provisions set forth in subsection 501.03.06, "Machine Mixing."

(d) Finishing Equipment.

1. Finishing Machine. Screeding and tamping shall be performed with two reciprocating screeds between which is mounted a tamping bar actuated at each end by positive displacement devices.

2. Vibrators. The concrete for the full paving width shall be vibrated by means of surface vibrators with internal vibrators adjacent to each longitudinal edge or by some other method of vibration that produces equivalent results without segregation. The rate of vibration shall be not less than three thousand five hundred (3,500) vibrations per minute for surface vibrators and five thousand (5,000) vibrations per minute for internal vibrators. The amplitude of vibration shall be sufficient to be perceptible on the surface of the concrete more than one (1) foot from the vibrating element. The Contractor shall furnish a tachometer or other suitable device for measuring and indicating the actual frequency of vibrations.

Vibrators shall not rest on new pavements or side forms. Power to the vibrators shall be so connected that vibration will cease when the forward or backward motion of the machine is stopped.

(e) Concrete Saw. The Contractor shall provide sawing equipment adequate in number of units and power to complete the sawing with a water-cooled diamond edge saw blade or an abrasive wheel to the required dimensions

and at the required rate. The Contractor shall provide at least one standby saw in good working order. An ample supply of saw blades shall be maintained at the site of the work at all times during sawing operations.

(f) Forms.

1. Side Form. Metal side forms shall be used exclusively and shall weigh, not including stakes, not less than eighteen (18) pounds per linear foot for pavement 0.67 foot thick, not less than twenty (20) pounds per linear foot for pavement 0.75 foot thick, and not less than twenty-two (22) pounds per linear foot for pavement 0.83 foot thick.

For pavement edges more than 0.67 foot thick, the forms used for 0.67 foot pavement may be built-up by rigidly attaching a metal section to either the top or the bottom of the form, or both. The attachment and form shall act as a rigid unit and shall conform to the weight requirements above for the dimension of the built-up unit. The width of the base shall be equal to 0.67 foot or to eighty (80) percent of the specified thickness of the pavement, whichever is the greater.

Side forms shall be of such section and of sufficient rigidity, both in the form and in the interlocking connection with the adjoining forms, that springing will not occur under the weight of the subgrading and paving equipment or from the pressure of the pavement when placed. The Contractor shall provide sufficient forms so that there will be no delay in placing the pavement due to lack of forms.

Side form sections shall be straight, free from warps, bends, indentations, or other defects. Defective forms shall be removed from the work.

2. Slip-Form. Slip-form paving equipment shall be equipped with traveling side forms of sufficient dimensions, shape, and strength to support the concrete laterally for a sufficient length of time during placement to produce pavement of the required cross section.

No abrupt changes in longitudinal alignment of the pavement will be permitted. The horizontal deviation shall not exceed 0.10 foot from the alignment established by the Engineer.

409.03.03 Preparation of Grade. Unless otherwise provided in the contract documents, concrete pavement shall be placed on a cement treated base conforming to the provisions of Section 304, "Portland Cement Treated Base."

The subgrade shall be moist at the time of placing concrete. The subgrade shall be thoroughly wet the night before or at least six (6) hours prior to placing the concrete, and again sprinkled immediately before the concrete is placed on it. Sprinkling shall be such that mud and pools of water will not be formed. At the time of placing the concrete, the grade shall not be muddy, soft, or frozen.

409.03.04 Setting Forms. Before placing side forms, the underlying material shall be at the proper grade. Side forms shall have full bearing upon the foundation throughout their length and width of base and shall be placed to the required grade and alignment of the edge of the finished pavement. They shall be so supported that they will not deviate vertically at any time more than 0.01 foot from the grade established by the Engineer.

The maximum vertical deviation of the top of any side form, including joints, shall not exceed 0.01 foot from a twelve (12) foot straightedge, nor shall the inside face vary more than 0.02 foot from a twelve (12) foot straightedge. Stake pockets and interlocking devices shall be in such condition that they will prevent movement of the form.

Side forms shall be staked firmly by means of steel stakes at each end of the section and at intermediate points not more than five (5) feet apart and shall be so designed that stakes may be driven through the base of the form. Forms shall be provided with means for locking stakes in position. Side form sections shall be laid with an expansion gap of approximately 0.01 foot. The stakes used in staking side forms shall be of sufficient length so that the side forms will be held firmly in place. Any lateral movement of forms greater than 0.02 foot while supporting moving equipment shall be considered as evidence that

the steel stakes do not hold the side forms firmly in place and longer stakes shall be provided by the Contractor at his expense.

Immediately in advance of placing pavement and after all subgrade operations are completed, side forms shall be trued and maintained to the required line and grade for a distance sufficient to prevent delay in placing the pavement.

Side forms shall remain in place until the day after placing the pavement, and in all cases until the edge of the pavement no longer requires the protection of the forms.

Side forms shall be thoroughly cleaned and oiled each time they are used and before pavement is placed against them.

409.03.05 Reinforcement. Concrete pavement shall be reinforced at structure approaches and other locations as shown on the plans or directed by the Engineer, and as specified in this section.

Bar reinforcement shall conform to the provisions in Section 505, "Reinforcing Steel."

Bar reinforcement shall be held accurately and firmly in position during the placing and compacting of the concrete without sagging by means of supporting devices which shall be left in place. The supports shall be specially manufactured for the purpose and each support shall be capable of supporting a vertical load of two hundred (200) pounds.

409.03.06 Mixing. Mixing of concrete shall conform to the provisions in subsections 501.03.06, "Machine Mixing," and 501.03.08, "Retempering," and in addition thereto shall meet the following requirements:

Suitable nonresettable batch counter shall be provided and maintained in proper operating order, which will correctly indicate the number of batches proportioned at the batching plant and mixed in the mixers.

All concrete shall be homogeneous and thoroughly mixed in appearance, and there shall be no lumps or other evidence of undispersed cement.

Concrete mixed at the site of the work or in a central mixing plant shall be mixed not less than fifty (50) seconds nor more than ninety (90) seconds. Four (4) seconds shall be added to the specified mixing time if timing starts the instant the skip reaches its maximum raised position. Mixing time ends when the discharge chute opens. Transfer time in multiple drum mixers is included in mixing time. The contents of an individual mixer drum shall be removed before a succeeding batch is emptied therein.

The batch shall be so charged into the drum that a portion of the mixing water shall enter in advance of the cement and aggregates. The flow of water shall be uniform and all water shall be in the drum by the end of the first fifteen (15) seconds of the mixing period. The throat of the drum shall be kept free of such accumulations as may restrict the free flow of materials into the drum.

409.03.07 Placing Concrete. The Contractor shall make adequate advance arrangements for preventing delay in delivery and placing of the concrete. An interval of more than forty-five (45) minutes between placing of any two consecutive batches or loads shall constitute cause for stopping paving operations and the Contractor shall make a contact joint at his expense at the location and of the type directed by the Engineer, in the concrete already placed.

Unless otherwise specified, concrete pavement shall be placed in twelve (12) foot traffic lane widths separated by contact joints as shown on the plans, or, at the option of the Contractor, the concrete pavement may be placed monolithic two or more lanes wide without a contact joint, but with a longitudinal weakened plane joint at each traffic lane line.

All concrete shall be used while fresh. The use of water for retempering any concrete will not be permitted.

Any concrete showing improper portions of materials, including water, shall not be used in the pavement and any such unsatisfactory concrete shall be removed and disposed of by the Contractor at his expense.

The Contractor shall protect freshly placed concrete

from damage by any cause and any damage shall be repaired by the Contractor at his expense.

Expansion joint material shall be protected while depositing fresh concrete adjacent thereto.

Concrete work shall be adequately barricaded in all directions to protect the work.

Equipment that damages the cement-treated base, as judged by the Engineer, will be prohibited from traveling thereon.

409.03.08 Spreading, Compacting, and Shaping. (a) Side Form Construction. The concrete shall be distributed uniformly with a mechanical spreader.

The spread concrete shall be vibrated, screeded, and tamped by a machine or machines.

The number and capacity of machines furnished shall be adequate to perform the work required at a rate equal to the progress of the mixer. Any delay in excess of fifteen (15) minutes in vibrating, screeding, and tamping shall constitute cause for stopping the mixer until the machines performing such work are again in proper position in the paving train.

Screeding and tamping shall be performed by making at least two complete passes over the entire area of the pavement. On the first pass, the tamper shall be adjusted to produce the proper tamping action and the tamping bar shall not be operated during the second pass unless otherwise directed by the Engineer. The screeds shall be adjusted to an elevation slightly above grade so that when properly consolidated and finished, the completed surface of the pavement will be at the established grade, true to the cross section shown on the plans, and free from porous areas. The tops of the forms or the adjacent pavement and the contact surface of the crawler tracks or wheels shall be kept clean by effective devices attached to the machine. The travel of the machine shall be maintained true without lift, wobble, or other variation tending to affect precision screeding. The machine shall be of ample strength to withstand severe use and shall be fully and accurately adjustable to compensate for wear. During each pass of the

machine, a roll of concrete shall be maintained ahead of the front screed for the entire width of pavement being placed and except when making an expansion joint, the machine shall not be operated beyond that point where the roll of concrete can be maintained. The intent of this specification is that the equipment shall produce a surface requiring minimum cutting during the floating and final finishing as specified in subsection 409.03.10, "Finishing."

Concrete required to be placed in widths less than a traffic lane may be compacted and shaped by a powered mechanical compacting and shaping machine, supplemented by hand methods as necessary. Where hand compaction is performed, the tamper shall be constructed of heavy plank which length exceeds the width of pavement by a minimum of one (1) foot; shall be shod with a heavy strip of metal for a tamping surface; and shall be stiffened adequately to maintain the required shape during use. For concrete production in excess of forty (40) cubic yards per hour, and where all compaction is performed by hand methods, not less than two tampers shall be used.

The hand tamper shall be used with a combined tamping and longitudinal motion raising it from the side form and dropping it to consolidate the concrete. A surplus of concrete shall be kept in front of the hand tamper and tamping shall continue until the required cross section is obtained and the mortar flushes slightly to the surface.

Where hand compaction is performed on grades in excess of five (5) percent, a light strike board constructed similar to the heavy tamper shall be used following the heavy tamper or tampers to correct any displacement caused by flow of the concrete.

(b) Slip-Form Construction. Slip-form paving equipment shall spread, consolidate, screed, and float-finish the freshly placed concrete in such a manner that a minimum of finishing with a hand float, as specified herein, will be required to provide a dense and homogeneous pavement.

The concrete shall be distributed uniformly into final position by the slip-form paver without delay.

The concrete, for the full paving width, shall be effectively consolidated by internal vibration with transverse

vibrating units or a series of equally spaced longitudinal vibrating units. If a series of longitudinal vibrating units are used, they shall be equally spaced at intervals not to exceed two and one-half (2½) feet, measured center to center.

The term "internal vibration" specified in the above paragraph shall be construed to mean vibration by means of vibrating units located within the specified thickness of pavement section and a minimum distance ahead of the screed equal to the pavement thickness.

When concrete is being placed adjacent to an existing pavement, that part of the equipment which is supported on the existing pavement shall be equipped with protective pads on crawler tracks or rubber-tired wheels on which the bearing surface shall be offset to run a sufficient distance from the edge of the pavement to avoid breaking or cracking the pavement edge.

At locations inaccessible to slip-form paving equipment, concrete pavement shall be placed by methods and equipment conforming to the requirements for placing concrete in widths less than a traffic lane, as specified in subsection 409.03.08(a), "Side Form Construction." At such locations, the use of stationary side forms conforming to subsection 409.03.02(f)1, "Side Form," will be required. Locations inaccessible to the slip-form paving equipment shall be finished by the hand float method and equipment specified in subsection 409.03.10(c), "Hand Float Method."

409.03.09 Joints. (a) General. Joints in pavement will be designated as longitudinal and transverse contact joints, transverse expansion joints, and longitudinal and transverse weakened plane joints, and shall be constructed as shown on the plans and in accordance with the following provisions:

All transverse joints shall be constructed at the angle to the centerline of the pavement shown on the plans, and the faces of all joints both transverse and longitudinal shall be normal to the surface of the pavement.

All sawed joints shall be clean and free of all foreign

material after completion of shoulder work and prior to acceptance of the contract.

Bent tie bars shall be bent at right angles approximately four (4) inches from one end to form a support resting on the subgrade. The free end of the bar shall be bent along the side form so as to lie parallel to the pavement edge. After the first lane of pavement is completed, the bar shall be straightened to the proper position before paving the adjoining lane. If an "S" shaped bend is formed in straightening the bar, the offset from a straight line shall not be more than 0.1 foot.

Straight tie bars shall be placed mechanically to a uniform depth of 0.33 foot for the longitudinal contact joints.

Tie bars shall be required for all contact joints and shall be placed as specified in this subsection and as indicated on the plans. Tie bars will not be required in longitudinal weakened plane joints in multi-lane monolithic pavement or in transverse weakened plane joints.

Tie bars may be bent at right angles against the form of the first lane constructed and straightened into final position before the concrete of the adjacent lane is placed, or in lieu of bent tie bars, approved two-piece connectors may be used.

(b) Contact Joints. Contact joints are those made by placing fresh concrete against hardened concrete at planned locations.

Concrete on both sides of longitudinal contact joints shall be connected with tie bars as shown on the plans.

When the plans require the construction of keyways, the grooved portion of the keyway shall be constructed as part of the pavement width being placed.

(c) Weakened Plane Joints. Weakened plane joints shall be formed by cutting a groove in the pavement with a power driven saw at the locations shown on the plans. The grooves shall be cut to a minimum depth of 0.17 foot and the width shall be the minimum width possible with the type of saw being used, but in no case shall the width exceed 0.02 foot. The sawed joint shall go through the pavement edge at full depth of cut. Every fourth planned transverse weakened plane joint in the initial lane of

concrete and also the first joint immediately after the transverse contact joint shall be sawed within twenty-four (24) hours after the concrete has been placed, unless otherwise permitted by the Engineer, the exact time to be determined by the Engineer. Every second planned transverse weakened plane joint shall be sawed within forty-eight (48) hours after placing the concrete, unless otherwise permitted by the Engineer, the exact time to be determined by the Engineer. The remaining longitudinal and transverse weakened plane joints may be sawed at such time, after twenty-four (24) hours, as the Contractor may elect, except they shall be completed before placing concrete in succeeding adjacent lanes and before permitting the Contractor's traffic or public traffic to use the pavement.

In succeeding lanes of the concrete pavement, transverse joints opposite those which have opened in the initial lane shall be sawed within twenty-four (24) hours after the concrete has been placed, the exact time to be determined by the Engineer, but in all cases not more than three (3) consecutive planned transverse weakened plane joints shall be omitted. The remaining longitudinal and transverse weakened plane joints may be sawed at such time, after twenty-four (24) hours, as the Contractor may elect, except they shall be completed before placing concrete in the succeeding adjacent lane and before permitting the Contractor's traffic or public traffic to use the pavement.

No sawing shall be done where volunteer transverse cracks exist. If a volunteer transverse crack falls within five (5) feet of the location of a proposed sawed joint, the sawed joint shall be omitted. Joints sawed in violation of the provisions in this paragraph will not be paid for.

When the pavement is cured by means of a curing seal, all portions of the seal which have been disturbed by sawing operations shall be restored by spraying the areas with additional curing seal.

The Contractor shall keep a standby power saw on the project at all times when concrete paving operations are under way.

When indicated on the plans, sawed transverse weakened plane joints shall be sealed with a preformed elastic joint sealer and lubricant adhesive as specified herein. The preformed elastic joint sealer and lubricant adhesive shall conform to the requirements of subsection 707.03.06, "Preformed Elastic Joint Sealer."

The elastic joint sealer shall be installed in one continuous piece without field splices and be placed so that its top edge is below the riding surface, but no deeper than one-fourth (¼) inch below the surface. The joint sealer shall be of the width recommended by the manufacturer for the width of the groove sawed in the pavement. The top edge of the seal shall be in contact with the vertical walls of the joint. If spalling is evident, major spalling shall be repaired. Damaged seals shall be replaced. The seal shall be placed using equipment that insures against the seal being in tension in the joint. The seal shall be precut to the exact length of joint for each joint prior to placement unless the installing equipment can demonstrate the installation of the seal without elongation. The seal should be installed and measured for stretch. Over five (5) percent in stretch shall be rejected and the seal removed and reinstalled. The lubricant adhesive shall be applied in a continuous film to the sides of the seal prior to being placed in the joint. Any lubricant adhesive on the top of the installed seal shall be removed before it dries.

At the option of the Contractor, longitudinal weakened plane joints at traffic lane lines in multi-lane monolithic concrete pavement may be formed by placing a continuous strip of plastic or other material which will not react adversely with the chemical constituents of the concrete. The joint insert material shall be of such width and character that when placed vertically in the concrete it will not bond with the concrete and will form an effective weakened plane joint of 0.17 foot minimum depth. The joint material shall be inserted with a mechanical device that places the material in a continuous strip, except where intervening structures break the continuity of paving. Splices in the joint material will be permitted providing they are effective in maintaining the continuity of the joint material as

placed. The joint material shall be placed in such manner that the top of the strip is not more than 0.01 foot below the finished surface of the concrete. The joint material shall not be deformed from a vertical position, either in the installation or in subsequent finishing operations performed on the concrete. The alignment of the finished joint shall be uniformly parallel with the centerline of the pavement and shall be free of any local irregularity which exceeds 0.04 foot measured by a twelve (12) foot straightedge, except for normal curvature of centerline alignment. During the placing of the strip, the mechanical installation device shall vibrate the concrete sufficiently to cause the concrete to flow evenly about the joint material producing homogeneous concrete free of segregation and rock pockets or voids.

(d) Transverse Expansion Joints. Transverse expansion joints shall be formed at structure approaches as shown on the plans and as specified herein.

Transverse expansion joints shall be formed by means of joint filler strips conforming to the provisions in Section 707, "Joint Materials," and placed as specified herein. The joint strips shall be firmly supported in position by metal holders and end supports. The supports shall be held firmly in position and shall remain in place after completion of the pavement.

The metal holders shall be fabricated of sheet steel not less than 16 gage. They shall be in the form of a deep channel, extending down on both sides of the joint strip to a depth of not less than 0.37 foot. They shall be slotted and cut away as necessary, to allow the concrete to make contact with the joint strip at close intervals. The ends of the holders shall be spread to admit the end supports.

During placing and compacting the concrete, the joint holder and end supports shall be so secured as to insure against movement of the joint strip and to keep the top edge of the joint strip approximately 0.04 foot below the surface of the finished pavement. After the concrete has been placed and compaction completed, the metal holder may be removed and a suitable shallow metal channel substituted therefore which shall fit snugly over the top edge of

the joint strip and shall remain there until the joint is edged.

Filler shall extend the full width of the concrete being placed less 0.04 foot and after the side forms have been removed, any concrete which has flowed around the ends of the joint filler shall be removed.

This work shall also include furnishing and installing "Preformed Polyethylene Joint Filler" in the concrete pavement in accordance with the details shown on the plans and as hereinafter specified.

The new concrete pavement shall be saw cut at locations shown on the plans for placement of the polyethylene joint filler. Forming of the open joint and subsequently removing the forms to allow placement of the joint filler will not be permitted. The joint shall be saw cut full width of the concrete pavement and full depth and shall be four (4) inches wide with a tolerance of plus zero (0) inches and minus one-eighth (⅛) inch between joint faces. Remove all concrete between the cuts and thoroughly clean the open joint with compressed air.

The height of the polyethylene joint filler shall be such that the top surface of the installed filler is one-half (½) inch below the finished surface of the concrete pavement. The width of the joint filler shall be four (4) inches. Prior to inserting the filler into the open joint, all sides of the material which will be in contact with concrete shall be coated with a joint lubricant and adhesive recommended by the manufacturer of the filler material.

The polyethylene joint filler material shall conform to the following requirements:

The material shall be black, flexible, low density, expanded extruded polyethylene plank formed by the expansion of polyethylene base resin, extruded as a multicellular, closed cell, homogeneous foamed polyethylene. Laminations will not be permitted.

The joint material shall conform to the following physical property requirements:

Compression, p.s.i. when tested in accordance with ASTM Designation: D1056 except that compressive

strength shall be determined at ten (10) percent and eighty (80) percent deflection:

At 10 percent deflection	less than 10
At 80 percent deflection	less than 125

Water absorption when tested in accordance with ASTM Designation: C272 using conditioning procedure 4.1.1 at a temperature of fifty (50) plus or minus three (3) degrees Centigrade:

Percent by volume	less than 0.5

Density when tested in accordance with ASTM Designation: D1564:

Pounds per cubic foot	2.6±0.2

Size: Thickness shall be four (4) inches, plus one-half (½) inch, minus zero (0) inch. Width shall be sufficient to fill the joint without laminating to within one-half (½) inch below the finished surface of the concrete pavement.

409.03.10 Finishing. (a) General. Unless adequate lighting facilities are provided by the Contractor, placing of concrete shall cease at such time so that finishing operations can be completed during daylight hours.

Necessary workmen shall remain at work long enough to complete the finishing and curing of the pavement.

At the start of each day's work, the Contractor shall mark at the edge of the pavement nearest the outside shoulder with an approved stamp, his name, the month, day, and year such section is placed, and the Engineer's station fifty (50) feet back from the location of the joint. The stamp shall be approximately one (1) foot by two (2) feet in size and shall be furnished by the Contractor and the cost thereof will be included in the paving items.

In case fine cracks or hair checks appear in newly placed concrete before it is thoroughly set, water shall be applied to the concrete surfacing, in the form of a fine fog mist until the finishing operations are completed and the curing is applied.

(b) Machine Float Method. The surface of the concrete shall be finished smooth and true to grade by means of a machine float.

The number and capacity of machines furnished shall be adequate to perform the work required at a rate equal to the progress of the mixer. Any delay in excess of thirty (30) minutes in performing the preliminary finishing shall constitute cause for stopping the mixer until the machine or machines performing such work are again in proper position in the paving train.

The machine float shall be self-propelled and designed to run on the side forms or adjacent lanes of concrete. When the machine float runs on the adjacent pavement, the pavement shall be protected as specified in subsection 409.03.02(a), "Equipment—General." The aggregate length of the floats in contact with the surface shall not be less than four (4) feet per foot of width of concrete being finished. The floats shall be of such length and shall be set at angles with the axis of the machine so as to effectively spread and smooth the surface of the concrete, eliminating unevenness and producing a surface texture of uniform appearance. The machine shall be equipped with a suitable full-width metal roller placed at one end ahead of all floats, which roller will have the effect of more fully embedding the coarse aggregate in the cement mortar and of bringing a slight excess of mortar to the surface of the concrete. The machine shall be equipped with a suitable water tank and spraying device designed to keep the roller clean and to spray water in a fine mist on the concrete surface as directed by the Engineer. All floats shall be constructed of hardwood, steel, or be steel shod. The roller and floats shall be equipped with adjusting devices which will permit the independent adjustment of each to the required cross section of the pavement and which will permit the lowering and raising of the floats both individually and as a unit. The machine shall be capable of operating at speeds adequate to perform all finishing operations necessary. The speed of operation shall be such as to give the best results. Alternative equipment may be substituted for the equipment provided for in

this section, provided the finished surface conforms to the provisions specified herein.

(c) Hand Float Method. The surface of the concrete shall be finished smooth and true to grade with two wooden floats sixteen (16) feet long, one (1) inch thick and four (4) inches wide, rigidly ribbed and with adjusting screws between the rib and float bars at not more than two (2) foot centers, to insure a true and flat surface on the under side at all times. Each float shall be operated from the side of the pavement and the float shall be parallel with the centerline of the pavement. The edge of the float shall be used to cut down all high areas, and the material so removed shall be floated into the depressions until a true surface is obtained. Each successive passage of the float shall just lap the previous path. Upon completion of the passage, the float shall be brought back and the overlap between the two passages smoothed.

The floats shall be operated as far back of the tamping machine as the concrete remains workable and the number of passes shall be sufficient to remove all perceptible inequalities.

At least one spare float in good condition shall be available on the work at all times.

(d) Final Finish. After the preliminary finishing has been completed, the edges of an initial pavement lane shall be rounded to a one-half (½) inch radius. Transverse contact joints, expansion joints, and joints adjacent to an existing pavement shall be rounded to a one-fourth (¼) inch radius.

In advance of the curing operations, or as directed by the Engineer, the pavement shall be textured with a drag strip of burlap or other device which will produce scoring parallel to the centerline. The burlap drag shall consist of one or more pieces of burlap fastened to a cross member riding on the subgrade or side forms by means of wheels or skids to form a continuous strip of burlap the full width of the pavement. Drags shall be maintained clean and free from encrusted mortar. Drags that cannot be cleaned shall be discarded and new drags substituted.

Completed pavement that is found to have a surface texture which, in the opinion of the Engineer, would not provide satisfactory skid resistance, shall be ground or scored by abrasive means by the Contractor, at his expense, to provide a surface texture satisfactory to the Engineer.

409.03.11 Riding Tolerances. Upon completion of the pavement, any points that are high in excess of the straightedge tolerances set forth in subsection 409.02.03, "Concrete Properties and Tests," shall be removed by abrasive means as provided in this section.

Equipment that consistently produces a finished surface having a Profile Index of seven (7) inches per mile or less shall be used. Should the Profile Index exceed the rate of seven (7) inches per mile, the paving operations shall be discontinued until other means and equipment are proposed for trial by the Contractor and are approved by the Engineer. Such revised methods and equipment shall be discontinued if they do not produce a finished surface having a Profile Index of seven (7) inches per mile or less. Operations shall not be resumed until the Engineer approves further changes in methods and equipment as proposed by the Contractor.

In addition to the requirement for average Profile Index, all areas representing high points having deviations in excess of 0.3 inch as defined in the following paragraph, shall be reduced by abrasive means until such deviations as indicated by reruns of the profilograph do not exceed 0.3 inch. The deviations in excess of 0.3 inch shall be determined by measurement of the profilogram in accordance with Test Method No. Nev. T446.

After grinding has been completed to reduce all individual deviations in excess of 0.3 inch as provided in the above paragraph, additional grinding shall be performed if necessary to reduce the Profile Index, as measured by the profilograph to seven (7) inches per mile, or less, in any 0.1 mile section along any line parallel to the edge of the pavement.

Additional grinding shall be performed as necessary to extend the ground area laterally to the nearest lane line or edge of pavement and longitudinally so that the grinding begins and ends at lines normal to the pavement centerline within any one ground area. It is the intent of this requirement that all ground areas be neat rectangular areas of uniform texture.

The Profile Index requirements herein will not apply to the pavement within thirty (30) feet of either end of a bridge. The finished surface of such pavement shall, however, meet all other requirements in this section.

409.03.12 Curing. (a) General. All Portland cement concrete pavement must be cured for seventy-two (72) hours by the methods specified in this section, subject to the conditions set forth in subsection 501.03.09(a), "Curing—General." In case of low temperatures, the curing period will be increased according to the provisions of subsection 501.03.10(b), "Cold Weather—General."

(b) Curing Compound Method. Curing by use of curing compound shall be as specified in subsection 501.03.09(c), "Curing Compound Method." The curing compound shall not be applied until all patching and surface finishing, except grinding, has been completed. When deemed necessary by the Engineer during periods of hot weather, fogging of the concrete with water shall be continued after curing compound is applied until the Engineer determines that a cooling effect is no longer required. Such fogging after the application of the curing compound will be paid for as extra work as provided in subsection 104.03, "Extra Work."

(c) Waterproof Paper Method. Curing by use of waterproof membrane material shall be as specified in subsection 501.03.09(d), "Waterproof Paper."

409.03.13 Protection of Pavement. Concrete shall not be placed on frozen ground nor shall it be mixed or placed while the atmospheric temperature is below thirty-five (35) degrees Fahrenheit, unless adequate means are

employed to heat the aggregates and water, and provision satisfactory to the Engineer has been made for protecting the work.

Placing concrete shall be stopped before the quantity of rainfall is sufficient to cause a flow or wash the surface.

Upon written notice from the Engineer, all concrete which has been damaged shall be replaced by the Contractor at his expense.

All concrete in pavement shall be protected from freezing or frost for a period of five (5) days after placing. The temperature of the surface of the concrete shall not be allowed to drop below forty (40) degrees Fahrenheit for this period of five (5) days.

When ordered by the Engineer or shown in the contract documents, pavement crossings shall be constructed for the convenience of public traffic. The material and work necessary for the construction of such ramps, and their subsequent removal and disposal, will be paid for at the contract unit prices for the items of work involved and if there are no contract items for the work involved, payment for pavement crossings will be made by force account work as provided in subsection 104.03, "Extra Work." Where public traffic will be required to cross over the new pavement, Type III Portland cement shall be used in concrete. When Type III Portland cement is used in concrete, and if permitted in writing by the Engineer, the pavement may be opened to traffic as soon as the concrete has developed a modulus of rupture of four hundred fifty (450) pounds per square inch.

No traffic or Contractor's equipment, except for subgrading equipment, will be permitted on the pavement before a period of ten (10) calendar days has elapsed after the concrete has been placed, nor before the concrete has developed a modulus of rupture of at least four hundred fifty (450) pounds per square inch, as determined by Test Method No. Nev. T442. Concrete that fails to attain a modulus of rupture of four hundred fifty (450) pounds per square inch within ten (10) days shall not be opened to traffic until directed by the Engineer.

Equipment used to prepare subgrade may be permitted to ride upon one edge of the previously placed concrete at the end of seventy-two (72) hours, provided, however, that no damage is done to the pavement edge by reason of such operations. Any damage to the pavement resulting from such operations shall be repaired by the Contractor at his expense prior to placing the adjacent lane.

METHOD OF MEASUREMENT

409.04.01 Measurement. The number of square yards of concrete pavement to be measured for payment will be determined from horizontal measurements of the completed finished surface of the pavement, except that the area for payment for pavement end anchors will be determined by computing the total specified compacted volume of material in the anchors and converting such volume to an equivalent area based on the thickness of pavement placed on the traveled way.

Preformed joint sealer in weakened plane joints will be measured by the linear foot of the sealed sawed joint.

Preformed joint filler in transverse expansion joints and preformed polyethylene joint filler in four (4) inch joints will be measured by the linear foot of joint filler complete in place.

Tie bars will not be measured for payment.

The length of sawed joint for preformed polyethylene joint sealer shall be the length in feet of the joint.

The length of sawed transverse weakened plane joints shall be the length in feet of the transverse weakened plane joints actually sawed except as otherwise provided in subsection 409.03.09(c), "Weakened Plane Joints." Volunteer cracks will not be included in the length of transverse weakened plane joints measured for payment. No measurement or separate payment will be made for longitudinal joints.

409.04.02 Pavement Thickness. It is the intent of the specifications that concrete pavement shall be constructed in accordance with the thickness requirements of

the plans and specifications. Tolerances allowed for subgrade construction and other specification provisions which may affect thickness shall not be construed to modify such thickness requirements.

It is agreed by the parties that compliance with the thickness requirements for concrete pavement will be determined by the Engineer in accordance with the provisions in this subsection. It is further agreed by the parties that the liability of the Contractor for failure to comply with such thickness requirements and the rights of the State in the event of such failure shall likewise be governed by the provisions in this subsection.

For the purposes of these specifications, the primary unit of pavement will be the area of pavement placed in each day's paving operations. Within such primary unit of pavement, there may be an area or areas which have been determined to be a secondary unit or units of pavement, as provided in subsection 409.04.02(b), "Thickness Deficiency of More Than 0.05 Foot." In such case, the primary unit area will be reduced by the secondary unit area included therein.

At such time after the concrete pavement has been placed, as is determined by the Engineer to be appropriate, thickness measurements will be made in each primary unit of pavement at the rate of not less than one measurement for each one thousand (1,000) linear feet of traffic lane, or fraction thereof, of pavement placed. The exact location and number of thickness measurements within each primary unit, both longitudinally and transversely, will be as determined by the Engineer. In general, thickness measurements will be made at approximately uniform intervals throughout each primary unit of pavement.

If required, secondary thickness measurements will be made as provided in subsection 409.04.02(b), "Thickness Deficiency of More Than 0.05 Foot."

Pavement thickness variation, if any, from the thickness requirements of the plans and specifications will be determined by comparing the actual thickness measurement with the thickness specified at the location where the

measurement was made. Such variation will be determined to the nearest 0.01 foot as either excess or deficient thickness.

(a) Thickness Deficiency of Not More Than 0.05 Foot. If the thickness measurements in a primary unit are deficient in thickness by not more than 0.05 foot, thickness variations in such unit will be averaged, algebraically, to the nearest 0.01 foot, to determine the average thickness deficiency, if any, in said primary unit. For the purpose of determining the average thickness deficiency, an excess thickness variation of more than 0.02 foot greater than the thickness specified will be considered to be 0.02 foot greater than the specified thickness.

For each primary unit of pavement which is deficient in average thickness, the Contractor shall pay to the Department as liquidated damages, or the Department, at its option, may deduct from any money due, or to become due the Contractor from the Department, an amount set forth in the following schedule:

Average Thickness Deficiency (feet)	Deficiency Adjustment (dollar per square yard)
0.01	0.10
0.02	0.25
0.03	0.45
0.04	0.70
0.05	1.00

(b) Thickness Deficiency of More Than 0.05 Foot. For each thickness measurement made in a primary unit by the Engineer that is deficient in thickness by more than 0.05 foot, the Engineer will determine from secondary thickness measurements the dimensions of the secondary unit area where the apparent thickness deficiency is more than 0.05 foot. The determination of the limits of said secondary unit area will be made by making secondary thickness measurements in each panel of pavement adjacent to the panel in which the original measurement in the primary unit was made. This procedure will continue, regardless of unit boundaries, until such secondary unit area is bounded by panels in which the secondary measurement is deficient in thickness by 0.05 foot or less.

Panels are the areas bounded by longitudinal and transverse joints and pavement edges. If a transverse weakened plane joint has been omitted at the location where a volunteer crack exists, in accordance with the provisions on subsection 409.03.09(c), "Weakened Plane Joints," the volunteer crack will be considered as a transverse joint only if the pavement adjacent thereto is not to be removed and replaced. If either longitudinal or transverse joints, or both are eliminated by the special provisions or plans, the limits of panels will be determined by the Enigneer as if such joints had been constructed.

The secondary unit area will be made up of entire panels only.

Each panel in which secondary thickness measurements are made pursuant to the provisions in this subsection will be deemed to be, in its entirety, of the thickness shown by such measurement.

After the Engineer has determined the limits of the secondary unit area, he will further determine, within such area, which panels, if any, will be required to be removed and replaced in accordance with procedure 1, below, and the panels, if any, which will remain in place in accordance with procedure 2, below:

1. The Contractor shall, at his expense, remove and replace the concrete pavement in such panels with concrete pavement meeting the thickness and all other requirements of the contract documents. If the area to be removed is not bounded by longitudinal or transverse joints, the Contractor shall saw, at his expense, weakened plane joints at the location designated by the Engineer, conforming to the provisions in subsection 409.03.09(c), "Weakened Plane Joints." Subgrade shall be lowered as necessary to meet the full thickness requirements. Replaced pavement will be tested for thickness compliance by means of additional secondary measurements and will be subject to all of the thickness requirements of the specifications.

2. The Contractor shall leave such panels of pavement in place without payment, if they meet all of the other requirements of the contract documents.

The cost of all secondary thickness measurements made in accordance with the provisions in this subsection, including filling of any necessary holes with concrete, will be deducted from any money due, or that may become due, the Contractor under the contract.

After eliminating the secondary unit area, or areas, and the thickness measurements therein from consideration, the average thickness deficiency, if any, of the remainder of primary unit areas will be determined as provided in subsection 409.04.02(a), "Thickness Deficiency of Not More Than 0.05 Foot." Secondary thickness measurements made outside of a secondary unit area may be used to determine average thickness deficiency, if any, in the remaining primary unit area in which they are taken.

The Contractor shall not be entitled to any additional compensation or extension of time due to any of the provisions in this subsection.

No additional compensation will be allowed the Contractor for any pavement constructed in excess of the thickness requirements of the contract documents.

If the Contractor believes that the number of thickness measurements made in primary unit areas by the Engineer in accordance with the provisions in this subsection are insufficient to fairly indicate the actual thickness of pavement placed, he may request that additional thickness measurements be made by the Engineer and such additional measurements will be used in determining the average thickness variation. The location of all such additional thickness measurements will be determined by the Engineer. The cost of all such additional measurements made, including filling of any necessary holes with concrete, will be deducted from any money due, or that may become due, the Contractor under the contract.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

409.05.01 Payment. The accepted quantities measured as provided in subsections 409.04.01, "Measurement,"

and 409.04.01, "Pavement Thickness," will be paid for at the contract unit price bid per square yard for Portland cement concrete pavement, and per linear foot for saw transverse weakened plane joints.

The above prices shall be full compensation for furnishing all the material including Portland cement and water, mixing, hauling, placing, finishing, and incidentals necessary for doing all the work as shown on the plans or established by the Engineer.

Full compensation for furnishing and placing all material used in constructing transverse expansion joints at structure approaches, as indicated on the plans, shall be considered as included in the contract price paid per square yard for concrete pavement and no additional compensation will be allowed therefor.

The accepted quantity of sawed joint for preformed polyethylene joint sealer, measured as provided in subsection 409.04.01, will be paid for at the contract unit price bid per linear foot for "4-inch Expansion Joint (saw cut)," which payment shall be considered full compensation for all sawing, removing of concrete and preparing the joint ready for the polyethylene joint filler as well as for all labor, tools and equipment necessary to complete the joint ready for the joint sealer.

The accepted quantity of preformed joint sealer, in weakened plane joints or preformed joint filler in transverse expansion joints, measured as provided in subsection 409.-04.01, "Measurement," will be paid for at the contract unit price bid per linear foot for "Joint Sealer" or "Joint Filler, 4-inch," which payment shall be considered full compensation for furnishing all labor, materials, tools, equipment, supplies and incidentals necessary to install the joint sealer or joint filler complete in place in the accepted work.

Reinforcement, except tie bars, will be paid for as provided in Section 505, "Reinforcing Steel."

Tie bars will not be paid for directly but the cost thereof shall be considered included in the contract unit price bid for other items of work and no further compensation will be allowed therefor.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Partial payments for Portland cement concrete pavement may be made as set forth under subsection 109.06, "Partial Payments."

Payment will be made under:

Pay Item	Pay Unit
Portland Cement Concrete Pavement (..... inches)	Square Yard
Saw Transverse Weakened Plane Joints	Linear Foot
Joint Sealer	Linear Foot
4-inch Expansion Joint (saw cut)	Linear Foot
Joint Filler, 4-inch	Linear Foot

SECTION 495

PRESTRESSING CAST-IN-PLACE CONCRETE

DESCRIPTION

495.01.01 General. This work shall consist of prestressing cast-in-place concrete by furnishing, placing, and tensioning of prestressing steel in accordance with details shown on the plans, and as specified herein.

This work shall include the furnishing and installation of any appurtenant items necessary for the particular prestressing system to be used, including but not limited to ducts, anchorage assemblies and grout used for pressure grouting ducts.

For prestressed cast-in-place concrete, the term "member" as used in this section shall be considered to mean the concrete which is to be prestressed.

MATERIALS

495.02.01 General. Prestressing steel shall be high-tensile wire conforming to ASTM Designation: A421, high-tensile wire strand conforming to ASTM Designation: A416 or high-tensile strength alloy bars conforming to the requirements in this section, or any combination thereof.

The cross-sectional steel area of wire strand shall be within 0.005-square inch of the nominal steel areas shown in Table I of ASTM Designation: A416 and in Table I below.

In the event the Contractor elects to use a wire strand manufactured to a higher breaking strength than is specified in ASTM Designation: A416, such higher strength strand shall, in addition, conform to the following requirements:

TABLE I

Breaking Strength Requirements

Nominal Diameter (Inches)	3/8	7/16	1/2
Breaking Strength (Lbs.), Min.	23,000	31,000	41,300
Nominal Steel Area (Sq. In.)	0.085	0.116	0.155
Nominal Weight, 1,000 ft. (Lbs.)	292	400	525

TABLE II

Yield Strength Requirements

Nominal Diameter (Inches)	3/8	7/16	1/2
Initial Load (Lbs.)	2,300	3,100	4,130
Minimum Load, 1 percent Extension (Lbs.)	19,600	26,400	35,100

High-tensile strength alloy bars shall be individually proof tested during the manufacturing process to a minimum of eighty-seven (87) percent of the manufacturer's minimum guaranteed ultimate strength, and shall be thermally stress relieved to produce a suitable and uniform metallurgical structure. The mechanical properties of the prestressed bars shall conform to the following requirements:

Nominal Diameter Inches	Nominal Area Square Inches	Ultimate Tensile Strength, Lbs. Min.		Yield Strength Lbs. Min.[1]	
		Special Grade	Regular Grade	Special Grade	Regular Grade
1 3/8	1.485	237,600	215,300	207,900	193,100
1 1/4	1.227	196,300	177,900	171,800	159,500
1 1/8	0.994	159,000	144,100	139,200	129,200
1	0.785	125,600	113,800	109,900	102,100
7/8	0.601	96,200	87,100	84,100	78,100
3/4	0.442	70,700	64,100	61,900	57,500

Elongation is 20 bar diameters after rupture, min. percent..... 4.0
Reduction in area, min. percent.....20.0
Modulus of elasticity at 70 percent of the manufacturer's minimum guaranteed ultimate strength, min. p.s.i.....25×10^6
Permissible Variations in Size: The maximum variation in diameter of a bar shall not exceed +2.0 percent or —1.0 percent from the nominal diameter.

[1]Measured by the 0.7 percent extension under load method.

All bars in any individual member shall be of the same grade, unless otherwise permitted by the Engineer.

Wires shall be straightened if necessary to produce equal stress in all wire or wire groups or parallel lay cables that are to be stressed simultaneously or when necessary to insure proper positioning in the ducts.

Where wires are to be button-headed, the buttons shall be cold formed symmetrically about the axes of the wires.

The buttons shall develop the minimum guaranteed ultimate tensile strength of the wire. No cold forming process shall be used that caused indentations in the wire.

All prestressing steel shall be protected against physical damage and rust or other results of corrosion at all times from manufacture to grouting or encasing in concrete. Prestressing steel that has sustained physical damage at any time shall be rejected. The development of visible rust or other results of corrosion shall be cause for rejection, when ordered by the Engineer.

Prestressing steel shall be packaged in containers or shipping forms for the protection of the steel against physical damage and corrosion during shipping and storage. A corrosion inhibitor which prevents rust or other results of corrosion shall be placed in the package or form, or shall be incorporated in a corrosion inhibitor carrier type packaging material, or when permitted by the Engineer, may be applied directly to the steel. The corrosion inhibitor shall have no deleterious effect on the steel or concrete or bond strength of steel to concrete. Packaging or forms damaged from any cause shall be immediately replaced or restored to original condition.

The shipping package or form shall be clearly marked with a statement that the package contains high-strength prestressing steel, and the care to be used in handling, and the type, kind and amount of corrosion inhibitor used, including the date when placed, safety orders and instruction for use.

If ordered by the Engineer, the Contractor shall submit the following for the corrosion inhibitor:

(a) A sample, a list of chemicals and their proportions, and instructions for use.

(b) Evidence that the prestressing steel will be protected from rust and other results of corrosion.

(c) A Certificate of Compliance in accordance with the provisions in subsection 106.05, "Certificates of Compliance," of the Standard Specifications.

Prestressing steel for post-tensioning which is installed in members prior to placing and curing of the concrete,

shall be continuously protected against rust or other corrosion, until grouted, by means of a corrosion inhibitor placed in the ducts or applied to the steel in the duct. The corrosion inhibitor shall conform to the requirements specified above.

All water used for flushing ducts shall contain either quick lime (calcium oxide) or slaked lime (calcium hydroxide) in the amount of 0.1 pound per gallon. All compressed air used to blow out ducts shall be oil free.

When acceptable prestressing steel for post-tensioning is installed in the ducts after completion of concrete curing, and if stressing and grouting are completed within ten (10) calendar days after the installation of the prestressing steel, rust which may form during said ten (10) days will not be cause for rejection of the steel. Prestressing steel installed, tensioned and grouted in this manner, all within ten (10) calendar days, will not require the use of a corrosion inhibitor in the duct following installation of the prestressing steel. Prestressing steel installed as above but not grouted within ten (10) calendar days shall be subject to all the requirements in this section pertaining to corrosion protection and rejection because of rust.

CONSTRUCTION

495.03.01 General. Prestressing shall be performed by post-tensioning methods. The method of prestressing to be used shall be optional with the Contractor, subject to the requirements specified herein.

The Contractor shall submit to the Engineer for review complete details and substantiating calculations of the method, materials and equipment he proposes to use in the prestressing operations, including any additions or rearrangement of reinforcing steel from that shown on the plans. Such details shall outline the method and sequence of stressing and shall include complete specifications and details of the prestressing steel and anchoring devices, working stresses, anchoring stresses, type of ducts, and all other data pertaining to the prestressing operations, including the proposed arrangement of the prestressing steel in

the members, pressure grouting materials and equipment. The Contractor shall not cast any member to be prestressed before review of the shop detail drawings is complete.

Three sets of all shop detail drawings prepared specifically for the contract shall be submitted to the Engineer for review. After review five (5) sets shall be submitted to the Engineer for use during construction. Shop detail drawings shall not exceed twenty-eight (28) inches by forty-two (42) inches in size and each drawing shall include the jobsite name of the structure as shown on the contract plans, district-county-route, bridge number, and contract number.

At the completion of the contract, one set of either (1) ink tracings on cloth, (2) ink tracings on polyester base drafting film, (3) silver sensitized cloth duplicate tracings, or (4) silver sensitized polyester based reproduction films with matte surface on both sides, of all shop detail drawings for railroad bridges shall be furnished and delivered to the Engineer by the Contractor at his expense.

495.03.02 Anchorages and Distribution. All post-tensioned prestressing steel shall be secured at the ends by means of approved permanent type anchoring devices.

All anchorage devices for post-tensioning shall hold the prestressing steel at a load producing a stress of not less than ninety-five (95) percent of the guaranteed minimum tensile strength of the prestressing steel.

When headed wires are used, the outside edge of any hole for prestressing wire through a stressing washer or through an unthreaded bearing ring or plate shall not be less than one-fourth (¼) inch from the root of the thread of the washer or from the edge of the ring or plate.

The load from the anchoring device shall be distributed to the concrete by means of approved devices that will effectively distribute the load to the concrete.

Such approved devices shall conform to the following requirements:

(a) The final unit compressive stress on the concrete

directly underneath the plate or assembly shall not exceed three thousand (3,000) pounds per square inch.

(b) Bending stresses in the plates or assemblies induced by the pull of the prestressing steel shall not exceed the yield point of the material or cause visible distortion in the anchorage plate when one hundred (100) percent of the ultimate load is applied as determined by the Engineer.

(c) Materials and workmanship shall conform to the requirements in Section 506, "Steel Structures."

Should the Contractor elect to furnish anchoring devices of a type which are sufficiently large and which are used in conjunction with a steel grillage embedded in the concrete that effectively distributes the compressive stresses to the concrete, the steel distribution plates or assemblies may be omitted.

Where the end of a post-tensioned assembly will not be covered by concrete, the anchoring devices shall be recessed so that the ends of the prestressing steel and all parts of the anchoring devices will be at least two (2) inches inside of the end surface of the members, unless a greater embedment is shown on the plans. Following post-tensioning, the recesses shall be filled with concrete conforming to the requirements for the structure and finished flush.

495.03.03 Ducts. Duct enclosures for prestressing steel shall be rigid galvanized ferrous metal, mortar-tight, and accurately placed at the locations shown on the plans or approved by the Engineer.

All ducts or anchorage assemblies shall be provided with pipes or other suitable connections for the injection of grout after prestressing.

Ducts for prestressing steel when bars are used shall have a minimum inside diameter three-eighths (⅜) inch larger than the diameter of the bars to be used.

Ducts for prestressing steel shall be securely fastened in place to prevent movement.

After installation in the forms, the ends of ducts shall at all times be covered as necessary to prevent the entry of water or debris. If prestressing steel is to be installed

after the concrete has been placed, duct shall be blown out or flushed and blown out immediately prior to installation of the steel.

Rigid ducts may be fabricated with either welded or interlocked seams. Galvanizing of the welded seam will not be required. Rigid ducts shall have sufficient strength to maintain their correct alignment during placing of concrete. Joints between sections of rigid duct shall be positive metallic connections which do not result in angle changes at the joints. Water proof tape shall be used at the connections. Ducts shall be bent without crimping or flattening. Transition couplings connecting said ducts to anchoring devices need not be galvanized.

All ducts for continuous structures shall be vented within three (3) feet of the high points or the cable path. Vents shall be one-half (½) inch minimum diameter standard pipe. Connections to ducts shall be made with metallic structural fasteners. The vents shall be mortar tight, taped as necessary, and shall provide means for injection of grout through the vents and for sealing the vents. Ends of vents shall be removed one (1) inch below the top of top slab after grouting has been completed.

495.03.04 Prestressing. All prestressing steel shall be tensioned by means of hydraulic jacks so that the force in the prestressing steel shall not be less than the value shown on the plans.

Unless otherwise specified or shown on the plans, the average working stress in the prestressing steel shall not exceed sixty (60) percent of the specified minimum ultimate tensile stress of the prestressing steel. The maximum temporary tensile strength (jacking stress) in prestressing steel shall not exceed seventy-five (75) percent of the specified minimum ultimate tensile strength of the prestressing steel. The prestressing steel shall be anchored at stresses (initial stress) that will result in the ultimate retention of working forces of not less than those shown on the plans, but in no case shall the initial stress exceed seventy (70) percent of the specified minimum ultimate tensile strength of the prestressing steel.

Working force and working stress will be considered as the force and stress remaining in the prestressing steel after all losses, including creep and shrinkage of concrete, elastic compression of concrete, creep of steel, losses in post-tensioned prestressing steel due to sequence of stressing, friction and take up of anchorages, and all other losses peculiar to the method or system of prestressing have taken place or have been provided for.

The loss in stress in post-tensioned prestressing steel due to creep and shrinkage of concrete, creep of steel, and sequence of stressing shall be as indicated on the plans.

The following formula and friction coefficients shall be used in calculating friction losses in tendons:

$$T^\circ = T_x e^{(Ua+Kl)}$$

T° = Steel stress at jacking end
T_x = Steel stress at any point x
e = Base of Naperian logarithms
U = Friction curvature coefficient
a = Total angular change of prestressing steel profile in radians from jacking end to point x
K = Friction wobble coefficient
l = Length of prestressing steel from jacking end to point x

Type of Steel	Type of Duct	K	U
Bright metal wire or strand	Galvanized—rigid	0.0002	0.25
Bright metal bars	Galvanized	0.0002	0.15

Each jack used to stress tendons shall be equipped with either a pressure gage or a load cell for determining the jacking stress, at the option of the Contractor. The pressure gage, if used, shall have an accurate reading dial at least six (6) inches in diameter and each jack and its gage shall be calibrated as a unit with the cylinder extension in the approximate position that it will be at final jacking force, and shall be accompanied by a certified calibration chart. The load cell, if used, shall be calibrated and shall be provided with an indicator by means of which the prestressing force in the tendon may be determined. The range of the load cell shall be such that the lower ten (10) percent of the manufacturer's rated capacity will not be used in determining the jacking stress.

The certified calibration charts for the hydraulic jacks, pressure gages, or load cells used for tensioning prestressing steel may be checked before and during tensioning operations with State-furnished load cells. The Contractor shall provide, at his expense, sufficient labor, equipment, and material to install and support the load cells at the prestressing tendons and to remove the load cells after the checking is complete, as ordered by the Engineer. The checking operations, except as provided in this paragraph, will be conducted by state forces.

Prior to placing forms for closing slabs of box girder cells, the Contractor shall demonstrate to the satisfaction of the Engineer that either the prestressing steel is free and unbonded in the duct or, if prestressing steel has not yet been placed, that all ducts are unobstructed.

Prior to post-tensioning any member, the Contractor shall demonstrate to the satisfaction of the Engineer that the prestressing steel is free and unbonded in the duct.

Except as herein provided, cast-in-place concrete shall not be prestressed until at least ten (10) days after the last concrete has been placed in the member to be prestressed and until the compressive strength of said last placed concrete has reached the strength specified for the concrete at the time of stressing. The Contractor at his option may, however, apply not more than fifty (50) percent of the required stressing force to the structure five (5) days or more from the date the last concrete was placed in the member to be prestressed, provided the compressive strength of said concrete is in accordance with the plans.

Where F'c 3500 concrete is specified on the plans for cast-in-place prestressed concrete, the tendons shall not be tensioned until the concrete to be prestressed has attained a compressive strength equal to the strength at the time of initial prestressing shown on the plans.

The tensioning process as applied to post-tensioned members shall be so conducted that tension being applied and the elongation of the prestressing steel may be measured at all times. A record shall be kept of gage pressures and elongations at all times and shall be submitted to the Engineer for approval.

Prestressing tendons in continuous post-tensioned members shall be tensioned by jacking from both ends of the tendon.

495.03.05 Bonding and Grouting. Post-tensioned prestressing steel shall be bonded to the concrete by completely filling the entire void space between the duct and the tendon with grout.

Grout shall consist of Portland cement, water, and an expansive admixture approved by the Engineer.

Portland cement shall be Type II "low-alkali" cement conforming to the requirements of Section 701 of the Standard Specifications.

Water shall comply with the requirements of Section 722 of the Standard Specifications.

The use of admixtures shall comply with the requirements of subsection 501.02.03 of the Standard Specifications except that the admixture shall not contain chloride ions in excess of 0.25 percent by weight of admixture and the admixture may be dispensed in solid form.

Water shall be first added to the mixer followed by cement and admixtures.

The grout shall be mixed in mechanical mixing equipment of a type that will produce uniform and thoroughly mixed grout. The water content shall be not more than five (5) gallons per sack of cement. Retempering of grout will not be permitted. Grout shall be continuously agitated until it is pumped.

The pump-ability of the grout shall be determined by the Engineer in accordance with the U.S. Corps of Engineers Test Method CRD–C79. The efflux time of a grout sample immediately after mixing shall be not less than eleven (11) seconds.

Grouting equipment shall be capable of grouting at a pressure of at least one hundred (100) pounds per square inch.

Grouting equipment shall be furnished with a pressure gage having a full-scale reading of not more than three hundred (300) pounds per square inch.

Standby flushing equipment capable of developing a

pumping pressure of two hundred fifty (250) pounds per square inch and of sufficient capacity to flush out any partially grouted ducts shall be provided.

All ducts shall be clean and free of deleterious materials that would impair bonding of the grout or interfere with grouting procedures.

All grout shall pass through a screen with 0.07 inch maximum clear openings prior to being introduced into the grout pump.

When hot weather conditions would contribute to quick stiffening of the grout, the grout shall be cooled by approved methods as necessary to prevent blockages during pumping operations.

Grout injection pipes shall be fitted with positive mechanical shutoff valves. Vents and ejection pipes shall be fitted with valves, caps or other devices capable of withstanding the pumping pressures. Valves and caps shall not be removed or opened until the grout has set. Leakage of grout through the anchorage assembly shall be prevented by positive mechanical means.

Grout shall be pumped through the duct and continuously wasted at the outlet until no visible slugs of water or air are ejected and the efflux time of ejected grout is not less than eleven (11) seconds. The outlet pipe shall then be closed and the pumping pressure held momentarily. The valve at the inlet shall then be closed while maintaining this pressure.

The surface of concrete against which concrete encasement over anchorage assemblies is to be placed shall be abrasive blast cleaned and clean aggregate exposed after grouting of the ducts has been completed.

495.03.06 Samples for Testing. Sampling and testing shall conform to the specifications of ASTM Designation: A416 and ASTM Designation: A421 and as specified below.

Samples from each size and each heat of prestressing bars, from each manufactured reel of prestressing steel strand, from each coil of prestressing wire and from each lot of anchorage assemblies and bar couplers to be used

shall be furnished for testing. With each sample of prestressing steel wires, bars or strands furnished for testing, there shall be submitted a certification stating the manufacturer's minimum guaranteed ultimate tensile strength of the sample furnished.

All materials for testing shall be furnished by the Contractor at his expense. The Contractor shall have no claim for additional compensation in the event his work is delayed awaiting approval of the materials furnished for testing.

All bars of each size from each mill heat, all wire from each coil, and all strand from each manufactured reel to be shipped to the site shall be assigned an individual lot number and shall be tagged in such a manner that each such lot can be accurately identified at the jobsite. Each lot of anchorage assemblies and bar couplers to be installed at the site shall be likewise identified. All unidentified prestressing steel, anchorage assemblies or bar couplers received at the site will be rejected.

The following samples of materials and tendons, selected by the Engineer from the prestressing steel at the plant or jobsite, shall be furnished by the Contractor to the Engineer well in advance of anticipated use:

(a) For wire, strand, or bars, one seven (7) foot long sample of each size shall be furnished for each heat or reel.

(b) If the prestressing tendon is to be prefabricated, one completely fabricated prestressing tendon five (5) feet in length for each size of tendon shall be furnished, including anchorage assemblies. If the prestressing tendon is to be assembled at the jobsite, sufficient wire or strand and end fittings to make up one complete prestressing tendon five (5) feet in length for each size of tendon shall be furnished, including anchorage assemblies.

(c) If the prestressing tendon is a bar, one seven (7) foot length complete with one end anchorage shall be furnished and in addition, if couplers are to be used with the bar, two four (4) foot lengths of bar equipped with one coupler and fabricated to fit the coupler shall be furnished.

When prestressing systems have been previously tested

and approved for Department of Highways' projects, complete tendon samples need not be furnished, provided there is no change whatsoever in the materials, design or details previously approved. Shop drawings shall contain an identification of the project on which approval was obtained, otherwise sampling will be required.

For prefabricated tendons, the Contractor shall give the Engineer at least ten (10) days notice before commencing the installation of end fittings or the heading of wires. The Engineer will inspect end fitting installations and wire headings while such fabrication is in progress at the plant and will arrange for the required testing of the material to be shipped to the site.

No prefabricated tendon shall be shipped to the site without first having been released by the Engineer, and each tendon shall be tagged before shipment for identification purposes at the site. All unidentified tendons received at the site will be rejected.

Jobsite or site as referred to herein shall be considered to mean the bridge site.

The release of any material by the Engineer shall not preclude subsequent rejection if the material is damaged in transit or later damaged or found to be defective.

MEASUREMENT

495.04.01 Measurement. The unit of measurement for "Prestressing Cast-in-Place Concrete" shall be lump sum.

PAYMENT

495.05.01 Payment. The contract lump sum price paid for "Prestressing Cast-in-Place Concrete" shall include full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all work involved in furnishing, placing, and tensioning the prestressing steel in cast-in-place concrete structures, complete in place, as shown on the plans, as specified in these special provisions, and as directed by the Engineer.

Full compensation for furnishing and placing additional deformed bar reinforcing steel required by the particular

system used, ducts, anchoring devices, distribution plates or assemblies and incidental parts, for furnishing samples for testing, for grouting recesses and pressure grouting ducts shall also be considered as included in the contract lump sum price paid for "Prestressing Cast-in-Place Concrete," and no additional compensation will be allowed therefor.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Prestressing Cast-in-Place Concrete	Lump Sum

SECTION 501

PORTLAND CEMENT CONCRETE

DESCRIPTION

501.01.01 General. This work shall consist of Portland cement, fine aggregate, coarse aggregate, water and when specified, an air-entraining admixture, proportioned, placed, and cured as herein specified.

MATERIALS

501.02.01 General. Materials shall meet the requirements of the following sections:

Water	Section 722
Aggregate for Portland Cement Products	Section 706
Portland Cement	Section 701
Concrete Curing Materials and Admixtures	Section 702

501.02.02 Gradation Requirements. The gradation requirements represent the extreme limits in determining the suitability of material. The gradation from any one source shall maintain a uniformity such that variations in the fineness modulus will not exceed ± 0.2 from the fineness modulus of samples of the material offered for use. Fine aggregate from any one source having a variation in fineness modulus of more than 0.2 as prescribed above shall be rejected, or at the discretion of the Engineer, may be accepted subject to such approved changes. The fineness modulus of fine aggregate shall be determined by adding the cumulative percentages, by weight, of material retained on each of U.S. Standard sieves Nos. 4, 8, 16, 30, 50, and 100, and dividing by 100.

Fine aggregates from different sources of supply shall not be mixed or stored in the same pile. They shall not be used alternately in the same class of construction or job-mix without written permission of the Engineer. Such permission shall be contingent on amending the job-mix and batch weights as necessary to protect the quality of the concrete produced.

If the fine aggregate for a job-mix is to be a composite material from two or more sources, material from respective sources shall be proportioned separately or blended by methods which will maintain the degree of uniformity or gradation required by these specifications.

Adequate supplies of aggregate shall be produced and stockpiled sufficiently in advance of construction operations as to permit sampling and testing before use.

Coarse aggregates secured from the same or different sources and which vary widely in gradation shall be placed in separate stockpiles or bins and recombined in proportions approved by the Engineer. Different sizes of aggregates shall be stored in stockpiles sufficiently removed from each other to prevent the materials at the edges of piles from becoming intermixed.

If the Contractor changes the source of any size of aggregate, opportunity shall be given in advance of use to permit the Engineer to determine the concrete-making properties as provided in subsection 501.02.04, "Concrete Making Properties."

501.02.03 Admixtures. Air-entraining admixtures and water reducers and retarders shall conform to the requirements of subsections 702.03.03, "Air-Entraining Admixtures," and 702.03.04, "Water Reducers and Retarders."

No admixtures shall be used without written permission from the Engineer, except as otherwise provided in these specifications or in the special provisions.

Admixtures shall not be used to replace cement. Admixtures containing chlorides as CL^- in excess of one (1) percent by weight shall not be used in prestressed concrete. If admixtures are used to entrain air, to reduce the water-cement ratio, to retard or accelerate setting time, or to accelerate the development of strength, they shall be used at the rate of dosage specified in the contract documents or as approved by the Engineer.

When the use of an air-entraining agent is specified, it shall be added in a quantity conforming to Table I of subsection 501.03.04, "Classifications and Proportions." It shall be measured accurately into each batch by equipment

and methods approved by the Engineer. Adjustments shall be made in the weights of the aggregates used per batch to compensate for increased yield due to air-entrainment so that the quantities of cement per cubic yard of concrete remain constant. Such adjustments shall be made by decreasing the weight of fine aggregate without changing the weight of coarse aggregate unless otherwise approved by the Engineer.

Admixtures shall be measured accurately into each batch by methods approved by the Engineer.

Except as otherwise provided for air-entraining agents, samples of admixtures proposed for use shall be submitted by the Contractor to the Engineer in advance of intended use sufficiently to permit tests to be made to determine compliance with claimed properties.

Any type of admixture shall be uniform in properties throughout its use in the work. Should it be found that the admixture as furnished is not uniform in properties, its use shall be discontinued.

Admixtures shall be dispensed in liquid form. Dispensers for liquid admixtures shall have sufficient capacity to measure at one time the full quantity required for each batch. Unless liquid admixtures are added to premeasured water for the batch, their discharge into the batch shall be arranged to flow uniformly into the stream of water. Dosages of liquid admixtures shall not vary from the dosage approved by the Engineer by more than five (5) percent. Equipment for measurement shall be designed for convenient confirmation of the accuracy of measurement. If more than one liquid admixture is used, each shall be dispensed by separate equipment unless otherwise permitted in writing by the Engineer.

When water-reducing agents or water-reducing retarders are used, the permitted dosage of the admixture shall not exceed that which will result in an increase in the drying shrinkage of the concrete in excess of twenty (20) percent when used in precast, prestressed concrete; ten (10) percent when used in cast-in-place prestressed concrete; ten (10) percent when used in cast-in-place reinforced concrete; or

three (3) percent when used in nonreinforced concrete pavements.

Water reducers shall reduce the water demand of concrete for a given slump at least seven (7) percent when used at the maximum dosage recommended by the manufacturer. Set retarders shall not be used in greater dosages than those recommended by the manufacturer, nor more than that needed to obtain the desired retardation. The strength of the concrete containing the admixture in the amount approved by the Engineer shall at the age of forty-eight (48) hours and longer be not less than that of similar concrete without the admixture.

When the Contractor proposes to use an air-entraining admixture which has been previously approved, he shall submit a certification stating that the admixture is the same as that previously approved. If an admixture offered for use is essentially the same (with only minor differences in concentration) as another previously approved material, a certification will be required stating that the product is essentially the same as the approved admixture and that no other admixture or chemical agent is present.

Either prior to or at any time during construction, the Engineer may require that the admixture selected by the Contractor be further tested to determine its effect upon the strength of the concrete. When so tested, seven (7) days compressive strength of concrete made with the cement and aggregates in the proportions to be used in the work and containing the admixture under test shall not be less than eighty-eight (88) percent of the strength of concrete made with the same materials and with the same cement content and consistency but without the admixtures.

501.02.04 Concrete Making Properties. Portland cement concrete shall be subject to the following requirements and test methods:

Test	Test Designation	Requirements
Compressive Strength of Molded Concrete Cylinders	Nev. T475*	Table I
Making and Curing Concrete Compression and Flexure Test Specimens in the Laboratory	Nev. T455	.....
Making and Curing Concrete Compression Test Specimens in the Field	Nev. T428	.....
Unit Weight and Cement Factor, Fresh Concrete	Nev. T435	Table I
Air Content	Nev. T432 or Nev. T431B	Table I
Method of Test for Specific Gravity and Absorption of Coarse Aggregate	Nev. T492	Min. saturated surface dry condition
Slump	Nev. T438 or Nev. T439†	Table I
Coring Concrete	Nev. T474	Section 502.04.01

*The compressive strength requirements of Portland cement concrete shall be based on the strength test, which is defined as the average of the breaking strength of three standard cylinders at twenty-eight (28) days. The cylinder strengths shall be determined in accordance with Test Method No. Nev. T475.

†Unless otherwise required, Test Method No. Nev. T438 will be used.

A test, as defined above, will be required for each one hundred (100) cubic yards, or portion thereof, placed each day. There shall be at least one strength test made each day that concrete is placed, regardless of the volume placed. Other cylinders may be made and broken for information purposes.

CONSTRUCTION

501.03.01 Equipment Methods employed in performing the work, and all equipment, tools, and machinery used for handling materials and executing any part of the work, shall be subject to the approval of the Engineer. All equipment necessary shall be on hand and approved before concrete operations are begun by the Contractor.

The Contractor shall maintain the equipment in good condition and adjustment. Concrete mixers and other

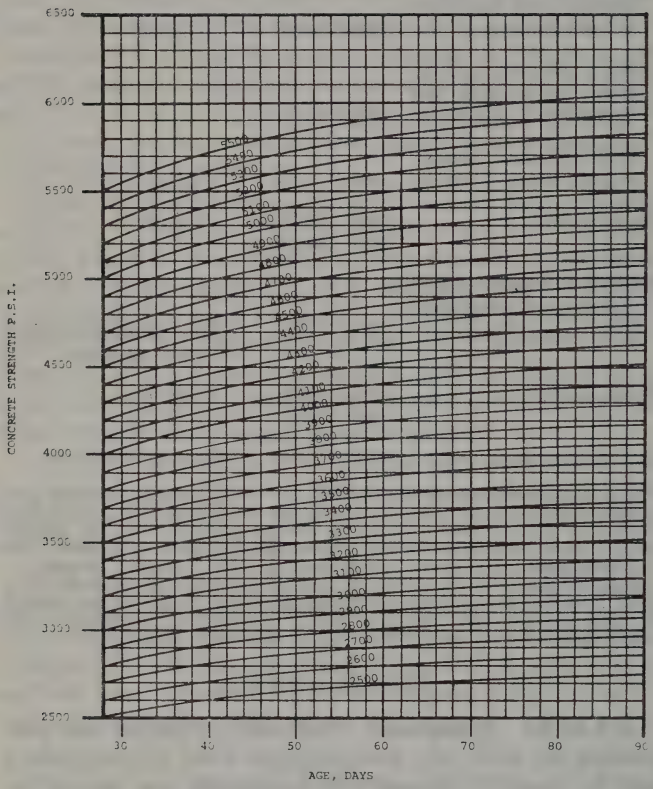
CONCRETE STRENGTH P.S.I.
6500
6000
5500
5000
4500
4000
3500
3000
2500
30
40
50
60
70
80
90
AGE, DAYS

CHART NO. 1

equipment which are not adequate or suitable for the work shall be removed and suitable equipment shall be provided by the Contractor.

501.03.02 Protecting and Sampling Cement. Suitable means of storing and protecting the cement against moisture or other injurious effects shall be provided by the Contractor. Sacked or bulk cement which, for any reason, has become partially set or which contains lumps of caked cement shall be rejected and shall be immediately removed from the worksite.

Different brands of cement shall not be mixed during use or in storage, nor shall they be used alternately in any one structure. The same brand and kind of cement shall be used in a given structure above the ground line.

The sacked cement shall be so piled as to permit access for tally, inspection, and identification of each shipment.

The Contractor shall obtain from the cement company from which the cement is purchased, a certificate stating that the cement delivered to the work complies with the specifications for the type of cement specified for use. The certificate shall be dated, signed, and indicate the quantity of shipment. Two copies shall be delivered directly to the Engineer in charge of the work.

Upon receipt of the Certificate of Compliance, the Engineer may permit the use of the cement. When a Certificate of Compliance is not furnished the Engineer, the cement shall not be used in the work until a release for its use has been received by him from the Department's Materials and Research Division.

When a Certificate of Compliance is not furnished, the Department shall be afforded sufficient time to make a seven (7) day test on approved brands of cement in common use, and a twenty-eight (28) day test on new or unapproved brands of cement.

Whenever it is determined by subsequent laboratory tests of mill or field samples that the cement does not comply with the specifications, subsequent use of cement from the same cement company will be delayed, if required

by the laboratory, until tests can be made on each lot of cement delivered.

All cement not conforming to the specifications and all cement damaged by exposure to moisture shall be removed immediately and permanently from the work.

501.03.03 Storage of Aggregates. The handling and storage of aggregates shall be such as to prevent segregation or contamination by foreign materials.

In placing materials in storage or in moving them from storage to the mixer, any method which may cause the segregation, degradation, or the combining of material of different gradings which will result in any stockpile or bunker failing to meet specified requirements shall be discontinued and the materials shall be reprocessed or wasted.

501.03.04 Classifications and Proportions. The Contractor shall notify the Engineer not less than thirty-two (32) calendar days in advance of use of the proposed sources of materials and shall make arrangements for the Engineer to obtain samples as required for testing purposes.

When requested by the Contractor, exceptions to the above requirement may be granted in writing by the Engineer under either of the following conditions:

(a) The concrete structures on the project are minor in nature, such as culvert headwalls, manholes, small boxes, sidewalks, etc., generally, when less than one hundred (100) cubic yards of concrete are called for on the project.

(b) When the aggregate source has been previously tested within the past one (1) year and accepted by the State.

Samples will not exceed five hundred (500) pounds for each separate grading. The Contractor shall furnish a written statement giving the cement factor in sacks per cubic yard, the proportions of cement, water, and each size of aggregate by weight in a saturated surface dry condition, and the percentage of air in the concrete proposed for use in the work. If the Contractor proposes to use an

admixture other than an air-entraining agent, he shall state its complete brand name and the quantity proposed to be used per sack of cement.

Portland cement concrete shall be proportioned, using the aggregates tested, such that the compressive strength requirements in Table I will be satisfied without falling below the minimum, or exceeding the maximum values given. The Contractor shall give the Engineer advance notice in writing when any changes are to be made in the batch proportions.

Batches of concrete shall not vary more than plus or minus three (3) pounds per cubic foot in unit weight from design mix. The cement factor of any individual batch placed in the work shall not be more than 0.15 sack per cubic yard less, nor more than 0.25 sack per cubic yard greater than the designated factor (sacks of cement per cubic yard). Aggregates shall be batched and reported to the resident engineer. The weights used may be varied as necessary to comply with the above tolerances in cement factor and unit weight.

501.03.05 Proportioning Methods. Except as hereinafter noted, aggregate bins shall conform to either (a) or (b) as follows:

(a) Each specified size of aggregate shall be stored in a separate bin. Except as hereinafter specified, each bin shall be provided with an individual outlet gate, designed and constructed to prevent leakage when closed. The gates shall cut off quickly and completely.

(b) Each size aggregate shall be weighed individually in a single bin, providing there is a satisfactory method employed to eliminate any excess material resulting from over-charging of the bin before the material reaches the surge hopper.

(a) and (b) above will not be required when batching for culvert headwalls, manholes, small boxes, sidewalks, etc., and the total quantity of class A, AA, D, DA, concrete called for on the project does not exceed three hundred (300) cubic yards.

TABLE I

Class of Concrete	Cem. Range, Sacks per Cu. Yd.	Coarse Agg. Size No.	Max. Water Gal. per Sack Cem.*	Min. Compr. Str. (28 day) p.s.i.	Slump Range, Inches† Nev. T438	Air Range Percent	Unit Weight Variations	Use
A	6.0–7.5	467	6	3,000	1–4	.....	±3 lbs.	General use and reinforced structures
AA	6.0–7.5	467	6	3,000	1–4	4–7	±3 lbs.	
B	5.5–7.5	357	6	3,000	1–5	.....	±3 lbs.	Massive or lightly reinforced sections
BA	5.5–7.5	357	6	3,000	1–4	4–7	±3 lbs.	
C	5.0–6.5	357	6.75	2,500	1–5	.....	±3 lbs.	Massive unreinforced and backfill
CA	5.5–7.0	357	5.75	2,500	1–5	4–7	±3 lbs.	
D	6.0–7.5	67	6	3,000	1–4	.....	±3 lbs.	Thin reinforced sections, handrails, etc.
DA	6.0–8.0	67	6	3,000	1–4	4–7	±3 lbs.	

PAA	6.0–8.0	67	6	Specified on plans	0–4	Specified on plans	±3 lbs.	Prestressed members
Modified A and AA	6.0–8.0	467	6	Specified on plans	1–4	4–7 (AA only)	±3 lbs.	Where specified on plans
Modified D and DA	6.0–8.0	67	6	Specified on plans	1–4	4–7	±3 lbs.	

*Based on aggregate in a saturated surface dry condition.

†When the deck of a structure is used as a riding surface, the slump shall conform to that specified in subsection 409.03.01, "Classification and Proportions."

The difference in slump, determined by comparing slump tests on two samples of mixed concrete for each individual batch tested, shall not exceed two (2) inches. When the difference in slump does exceed two (2) inches, procedure and equipment used in producing the concrete shall be adjusted to reduce the difference in slump to not more than two (2) inches.

All aggregates for use in Portland cement concrete shall be proportioned by weight, with the exception that aggregates for culvert headwalls, short pieces of curbs and gutter, or small sections of sidewalk and related minor work may be proportioned either by weight or volume as the Contractor may elect. Measuring boxes of known capacity shall be furnished and used to measure each size of aggregate proportioned by volume.

Batches requiring fractional sacks of cement will not be permitted, unless the Contractor elects to weigh the cement in each batch.

Bulk cement shall be weighed separately when the batch is one (1) cubic yard or more. The scale and weigh hopper for the cement shall be separate and distinct from the aggregate hopper or hoppers. The discharge mechanism of the bulk cement hopper shall be interlocked against opening before the full amount of cement is in the hopper, against closing before the contents of the hopper are entirely discharged and the scales are back in balance, and against opening when the amount of cement in the hopper is under weight by more than one (1) percent of the amount specified. An interlock system will not be required on projects having less than three hundred (300) cubic yards in the bid schedule.

Scales utilized in the proportioning device may be of the springless dial type or of the multiple beam type.

If of the dial type, the dial shall be of such size and so arranged that it may be read easily from the operating platform.

If of the multiple beam type, the scales shall be provided with an indicator operated by the main beam which will give positive visible evidence of over or under weight. The indicator shall be so designed that it will operate during the addition of the last four hundred (400) pounds of any weighing. The over travel of the indicator hand shall be at least one-third (⅓) of the loading travel. The indicator shall be enclosed against moisture and dust.

Weighing equipment shall be insulated against vibration or movement of other operating equipment in the plant. When the entire plant is running, the scale reading and

cutoff shall not vary from the weight designated by more than one (1) percent for cement and one and one-half (1½) percent for any size of aggregate, nor one (1) percent for the total aggregate in any batch.

Scales shall be approved with a Certificate of Inspection as required in subsection 109.01, "Measurement of Quantities."

Should separate supplies of aggregate and material of the same size group, but of different moisture content or specific gravity be available at the proportioning plant, withdrawals shall be made from one supply exclusively and the material therein completely exhausted before starting upon another.

Stockpiled aggregates shall be in a saturated surface dry condition just prior to batching. The moisture content of the aggregate shall be such that no visible separation of moisture and aggregate will take place during transportation from the proportioning plant to the point of mixing. Aggregate containing excess moisture shall be stockpiled prior to use until sufficiently dried to meet the above requirements.

Batches with cement in contact with damp aggregates shall be mixed within thirty (30) minutes after being proportioned. Batch trucks hauling more than one batch of cement and aggregate shall be so constructed that materials do not flow from one compartment to another during haul or discharge.

Coarse and fine aggregate shall be handled and measured separately. Each bag of cement shall contain ninety-four (94) pounds net and shall be emptied directly into charging skip of the mixer. Water shall be measured either by volume or by weight.

The equipment for measuring and supplying the water to the mixer shall be so constructed and arranged that the amount of water added to the mixture can be measured positively and that the predetermined quantity of water required can be discharged rapidly in one operation into the mixing drum without dribbling. The equipment shall be so designed that water from the source of supply cannot

enter the measuring tank while the water is being discharged from the measuring tank into the mixer. Tanks or other equipment for measuring and discharging water into the mixer shall be sufficiently accurate that the amount of water delivered to the mixer for any batch shall not vary more than one (1) percent from the required quantity of water for any position of the mixer with respect to level plane. The tanks or other equipment shall be so arranged as to permit the checking of the amount of water delivered by discharging into measured containers.

501.03.06 Machine Mixing. (a) General. All concrete shall be mixed in mechanically operated mixers, except that when permitted by the Engineer, batches not exceeding one-third (⅓) cubic yard may be mixed by hand methods in accordance with the provisions of subsection 501.03.07, "Hand Mixing." Mixers shall have legible permanently attached plates showing manufacturer's rated capacity, mixing speeds, and serial number.

Mixers may be stationary mixers or truck mixers. Agitators may be truck mixers operating at agitating speed or truck agitators. Each mixer and agitator shall have attached thereto in a prominent place a metal plate or plates on which is plainly marked the various uses for which the equipment is designed, the manufacturer's guaranteed 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.

The Contractor, at his expense, shall furnish samples of the fresh concrete and provide safe and satisfactory facilities for obtaining the samples.

Concrete mixers may be of the revolving drum or the revolving blade type and the mixing drum or blades shall be operated uniformly at the mixing speed recommended by the manufacturer.

The temperature of materials as charged into the mixer shall be such that the temperature of the mixed concrete at the time it is placed in final position is not less than fifty (50) degrees Fahrenheit nor more than ninety (90) degrees Fahrenheit as specified in subsection 501.03.10(b).

Aggregates and water used for mixing shall not exceed one hundred fifty (150) degrees Fahrenheit.

Concrete for structures shall be mixed for a period of not less than sixty (60) seconds nor more than five (5) minutes after all materials, including water, are in the mixer.

Cement shall be batched and charged into the mixer by means that will not result either in loss of cement due to the effect of wind, or in accumulation of cement on surfaces of conveyors or hoppers, or in other conditions which reduce or vary the required quantity of cement in the concrete mixture.

Stationary mixers having a capacity of one (1) cubic yard or more and all paving mixers shall be operated with an automatic timing device that can be locked by the Engineer. The time device and discharge mechanisms shall be so interlocked that during normal operations no part of the batch will be discharged until the specified mixing time has elapsed.

The total elapsed time between the intermingling of damp aggregates and cement and the start of mixing shall not exceed thirty (30) minutes.

Mixers and agitators which have an accumulation of hard concrete or mortar or worn blades shall not be used.

When central-mixed concrete is furnished and non-agitating hauling equipment is used for transporting concrete to the delivery point, for Portland cement concrete pavement, discharge into the laydown machine shall be completed within forty-five (45) minutes after the addition of the cement to the aggregates.

(b) On-Site Mixed Concrete. When mixing at the site of the work the mixers used shall be of the paving or stationary type. The size of batch shall not exceed the rated capacity as determined by the standard requirements of the Associated General Contractors of America, except that in paving mixers when used for Portland cement concrete pavement, concrete slope protection and curbs and sidewalks, the size of batch may exceed the rated capacity of the mixer as determined by the standard requirements of the Associated General Contractors of America to a total of 32.4 cubic feet in 27 E mixers and 40.8 cubic

feet in 34 E mixers, provided that all parts of the mixer will hold the overcharge without spillage, that the uniformity and strength of the resulting concrete is not reduced, and provided further that when paving mixers are operating on grades in excess of six (6) percent, the size of batch shall not exceed 29.7 cubic feet in 27 E mixers or 37.4 cubic feet in 34 E mixers.

(c) Ready-Mixed Concrete. Ready-mixed concrete shall include central-mixed, shrink-mixed and transit-mixed concrete. Shrink-mixed concrete is that which has been mixed partially in a stationary mixer and the mixing completed in a truck mixer.

The size of batch in truck mixers and truck agitators shall not exceed the rated capacity as determined by the current Standard Requirements of Truck Mixer Manufacturers Bureau. The size of batch in stationary mixers shall not exceed the rated capacity of the mixer as determined by the standard requirements of the Associated General Contractors of America. No batches requiring fractional sacks of cement will be permitted unless all of the cement is weighed when added to the batch.

If the use of ready-mixed concrete is approved, the producer shall use only that cement approved by the State for use on the project. State approved cement shall be stored at the concrete plant in such a manner that it can be identified and kept separate from other cement.

Ready-mixed concrete for structures shall be transported in truck mixers or truck agitators.

The mixer, when loaded to capacity, shall be capable of combining the ingredients of the concrete within the specified time, into a thoroughly mixed and uniform mass and of discharging the concrete with a satisfactory degree of uniformity. The agitator, when loaded to capacity, shall be capable of maintaining the mixed concrete in a thoroughly mixed uniform mass and of discharging the concrete with a satisfactory degree of uniformity.

Mixers and agitators shall be examined periodically for changes in condition due to accumulation of hardened concrete or mortar or to wear of the blades. When any such change of condition is found, the concrete should be

subjected to the slump tests. If the tests indicate that the concrete is not being properly mixed, the faulty equipment shall be corrected before its further use is allowed.

Truck mixers shall be equipped with electrically or mechanically actuated revolution counters by which the number of revolutions of the drum or blades may be readily verified. The counters shall be of the continuous-registering, nonresettable type, which accurately register the number of revolutions, and shall be mounted on the truck mixer so that the Engineer may safely and conveniently inspect them from alongside the truck.

When a truck mixer is used, each batch of concrete shall be mixed for not less than seventy (70) nor more than one hundred (100) revolutions of the drum or blades at the rate of rotation designated by the manufacturer of the equipment as mixing speed. If any additional mixing is done, it shall be at the speed designated by the manufacturer of the equipment as agitating speed.

When shrink-mixed concrete is furnished, concrete that has been partially mixed at a central plant shall be transferred to a truck mixer and all requirements for transit-mixed concrete shall apply. No credit in the number of revolutions at mixing speed shall be allowed for partial mixing in a central plant.

No additional mixing water shall be incorporated into the concrete during hauling or after arrival at the delivery point, unless permitted by the Engineer. If the Engineer permits additional water to be incorporated into the concrete, the drum shall be revolved not less than thirty (30) revolutions at mixing speed after the water is added and before discharge is commenced.

The rate of discharge of mixed concrete from truck mixer-agitators shall be controlled by the speed of rotation of the drum in the discharge direction with the discharge gate fully open.

When truck mixer or truck agitator is used for transporting concrete that has been completely mixed in a stationary mixer, mixing during transportation shall be at the speed designated by the manufacturer of the equipment as agitating speed.

When a truck mixer or agitator is used for transporting concrete, the concrete shall be delivered to the site of the work and discharge shall be completed within ninety (90) minutes after the introduction of the mixing water to the cement and aggregates, or the introduction of the cement to the aggregates. In hot weather, or under conditions contributing to quick stiffening of the concrete as determined by the Engineer, a delivery time of less than ninety (90) minutes may be required. When a truck mixer is used for the complete mixing of the concrete the mixing operations shall begin within thirty (30) minutes after the cement has been intermingled with the aggregate.

If the mixing plant is such a distance from the site of the work that it is not practical to have the mixed concrete delivered and placed in forms within the time limit specified, cement and water shall not be added until such time requirement can be complied with.

The organization supplying concrete shall have sufficient plant capacity and transporting apparatus to insure continuous delivery at the rate required. The rate of delivery of concrete shall be such as to provide for the proper handling and placing of concrete. An interval of more than forty-five (45) minutes between any two consecutive batches or loads, or a delivery and placing rate of less than eight (8) cubic yards of concrete per hour shall constitute cause for shutting down work for the remainder of the day, and if so ordered by the Engineer, the Contractor shall make, at his own expense, a construction joint at the location and of the type directed by the Engineer in the concrete already placed.

After mixing of ready-mixed concrete has been completed it shall be agitated continuously at agitating speed until it has been discharged from the drum.

Concrete manufactured by any procedure which results in any unmixed lumps of cement in the mixed product shall be rejected.

A ticket system shall be used for recording the transportation and delivery of batches from the plant to the site of the work. The tickets will be issued by a state inspector to the truck operator at the plant for each load. The tickets

shall be delivered to the inspector at the site of the work. Loads which do not carry such tickets or which do not arrive in satisfactory condition shall not be used in the work.

501.03.07 Hand Mixing. Hand mixing shall not be permitted, except in case of an emergency or under written permission of the Engineer. When permitted, it shall be done only on watertight platforms. The sand shall be spread evenly over the platform and the cement spread upon it. The sand and cement shall then be thoroughly mixed while dry by means of shovels until the mixture is of uniform color, after which it shall be formed into a "crater" and water added in the amount necessary to produce mortar of the proper consistency. The material upon the outer portion of the "crater" ring shall then be shoveled to the center and the entire mass turned and sliced until a uniform consistency is produced. The coarse aggregate shall then be thoroughly wetted and added to the mortar and the entire mass turned and re-turned at least six times and until all of the stone particles are thoroughly covered with mortar and the mixture is of a uniform color and appearance. Hand mixing will not be permitted for concrete to be placed under water.

501.03.08 Retempering. Concrete shall be mixed only in such quantities as are required for immediate use and shall be placed before initial set has taken place. Any concrete in which initial set has begun shall be wasted and not used in the work. No retempering of concrete shall be allowed.

501.03.09 Curing. (a) General. All concrete shall be cured for the length of time hereinafter specified. If Type III cement is used, the curing time may be reduced as directed by the Engineer. In the event of low temperatures, the time will be increased according to the procedure specified in subsection 501.03.10(b), "Cold Weather."

Curing shall commence immediately upon completion of the finish. In the event that the application or placement

of the curing medium is delayed, curing will be as described under (b) below.

(b) Water Method. The concrete shall be kept continuously wet by the application of water for a minimum period of seven (7) days after the concrete has been placed.

The entire surface of the concrete shall be kept damp by applying water in the form of a fine fog mist until the surface of the concrete is covered with the curing medium. The moisture from the nozzle shall not be applied under pressure directly upon the concrete and shall not be allowed to accumulate on the concrete in a quantity sufficient to cause a flow or wash the surface.

Cotton mats, rugs, carpets, or earth or sand blankets may be used as a curing medium to retain the moisture during the curing period. The cotton mats, rugs, or carpets shall be of such character that they will retain water.

(c) Curing Compound Method. The entire surface of the concrete shall be sprayed uniformly with a curing compound. It shall be applied when just a light film of water is present on the surface. If the surface is dry, water shall be added as specified in (b) above before the curing compound is applied.

On decks or slabs cured by this method, foot traffic must be held to a minimum and these surfaces shall not be used as a work area during the cure period. Should the film of the compound be damaged before the expiration of seven (7) days, the damaged portions shall be repaired immediately with additional compound.

This method shall not be used on surfaces until all finishing is completed.

The curing compound shall be delivered to the work in ready-mixed form. At the time of use, the compound shall be in a thoroughly mixed condition with the pigment uniformly dispersed throughout the vehicle. The compound shall not be diluted or altered in any manner, unless dilution is recommended by the manufacturer.

Curing compound that has become chilled to such an extent that it is too viscous for satisfactory application

shall be warmed to a temperature not exceeding one hundred (100) degrees Fahrenheit.

The curing compound shall be applied to the exposed surface at a uniform minimal rate of one (1) gallon per one hundred fifty (150) square feet of area.

All Portland cement concrete pavement shall be cured with a white pigmented curing compound. White pigmented curing compound shall conform to the requirements of subsection 702.03.01, except as modified herein. Surfaces of the concrete which are exposed to the air shall be sprayed uniformly so as to obtain total coverage of the concrete surface, with either white pigmented chlorinated rubber curing compound, or white pigmented curing compound at the option of the Contractor. The rate of application of white pigmented curing compound, at any point, shall be one (1) gallon per 200 $\pm$50 sq. ft. and the average rate of application shall be one (1) gallon per 200 $\pm$25 sq. ft. The rate of application for white pigmented chlorinated rubber curing compound, at any point, shall be one (1) gallon per 250 $\pm$50 sq. ft. and the average rate of application shall be one (1) gallon per 250 $\pm$25 sq. ft. Power operated spraying equipment for application of curing compound shall be equipped with an operational pressure gage and means of controlling the pressure.

All surface finishing of the concrete shall be completed before application of the curing compound. The compound shall be applied immediately after the moisture sheen begins to disappear from the surface; but, before any drying shrinkage or craze cracks begin to appear. In the event of any delay in the application of curing compound application of water with an atomizing nozzle as specified in subsection 501.03.09(b), water method of the Standard Specifications, shall be started immediately and shall be continued until the application of the compound is resumed or started. Should the film of compound be damaged from any causes before the expiration of seventy-two (72) hours after the concrete is placed, the damaged portion shall be repaired immediately with additional compound.

All curing compounds shall remain sprayable at temperatures above forty (40) degrees Fahrenheit and shall not

hard settle in storage. They shall not be diluted or altered in any manner after manufacture. At the time of use, the compound shall be in a thoroughly mixed condition with the pigment uniformly dispersed throughout the vehicle. If the compound has not been used within one hundred twenty (120) days after the date of manufacture, the Engineer may require additional testing before use, to determine compliance to requirements.

An antisettling agent or combination of antisettling agents shall be incorporated in the curing compound to prevent caking and excessive settling of the pigment in the package. The total amount of antisettling agent used shall not exceed five (5) pounds per one hundred (100) gallons of the curing compound. There shall be no caking or excessive settling of the pigment in the package that cannot be readily redispersed with a paddle.

Curing compound may be sampled by the Engineer at the source of supply and at the jobsite. Each container of a packaged compound shall be clearly labeled showing the date of manufacture and date of shipment, the manufacturer's name and batch number, and the type of compound.

Portland cement concrete bridge decks that are to be the roadway surfaces shall be cured with a White Pigmented Curing Compound—Chlorinated Rubber Base conforming to the requirements of Section 702. The area to be treated shall be the top surface of concrete bridge decks except that care shall be exercised to keep the compound off all parapets or other surfaces which are to receive a "Fine Surface Finish ("FSF")" as specified on the plans.

The average minimal rate of application of the chlorinated rubber base type, at any point, shall be one (1) gallon per 250 $\pm$50 sq. ft. Power operated spraying equipment for application of curing compound shall be equipped with an operational pressure gage and means of controlling the pressure.

The curing compound shall be applied to the top surface of concrete bridge decks following the surface finishing operation immediately after the moisture sheen begins to disappear from the surface, but before any drying

shrinkage or craze cracks begin to appear. In the event of any delay in the application of curing compound, which could result in any drying or cracking of the surface, application of water with an atomizing nozzle as specified in subsection 501.03.09(b), "Water Method," of the Standard Specifications, shall be started immediately and shall be continued until application of the compound is resumed or started; however, the compound shall not be applied over any resulting free standing water. Should the film of compound be damaged from any cause before the expiration of seven (7) days after the concrete is placed, the damaged portion shall be repaired immediately with additional compound.

Curing compound shall remain sprayable at temperatures above forty (40) degrees Fahrenheit and shall not hard settle in storage. The compound shall not be diluted or altered in any manner after manufacture. At the time of use, the compound shall be in a thoroughly mixed condition with the pigment uniformly dispersed throughout the vehicle. If the compound has not been used within one hundred twenty (120) days after the date of manufacture, the Engineer may require additional testing before use, to determine compliance to requirements.

An antisettling agent or combination of antisettling agents shall be incorporated in the curing compound to prevent caking and excessive settling of the pigment in the package. The total amount of antisettling agent used shall not exceed six (6) pounds per one hundred (100) gallons of the curing compound. There shall be no caking or excessive settling of the pigment in the package that cannot be readily redispersed with a paddle.

The curing compound shall be packaged in clean fifty-five (55) gallon steel barrels or round five (5) gallon steel containers or shall be supplied from a suitable storage tank located at the jobsite. Each fifty-five (55) gallon barrel shall be equipped with a built-in agitator having two (2) sets of blades; one at the bottom, and the second, midway between top and bottom of container, and shall have removable lids and airtight band fasteners. On-site

storage tanks shall be kept clean and free of all contaminants. Each tank shall have a permanent system designed to completely redisburse any settled material without introducing air or any other foreign substance. Barrels shall be filled in a manner that will prevent skinning. Five (5) gallon containers shall be well sealed with ring seals and lug type crimp lids. The lining of the containers shall be of a character that will resist the solvent of the curing compound and will not permit skins to be loosened into the body of the curing compound. Each container shall be labeled with the manufacturer's name, batch number, number of gallons and date of manufacture, and shall have an Interstate Commerce Commission Red Label warning concerning flammability. The label shall also warn that the curing compound shall be well stirred before use. When the curing compound is shipped in tanks or tank trucks, a shipping invoice shall accompany each load. The invoice shall contain the same information as that required herein for container labels.

The curing compound shall not be applied until all patching and surface finishing, except grinding, has been completed. When deemed necessary by the Engineer during periods of hot weather, fogging of the concrete with water shall be continued after curing compound is applied until the Engineer determines that a cooling effect is no longer required. Such fogging after the application of the curing compound will be paid for as extra work as provided in subsection 104.03, "Extra Work."

(d) Waterproof Paper. The membrane shall be formed into sheets of such width as to provide a complete cover of the entire concrete surface. All joints in the sheets shall be securely cemented together in such a manner as to provide a waterproof joint. Overlap of sheets shall have a minimum lap of eighteen (18) inches. The sheets shall be securely weighted down by placing a bank of earth on the edges of the sheets or by other means satisfactory to the Engineer.

The curing membrane shall remain in place for a period of not less than seven (7) days.

Should any portion of the sheets be broken or damaged

before the expiration of the curing period, the broken or damaged portion shall be immediately repaired with new sheets properly cemented into place, or water curing as described above shall commence immediately. Sections of the membrane shall not be used which have lost their waterproof qualities or have been damaged to such an extent as to render them unfit for curing.

(e) Form Method. If forms are kept on concrete surfaces, this will be considered adequate cure for these surfaces. However, should the forms be removed within seven (7) days after the concrete has been placed, one of the above methods must be used on the exposed surfaces.

Attention is directed to subsection 502.03.12, "Removal of Falsework, Forms, and Housing."

501.03.10 Weather Limitations. (a) General. If impending inclement weather conditions exist, the Contractor shall decide whether or not to begin the pour and he shall have sole responsibility for his decision. Before any concrete is placed, the Contractor shall have adequate provisions readily available as approved by the Engineer, to protect the concrete from any impending weather conditions. In case precipitation should occur after placing operations have started, the Contractor shall provide ample covering to protect the work. The placing of concrete shall be stopped before the quantity of precipitation is sufficient to cause a flow or to wash the surface.

(b) Cold Weather—General. All concrete shall be maintained at a temperature of not less than fifty (50) degrees Fahrenheit for three (3) days or not less than forty (40) degrees Fahrenheit for seven (7) days. The count of time shall commence immediately upon completion of final placement and vibration. The three (3) fifty (50) degree days need not be consecutive.

One twenty-four (24) hour period shall constitute one (1) day.

The temperature of the concrete shall be determined by placement of thermometers on the concrete surfaces and properly insulating said devices to record the surface temperature of the concrete in accordance with Test

Method No. Nev. T440. Temperatures shall be monitored continuously throughout the total protection time required by this subsection. In case the surface temperature of the concrete falls below forty (40) degrees Fahrenheit for a duration of three (3) hours or more in any twenty-four (24) hour period during the time of temperature protection, the time shall be increased one (1) day for each day this occurs. An absolute minimum temperature of thirty-five (35) degrees Fahrenheit must be maintained for the total time of protection specified in this subsection. Should the temperature of the concrete fall below thirty-five (35) degrees Fahrenheit at any time, damage may occur. The assessment of damage will be determined by the Department and concrete so damaged may require repair or replacement at the option of the Engineer.

The concrete shall have a temperature of at least fifty (50) degrees Fehrenheit and not more than ninety (90) degrees Fahrenheit at the time of placing. (See also subsection 501.03.06, "Machine Mixing.") Heating equipment or methods which alter or prevent the entrainment of the required amount of air in the concrete shall not be used. The equipment shall be capable of heating the materials uniformly. Aggregates and water used for mixing shall not be heated to a temperature exceeding one hundred fifty (150) degrees Fahrenheit. Concrete containing frost or lumps at the time of placing 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 fire. The use of live steam on or through binned aggregates will not be permitted.

Reinforcing steel shall be free of ice, snow or frost during placement of concrete. Concrete shall not be placed on frozen ground.

(c) Low Temperature Protection.

1. General. After the concrete has been placed, means shall be taken to protect the concrete from any impending low temperatures. Methods and materials not hereinafter prescribed may be used if approved by the Engineer and the following requirements adhered to:

a. Materials shall be fire resistant;

b. Materials shall be waterproof; and

c. Materials shall not adhere, abraid or damage the surface of the concrete.

Approval of the Engineer shall not relieve the Contractor from obtaining specification results.

2. Insulating Blankets. Insulating blankets used to protect concrete from low temperatures shall be fire resistant and waterproof. The blankets must be secured and overlapped along the edges and joints to insure that no opening will exist in the protection due to high winds or other adverse conditions. Provisions shall be made to allow the reading of any thermometers placed inside of the protection. When depositing concrete against previously cast concrete, the blanket insulation shall extend at least fourteen (14) inches onto the existing concrete and securely held in place.

3. Low Temperature Protection—Heating and Housing. In order to meet the provisions of articles (a) and (b) of this subsection, the concrete may be protected by applying artificial heat within an enclosure. The enclosure will be constructed with fire resistant material, unless otherwise directed by the Engineer, and shall be subject to his approval. The heating system shall be so arranged as to provide uniform heating, insuring that the concrete farthest from the source of heat is receiving adequate protection without drying the concrete near the source of heat so as to cause shrinkage cracks.

(d) Hot Weather. The maximum temperature of cast-in-place concrete shall not exceed ninety (90) degrees Fahrenheit immediately before placement.

For continuous placement on the deck on continuous steel units, the initial set of the concrete shall be retarded sufficiently to insure that it remains plastic in not less than the span immediately preceding the one being placed.

For both simple and continuous spans, a retardation schedule shall be submitted by the Contractor and approved by the Engineer.

The consistency of the concrete as placed should allow the completion of initial finishing operations without the

addition of water to the surface. When conditions are such that additional moisture is needed for initial finishing, the required water shall be applied to the surface by fog spray only, and shall be held to a minimum amount. Fog spray for this purpose may be applied with hand operated fog equipment, as approved by the Engineer.

From the time of initial strike-off until final finish is complete, the uniformed surfaces of slab concrete shall be protected from rapid evaporation of mixing water from the concrete due to wind, high temperature, low humidity or combinations thereof.

Equipment for fogging, type of evaporation retarder and method of application shall be approved by the Engineer. Equipment shall be portable adapted for intermittent use and operable in the direction of any prevailing wind.

After all finishing operations are complete a final curing membrane shall be applied.

BASIS OF PAYMENT

501.05.01 Payment. Portland cement concrete will be measured and paid for in accordance with the provisions specified in the various sections of these specifications covering construction requiring concrete.

SECTION 502

CONCRETE STRUCTURES

DESCRIPTION

502.01.01 General. This work shall consist of furnishing and placing Portland cement concrete in bridges, culverts, headwalls, retaining walls, barrier rail, and all other types of concrete structures. The concrete structures shall be constructed to the lines and grades given by the Engineer and in accordance with the design shown on the plans; the concrete shall be of the class or classes of concrete designated in the proposal and on the plans and shall conform to the requirements of Section 501, "Portland Cement Concrete." Unless otherwise specified, Class AA concrete shall be used, however, the Contractor may at his option substitute Class DA for Class AA concrete or Class D for Class A concrete.

MATERIALS

502.02.01 General. The materials used shall be those prescribed for the several items which constitute the finished work and shall conform to the requirements for such materials in the following sections:

Portland Cement Concrete	Section 501
Concrete Curing Materials and Admixtures	Section 702
Joint Materials	Section 707
Reinforcement	Section 713
Miscellaneous Metals	Section 712
Elastomeric Bearing Pads	Section 725

Type II "low alkali" cement shall be used in all concrete structures unless otherwise specified.

CONSTRUCTION

502.03.01 Depth of Footings. The elevation of the bottoms of footings, as shown on the plans, shall be considered as approximate only and the Engineer may order, in writing, such changes in dimensions or elevations of

footings as may be necessary to secure a satisfactory foundation.

502.03.02 Forms. All forms shall be built mortar tight and of sufficient rigidity to prevent distortion due to the pressure of the concrete and other loads incidental to the construction operations. Forms previously used shall be thoroughly cleaned of all dirt, mortar, and foreign matter before being reused. Before concrete is poured in forms all inside surfaces of the forms shall be thoroughly coated with an approved coating or form oil. Coating or form oil shall leave no film on the surface of the form that can be absorbed by the concrete. When required by the Engineer and immediately before placing concrete, the forms shall be thoroughly wetted with water.

When requested by the Engineer, the Contractor shall submit detailed plans of form work for examination by the Engineer. If such plans are not satisfactory to the Engineer, the Contractor shall make such changes as may be required, but it is understood that the Engineer's concurrence in the use of the plans as submitted or corrected shall in no way relieve the Contractor of responsibility in obtaining satisfactory results.

The forms shall be substantial and unyielding and shall be so designed that the finished concrete will conform to the proper dimensions and contours. The design of the forms shall take into account the effect of vibration on the concrete as it is placed.

Forms shall be filleted at all exposed corners unless corners are rounded as hereinafter provided. Triangular molding used for fillets shall have two (2) equal sides. In general, the width of the equal sides of moldings shall be three-fourths (¾) inch; for massive work, such as heavy pier copings and columns, the width shall be one and one-half (1½) to two (2) inches. Top edges of walls may be filleted or rounded as hereinafter provided for curbs. Top edges of curbs and slabs shall be rounded with an edging tool to a radius of one-half (½) to three-fourths (¾) inch.

When concrete is placed in excavation, forms shall be provided for all vertical surfaces unless otherwise permitted

by the Engineer. Ports shall be provided in high, thin walls to permit thorough cleaning before placing concrete.

If the forms develop any defects, such as bulging or sagging, after the concrete has been poured, that portion of the work shall be corrected in a manner satisfactory to the Engineer, without additional compensation to the Contractor.

During the erection and after the completion of the forms, they shall be protected in such manner as to preclude shrinkage, warping, curling, and distortion. Form lumber used a second time shall be free from bulge or warp and shall be thoroughly cleaned.

Forms for concrete over or in the vicinity of operating railroads shall be so constructed and placed that standard clearances demanded by the railroad company will be maintained at all times.

The falsework and forms supporting the bottom slab of the superstructure of box girder structures shall remain in place until the curing period of the deck of the superstructure has expired. Unless otherwise permitted by the Engineer, forms for the webs of box girders shall be removed before the deck slab is poured. All interior forms in box girders, except those permitted to remain in place, shall be completely removed and the inside of the box girder cleared of all loose material and swept clean.

Side forms for beams, girders, columns, railing, or other members of the structure wherein the forms do not resist dead load bending may be removed as specified in subsection 502.03.12(c).

The side forms for arch rings, columns and piers shall be removed before the members of the structure which they support are poured or placed, so that the quality of the concrete may be inspected. All such side forms shall be so constructed that they may be removed without disturbing other forms which resist direct load or bending stresses.

The condition of the forms will have a direct bearing upon the amount of finishing required.

Full pieces of forms shall be used and shall extend from the bottom to the top of the wall or post.

Curved surfaces shall be formed to provide a smooth surface without visible breaks.

The forms shall be so constructed that portions, where finishing is required, may be removed without disturbing portions of forms to remain.

Forms shall be of sufficient strength to carry the dead weight of the concrete as a liquid without a deflection in excess of $\frac{L}{270}$, and if such deflection occurs, it shall be sufficient cause for rejection of the work.

Forms for girders and slabs shall be cambered in such amounts as may be required by the Engineer.

Approved form clamps or bolts shall be used to fasten forms. The use of ties consisting of twisted wire loops to hold forms in position during the placing of concrete will not be permitted.

Bolts or form clamps shall be positive in action and shall be of sufficient strength and number to prevent spreading of the forms. They shall be of such type that they can be entirely removed or cut back sufficiently to allow finishing of the concrete.

Plywood for forms shall be "exterior type" of the grade Concrete-Form Exterior, conforming to the specifications of U.S. Department of Transportation, National Bureau of Standards, Commercial Standards, latest edition. Plywood form panels shall be furnished and placed in four (4) foot widths and in uniform lengths of not less than eight (8) feet, except where the diminsions of the member form are less than the specified panel dimensions. Where form panels are attached directly to the studding or joints, the panel shall not be less than five-eighths (⅝) inch thick. Form panels less than five-eighths (⅝) inch thick, otherwise conforming to the requirement herein specified, may be used with continuous backing of one (1) inch nominal thickness surfaced material. All form panels shall be placed in a neat symmetrical pattern subject to the approval of the Engineer. The panel shall be placed with the long dimension perpendicular to the studs.

Plywood for left-in-place forms in box girders may be of

any grade and thickness that will satisfy the other requirements of this subsection.

Fabricated stay-in-place metal forms may be used for concrete floor slabs at the Contractors option when so noted on the plans.

Metal forms to remain in place for concrete floor slabs shall be fabricated from steel conforming to ASTM Designation: A466 (Grade A through E) having a coating class of G165 according to ASTM Designation: A525.

The following criteria shall govern the design of permanent stay-in-place steel bridge deck forms.

The steel forms shall be designed on the basis of dead load of form, reinforcement and plastic concrete plus fifty (50) pounds per square foot for construction loads. The unit working stress in the steel sheet shall be not more than 0.725 of the specified minimum yield strength of the material furnished, but not to exceed thirty-six thousand (36,000) pounds per square inch.

Deflection under the weight of the forms, the plastic concrete and reinforcement shall not exceed one one-eightieth (1/180) of the form span or one-half (½) inch, whichever is less, but in no case shall this loading be less than one hundred twenty (120) PSF total.

The permissible form camber shall be based on the actual dead load condition. Camber shall not be used to compensate for deflection in excess of the foregoing limits.

The design span of the form sheets shall be the clear span of the form plus two (2) inches measured parallel to the form flutes.

Physical design properties shall be computed in accordance with requirements of the American Iron and Steel Institute Specification for the Design of Cold Formed Steel Structural Members, latest published edition.

All reinforcement shall have minimum concrete cover of one (1) inch.

The plan dimensions of both layers of primary deck reinforcement from the top surface of the concrete deck shall be maintained.

Permanent steel bridge deck form shall not be considered

as lateral bracing for compression flanges of supporting structural members.

Permanent steel bridge deck form shall not be used in panels where longitudinal deck construction joints are located between stringers.

Welding shall not be permitted to flanges in tension or to structural steel bridge elements fabricated from non-weldable grades of steel.

Fabricator shop and erection drawings shall be submitted to the Engineer for approval. These plans shall indicate the grade of steel the physical and section properties for all permanent steel bridge deck form sheets and a clear indication of locations where the forms are supported by steel beam flanges subject to tensile stresses.

All forms shall be installed in accordance with detailed fabrication and erection plans submitted to the Engineer for approval. The fabrication plans shall clearly indicate locations where the forms are supported by steel beam flanges subject to tensile stresses.

Form sheets shall not be permitted to rest directly on the top of the stringer or floor beam flanges. Sheets shall be securely fastened to form supports and shall have a minimum bearing length of one (1) inch at each end. Form supports shall be placed in direct contact with the flange of stringer on floor beam. All attachments shall be made by permissible welds, bolts, clips or other approved means. However, welding of form supports to flanges of steels not considered weldable and to portions of flange subject to tensile stresses shall not be permitted. Welding and welds shall be in accordance with the provisions of AWS D2.0 pertaining to fillet welds except that one-eighth (⅛) inch fillet welds will be permitted.

Any permanently exposed form metal where the galvanized coating has been damaged shall be thoroughly cleaned, wire brushed and painted with two coats of zinc oxide-zinc dust primer, Federal Specification TT–P–641d, Type II, no color added, to the satisfaction of the Engineer. Minor heat discoloration in areas of welds need not be touched up.

Transverse construction joints shall be located at the bottom of a flute and one-fourth (¼) inch weep holes shall be field drilled at not more than twelve (12) inches on center along the line of the joint.

Particular emphasis shall be placed on proper vibration of the concrete to avoid honeycomb and voids, especially at construction joints, expansion joints, and valleys and ends of form sheets. Pouring sequences, procedures and mixes shall be approved by the Engineer. Calcium chloride or any other admixture containing chloride salts shall not be used in the concrete placed on permanent steel bridge deck forms.

The Contractor's method of construction shall be carefully observed during all phases of the construction of the bridge deck slab. These phases include installation of the metal forms; location and fastening of the reinforcement; composition of concrete items; mixing procedures, concrete placement and vibration; and finishing of the bridge deck. Should the Engineer determine that the procedures used during the placement of the concrete warrant inspection of the underside of the deck, the Contractor shall remove at least one section of the forms at a location and time selected by the Engineer for each span in the contract. This should be done as soon after placing the concrete as practicable in order to provide visual evidence that the concrete mix and the Contractor's procedures are obtaining the desired results. An additional section shall be removed if the Engineer determines that there has been any change in the concrete mix or in the Contractor's procedures warranting additional inspection.

After the deck concrete has been in place for a minimum period of two (2) days, the concrete shall be tested for soundness and bonding of the forms by sounding with a hammer as directed by the Engineer. If areas of doubtful soundness are disclosed by this procedure, the Contractor will be required to remove the forms from such areas for visual inspection after the pour has attained adequate strength. This removal of the permanent steel bridge deck forms shall be at no cost to the project.

At locations where sections of the forms are removed, the Contractor will not be required to replace the forms, but the adjacent metal forms and supports shall be repaired to present a neat appearance and assure their satisfactory retention. As soon as the form is removed, the concrete surfaces will be examined for cavities, honeycombing and other defects. If irregularities are found, and it is determined by the Engineer that these irregularities do not justify rejection of the work, the concrete shall be repaired as the Engineer may direct and shall be given an Ordinary Surface Finish. If the concrete where the form is removed is unsatisfactory, additional forms, as necessary, shall be removed to inspect and repair the slab, and the Contractor's methods of construction shall be modified as required to obtain satisfactory concrete in the slab. All unsatisfactory concrete shall be removed or repaired as directed by the Engineer.

The amount of sounding and form removal may be moderated, at the Engineer's discretion, after a substantial amount of slab has been constructed and inspected, if the Contractor's methods of construction and the results of the inspections as outlined above indicate that sound concrete is being obtained throughout the slabs.

502.03.03 Falsework. Detailed plans of the falsework or centering shall be furnished by the Contractor to the Engineer in accordance with subsection 105.02, "Plans and Working Drawings," for any structures having a clear cast-in-place span of twenty (20) feet or over or any cast-in-place structure over traffic. If such plans are not satisfactory to the Engineer, the Contractor shall make such changes in them as may be required.

In addition to the detailed drawings of the falsework or centering which are to be furnished the Engineer as specified herein, the Contractor shall also furnish the Engineer with a copy of falsework or centering design calculations.

All falsework or centering shall be designed and constructed to provide the necessary rigidity and to support the loads. Falsework for the support of superstructures for box girder spans shall be designed to support the loads that

would be superimposed were the entire superstructure poured at one time.

For designing falsework and centering, a weight of one hundred fifty (150) pounds per cubic foot shall be assumed for green concrete (one hundred twenty (120) pounds for lightweight concrete) and an allowance of not less than twenty-five (25) pounds per cubic foot for forms, live load, and impact. Falsework or forms shall be constructed to produce in the finished structure the lines and grades indicated on the plans. Suitable screw jacks or wedges in pairs shall be used in connection with falsework or centering to set the forms to grade or cambered as shown on the plans, or to take up any settlement in the form work either before or during the placing of concrete. Excessive use of blocking and shims shall be cause for rejection of the falsework. Falsework failures shall become the sole responsibility of the Contractor.

Immediately prior to placing bridge deck or slab concrete, the Contractor shall check all falsework and wedges or jacks and shall make all necessary adjustments. Care shall be exercised to insure that settlement and deflection due to the added weight of the deck or slab concrete will be a minimum. Suitable means such as telltales shall be provided by the Contractor to permit ready measurement of settlement and deflection as it occurs.

Falsework or centering shall be founded on a solid footing safe from undermining and protected from softening. Falsework which cannot be founded on a satisfactory footing shall be supported on piling which will be spaced, driven, and removed in a manner approved by the Engineer.

Arch span shall be removed uniformly and gradually beginning at the crown and working toward the spring, to permit the arch to take its load slowly and evenly. Centering for bridges having two or more adjacent arch spans shall be struck simultaneously.

Falsework supporting the main carrying members of all continuous structures shall not be removed from any span until all spans between expansion joints are cured. Falsework and forms left in place in the cells of box girders shall

not exceed twelve (12) pounds per square foot of deck. All supports between the top and bottom slabs in the cells of box girders shall be water soaked for a period of not less than forty-eight (48) hours.

502.03.04 Reinforcement. Reinforcing shall be furnished and placed as shown on the plans and in accordance with the applicable provisions of Section 505, "Reinforcing Steel," of these specifications.

502.03.05 Cofferdams and Cribs. Cofferdams for foundation construction shall be carried well below the bottom of the footings and shall be well braced and as watertight as practical. The interior dimensions of cofferdams shall be such as to provide sufficient clearance for constructing forms and, when no seal is placed, to permit pumping outside the forms.

The Contractor shall submit for approval drawings showing proposed method of construction of cofferdams or cribs in accordance with subsection 105.02, "Plans and Working Drawings." Approval of such drawings shall in no way relieve the Contractor of his responsibility under the contract for the successful completion of the improvement. Cofferdam construction shall not start before the submitted drawings are approved and returned.

After the completion of the substructure, the cofferdams with all sheeting and bracing shall be removed to one (1) foot below the stream bed, by the Contractor, and such removal shall be performed in such a manner as not to disturb or mar the finished concrete foundation. Removal of cofferdams, sheeting, and bracing shall be considered subsidiary to other pay items of work and no further payment will be made therefor.

502.03.06 Pumping Water. Pumping from the interior of any foundation enclosure shall be done in such a manner as to preclude the possibility of the movement of water through any fresh concrete. No pumping will be permitted during the placing of concrete or for a period of at least twenty-four (24) hours thereafter, unless it be done

from a suitable pump separated from the concrete work by a watertight wall or other effective means.

Pumping to unwater a sealed cofferdam shall not commence until the seal has set sufficiently to withstand the hydrostatic pressure.

502.03.07 Mixing Concrete. All concrete shall be mixed and proportioned as specified in Section 501, "Portland Cement Concrete."

502.03.08 Handling and Placing Concrete. (a) General. In preparation for the placing of concrete, all sawdust, chips, and other construction debris, and extraneous matter shall be removed from the interior of forms. Struts, stays, and braces, serving temporarily to hold the forms in correct shape and alignment, pending the placing of concrete at their locations, shall be removed when the concrete placing has reached an elevation rendering their service unnecessary. These temporary members shall be entirely removed from the forms and not buried in the concrete.

No concrete shall be used which does not reach its final position in the forms within the time stipulated under Section 501, "Portland Cement Concrete."

Surfaces on which concrete is to be placed shall be thoroughly moistened with water immediately before placing concrete.

Concrete shall be placed so as to avoid segregation of the material and the displacement of the reinforcement. The use of long troughs, chutes, and pipes for conveying concrete from the mixer to the forms shall be permitted only on written authorization of the Engineer. In case an inferior quality of concrete is produced by the use of such conveyors, the Engineer may order discontinuance of their use and the substitution of a satisfactory method of placing.

Open troughs and chutes shall be of metal or metal lined; where steep slopes are required, the chutes shall be equipped with baffles or be in short lengths that reverse the direction of movement.

All chutes, troughs, and pipes shall be kept clean and free from coatings of hardened concrete by thoroughly

flushing with water after each run; water used for flushing shall be discharged clear of the structure.

When placing operations would involve dropping the concrete more than five (5) feet, it shall be deposited through sheet metal or other approved pipes, except when placing concrete for thin vertical walls less than fifteen (15) inches thick, double belting may be used in lieu of adjustable pipes or elephant trunks. As far as practicable, the pipes shall be kept full of concrete during placing and their lower ends shall be kept buried in the newly placed concrete. After initial set of the concrete, the forms shall not be jarred and no strain shall be placed on the ends of reinforcement bars which project.

All concrete placed in concrete structures, except tremie steel concrete, shall be compacted by means of mechanical vibration subject to the following provisions:

1. The number of vibrators employed shall be ample to consolidate incoming concrete to a proper degree within fifteen (15) minutes after it is deposited in the forms. In all cases, at least two vibrators shall be available at the site of the structures in which more than twenty-five (25) cubic yards is being placed.

2. The vibration shall be internal unless special authorization of other methods is given by the Engineer or as provided herein.

3. Vibrators shall be capable of transmitting vibration to the concrete at frequencies of not less than four thousand five hundred (4,500) impulses per minute.

4. The intensity of vibration shall be such as to visibly affect a mass of concrete of one (1) inch slump over a radius of at least eighteen (18) inches.

5. Vibrators shall be manipulated so as to thoroughly work the concrete around the reinforcement and imbedded fixtures and into the corners and angles of the forms.

Vibration shall be applied at the point of deposit and in the area of freshly deposited concrete. The vibrators shall be inserted and withdrawn out of the concrete slowly. The vibration shall be of sufficient duration and intensity

to thoroughly compact the concrete, but shall not be continued at any one point to the extent that localized areas of grout are formed.

Application of vibrators shall be at points uniformly spaced and not farther apart than twice the radius over which the vibration is visibly effective.

6. Vibration shall not be applied directly or through the reinforcement to sections or layers of concrete which have hardened to the degree that the concrete ceases to be plastic under vibration. It shall not be used to make concrete flow in the forms over distances so great as to cause segregation, and vibrators shall not be used to transport concrete in the forms.

7. Vibration shall be supplemented by such spading as is necessary to insure smooth surfaces and dense concrete along form surfaces and in corners and locations impossible to reach with the vibrators.

8. The provisions of this article shall apply to the filler concrete for steel grid floor except that the vibrator shall be applied to the steel.

Immediately following the discontinuance of placing concrete, all accumulations of mortar splashed upon the reinforcement steel and the surfaces of forms shall be removed. Dried mortar chips and dust shall not be puddled into the unset concrete. If the accumulations are not removed prior to the concrete becoming set, care shall be exercised not to injure or break the concrete-steel bond at and near the surface of the concrete while cleaning the reinforcement steel.

(b) Culverts. In general, the base slab or footings of box culverts shall be placed and allowed to set before the remainder of the culvert is constructed. In this case, suitable provision shall be made for bonding the sidewalls to the culvert base.

Before concrete is placed in the sidewalls, the culvert footing shall be thoroughly cleaned of all shavings, sticks, sawdust, or other extraneous material and the surface carefully chipped and roughened in accordance with the method of bonding construction joints as specified therein.

Walls and top slab shall not be constructed as a monolith on box culverts where the depth of pour below the bottom of the top slab exceeds four (4) feet unless approved in writing by the Engineer. When this method of construction is used any necessary construction joints shall be vertical and at right angles to the axis of the culvert.

When walls are poured separately, in non-rigid frame box culverts, the concrete in the walls shall be placed and allowed to set a minimum of two (2) hours before the top slab is placed.

When walls are poured separately, in rigid frame box culverts, the concrete in the walls shall be placed and allowed to set a minimum of twelve (12) hours before the top slab is placed.

Each wing wall shall be constructed, if possible, as a monolith. Construction joints, where unavoidable, shall be horizontal and so located that no joint will be visible in the exposed face of the wing wall above the ground line.

(c) Girders, Slabs, and Columns. When the height of any point of web is more than three (3) feet from the bottom of the top slab to bottom of the web for "T" beams, or to construction joint for box girders, the top slab shall be poured independent of webs.

Concrete in slab spans shall be placed in one continuous operation for each span unless otherwise specified.

Concrete in columns shall be placed in one continuous operation unless otherwise specified. The concrete shall be allowed to set at least twelve (12) hours before the succeeding pour is started.

Before pouring concrete for superstructure, the forms on base of columns shall be exposed sufficiently to determine the character of the concrete in the columns.

502.03.09 Pumping Concrete. Placement of concrete by pumping will not be permitted unless authorized in writing by the Engineer. The equipment shall be so arranged that no vibrations result which might damage freshly placed concrete.

Where concrete is conveyed and placed by mechanically applied pressure the equipment shall be suitable in kind

and adequate in capacity for the work. The operation of the pump shall be such that a continuous stream of concrete without air pockets is produced. When pumping is completed, the concrete remaining in the pipeline, if it is to be used, shall be ejected in such a manner that there will be no contamination of the concrete or separation of the ingredients. After this operation, the entire equipment shall be thoroughly cleaned.

The use of aluminum conduit for concrete pumping is prohibited.

502.03.10 Concrete Deposited Under Water. If conditions render it impossible or inadvisable, in the opinion of the Engineer, to dewater excavations before placing concrete, the Contractor shall deposit under water, by means of a tremie or underwater bottom dump bucket, a seal course of concrete of sufficient thickness to thoroughly seal the cofferdam. The concrete shall be carefully placed in a compact mass and shall not be disturbed after being deposited. Still water shall be maintained at the point of deposit.

The use of an aluminum tremie for placing concrete is prohibited.

A tremie shall consist of a watertight tube having a diameter of not less than ten (10) inches with a hopper at the top. The tube shall be equipped with a device that will prevent water from entering the tube while charging the tube with concrete. The tremie shall be supported so as to permit free movement of the discharge end over the entire top surface of the work and to permit rapid lowering when necessary to retard or stop the flow of concrete. 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 contain sufficient concrete to prevent any water entry. When a batch is dumped into the hopper, the flow of concrete shall be induced by slightly raising the discharge end, always keeping it in the deposited concrete. The flow shall be continuous until the work is completed

and the resulting concrete seal shall be monolithic and homogeneous.

The underwater bucket shall have an open top and the bottom doors shall open freely and outward when tripped. The bucket shall be completely filled and slowly lowered to avoid backwash and shall not be dumped until it rests on the surface upon which the concrete is to be deposited. After discharge, the bucket shall be raised slowly until well above the concrete.

Concrete deposited in water shall be Class A or Class AA with ten (10) percent extra cement added. The exact thickness of the seal will depend upon the hydrostatic head, bond and spacing of piles, size of cofferdam, and other related factors, but in no case shall the seal be less than two (2) feet in thickness, unless otherwise shown on the plans. Before dewatering, the concrete in the seal shall be allowed to cure for not less than five (5) days after placing.

If a seal which is to withstand hydrostatic pressure is placed in water having a temperature below forty-five (45) degrees Fahrenheit, the curing time before dewatering shall be increased. Periods of time during which the temperature of the water has been continuously below thirty-eight (38) degrees Fahrenheit shall not be considered as curing time. After sufficient time has elapsed to insure adequate strength in the concrete seal, the cofferdam shall be dewatered and the top of the concrete cleaned of all scum, laitance, and sediment. Before fresh concrete is deposited, local high spots shall be removed as necessary to provide proper clearance for reinforcing steel.

502.03.11 Construction Joints. Construction joints shall be made only where located on the plans or shown in the pouring schedule, unless otherwise approved by the Engineer.

Construction joints where the placing of concrete is delayed until the concrete has taken its initial set and for which no expansion is provided, shall be planned in advance and shall be subject to approval by the Engineer. The placing of concrete shall be continuous from joint to

joint. These joints shall be perpendicular to the principal lines of stress and, in general, located at points of minimum shear. Only joints shown on the plans will be permitted in a cantilevered member. Horizontal joints at piers and abutments, except where specified, shall generally be avoided, and when used shall not be located within two (2) feet of the normal water level.

Unless otherwise specified, construction joints shall be struck off but not troweled.

When making a horizontal construction joint, care shall be taken to have the concrete as dry as possible, and any excess water or creamy material shall be drawn off before the concrete sets. On all exposed surfaces, the line of the proposed joint shall be made truly straight by taking a temporary straightedge on the inside of the form and pouring the concrete so that it will set flush with the edge as provided.

To avoid visible joints as far as possible upon exposed faces the top surfaces of the concrete adjacent to the forms shall be smoothed with a trowel. Where a "feather edge" might be produced at a construction joint, as in the sloped top surface of a wing wall, an insert form work shall be used to produce a blocked out portion in the preceding layer which shall produce an edge thickness of not less than six (6) inches in the succeeding layer.

When the work is unexpectedly interrupted by breakdowns, storm, or other causes, and the concrete as placed would produce an improper construction joint, the Contractor shall either rearrange the freshly deposited concrete, or continue by hand mixing, if necessary, until a suitable arrangement is made for a construction joint. When such a joint occurs at a section on which there is shearing stress, he shall provide adequate mechanical bond across the joint by inserting reinforcing steel, or by some other means satisfactory to the Engineer, which will prevent a plane of weakness.

In resuming work, the surface of the concrete previously placed shall be thoroughly cleaned of dirt, scum, laitance, or other soft or porous materials by one of the following methods:

(a) Concrete surface of fresh concrete (not more than eight (8) hours after placement) shall be cleaned with air and water jets in such a manner that the surface is thoroughly cleaned and the aggregate is not loosened.

(b) Hardened concrete surface (more than eight (8) hours after placement) shall be cleaned by abrasive blast methods in such a manner that the aggregate is not loosened or the edges of the concrete shattered.

The surface of the joint shall be thoroughly washed with clean water and the forms tightened to close contact with the previously placed work, after which the concreting may proceed. The surface of the joint shall be wet just prior to placing new concrete.

502.03.12 Removal of Falsework and Forms.

(a) General.

1. Method of form removal likely to cause overstressing of the concrete shall not be used. Forms and their supports shall not be removed without the approval of the Engineer. Supports shall be removed in such a manner as to permit the concrete to uniformly and gradually take the stresses due to its own weight.

2. Compressive strengths will be determined by Test Methods Nos. Nev. T475 and T428 and will be considered information tests only and not acceptance tests as described in subsection 501.02.04, "Concrete Making Properties."

3. Attention is directed to subsection 501.03.09, "Curing."

(b) Falsework. Where stresses will be placed on the concrete in arch centers, centering under beams and girders, and in floor slabs, falsework shall not be removed until the concrete has reached an age of ten (10) days and it has reached seventy-five (75) percent of the required twenty-eight (28) day compressive strength.

In the event of cold weather, the ten (10) day time requirements shall be increased one (1) day for every day the curing time is increased as prescribed in subsection 501.03.10(b), "Cold Weather—General."

In case the concrete does not reach the desired strength

within the time specified, the Engineer shall determine when the strength is adequate to allow removal of falsework.

Form removal and replacement with shoring will not be permitted.

(c) Forms. Forms on parapets and curbs shall not be removed until concrete has set sufficiently to prevent distorting or cracking.

Forms for columns, walls, sides of beams, girders and all other parts which are not subjected to stress shall not be removed until the concrete has reached a minimum age of twelve (12) hours.

Forms which are subjected to stresses shall not be removed until the requirements of (b) above have been satisfied, unless otherwise approved by the Engineer.

502.03.13 Expansion and Fixed Joints and Bearings. All joints shall be constructed according to details shown on the plans and the following:

(a) Open Joints. Open joints shall be placed in the locations shown on the plans and shall be constructed by the insertion and subsequent removal of a wood strip, metal plate, or other approved material. The insertion and removal of the template shall be accomplished without chipping or breaking the corners of the concrete. Reinforcement shall not extend across an open joint unless so specified on the plans.

(b) Filled Joints. Poured expansion joints shall be constructed similar to open joints. When premolded types are specified, the filler shall be placed in correct position as the concrete on one side of the joint is placed. When the form is removed, the concrete on the other side shall be placed.

(c) Steel Joints. The plates, angles, or other structural shapes shall be accurately shaped, at the shop, to conform to the section of the concrete floor. The fabrication and painting shall conform to the requirements of these specifications covering those items. When called for on the plans or in the special provisions the materials shall be galvanized in lieu of painting. Care shall be taken to insure

that the surface in the finished plane is true and free of warping. Positive methods shall be employed in placing the joints to keep them in correct position during the placing of the concrete. The opening at expansion joints shall be that designated on the plans at normal temperature, and care shall be taken to avoid impairment of the clearance in any manner.

(d) Waterstops. Waterstops shall be furnished and installed in accordance with the details shown on the plans. The edge of the waterstop shall be supported in a manner satisfactory to the Engineer.

Waterstops shall be manufactured from either natural rubber, synthetic rubber, or polyvinyl chloride (PVC), at the option of the Contractor.

Waterstops shall be manufactured with an integral cross section which shall be uniform within $\pm 1/8$ inch in width, and the web thickness or bulb diameter, within $+1/16$ inch and $-1/32$ inch. No splices will be permitted in straight strips. Strips and special connections pieces shall be well cured in a manner such that any cross section shall be dense, homogeneous, and free from all porosity. All junctions in the special connection pieces shall be full molded. During the vulcanizing period the joint shall be securely held by suitable clamps. The material at the splices shall be dense and homogeneous throughout the cross section.

Field splices for either natural or synthetic rubber waterstops shall be either vulcanized; mechanical, using stainless steel parts; or made with a rubber splicing union of the same stock as the waterstop, at the option of the Contractor. All finished splices shall have a full size tensile strength of 600 $\frac{\text{(width in inches)}}{6}$ pounds.

Field splices for polyvinyl chloride waterstops shall be formed by heat sealing the adjacent surfaces in accordance with the manufacturer's recommendations. A thermostatically controlled electric source of heat shall be used to make all splices. The heat shall be sufficient to melt but not char the plastic.

Waterstops, when being installed, shall be cut and

spliced at changes in direction as may be necessary to avoid buckling or distortion of the web or flange.

(e) Bearing Devices. Bearing plates, bars, rockers, assemblies, and other expansion or fixed devices shall be constructed in accordance with the details shown on the plans and shall be hot-dip galvanized after fabrication in accordance with Section 715, "Galvanizing." Structural steel and cast steel shall conform to the provisions in Section 506, "Steel Structures," for those items.

The bearing plates shall be set level and the rockers or other expansion devices shall be set to conform to the temperature at the time of erection or to the setting specified.

When bearing assemblies or masonry plates are shown on the plans to be placed (not embedded) directly on concrete, the concrete bearing area shall be constructed slightly above grade and shall be finished by grinding or other approved means to a true level plane which shall not vary perceptibly from a straightedge placed in any direction across the area. The finished plane shall not vary more than one-eighth (⅛) inch from the elevation shown on the plans.

When elastomeric bearing pads, elastic bearing pads, preformed fabric pads, or asbestos sheet packing are shown on the plans, the concrete surfaces on which pads or packing are to be placed shall be wood float finished to a level plane which shall not vary more than one-sixteenth (1/16) inch from a straightedge placed in any direction across the area. The finished plane shall not vary more than one-eighth (⅛) inch from the elevation shown on the plans.

Where bearing assemblies or masonry plates are shown on the plans to be placed on grout pads, they shall be placed in accordance with the provisions in subsection 506.03.28, "Bearing and Anchorage."

(f) Elastomeric Bearing Pads. Pads over one (1) inch in thickness shall be laminated. Laminated pads shall consist of alternate laminations of elastomer and metal or elastomer and fabric bonded together.

All elastomeric bearing pads shall be fifty (50) durometer.

Pads shall be installed where designated on the plans.

502.03.14 Curing. Curing of formed concrete shall conform to the requirements of subsection 501.03.09, "Curing," and attention is directed thereto.

502.03.15 Patching. After removal of forms, all metal ties except those to be used to a future forming shall be cut back and patched. Honeycomb shall be removed and patched. When honeycomb is determined by the Engineer to be excessive, it shall be sufficient cause for rejection of all or a part of the structure.

Loose or broken material shall be chipped away until a dense, uniform surface exposing solid coarse aggregate is obtained. Feather edges shall be cut away to form a face perpendicular to the surface being patched. All surfaces of the cavity shall be thoroughly saturated with water. Contact surfaces shall be coated with an approved bonding agent. Bonding agent may be mixed with mortar in lieu of coating the contact surfaces.

Patching mortar shall consist of one part cement and three parts sand. White cement or other approved tinting materials shall be used on all surfaces where an "ordinary finish" is final. For patching large or deep areas, coarse aggregate shall be added to the patching mortar.

The patching mortar shall be thoroughly tamped into place. Mortar may be placed pneumatically when approved by the Engineer. The surface of the mortar shall be floated with a wooden float before initial set takes place. The patch shall present a neat and workmanlike appearance.

The patched surface shall be cured by one of the methods described in subsection 501.03.09, "Curing."

Patching is the only treatment required for those portions of the structure below ground.

502.03.16 Finish of Horizontal Surfaces. Concrete bridge decks shall be struck off with a template immediately after pouring to provide the proper crown and shall be

finished to a smooth even surface by means of both longitudinal and transverse wooden floats, or other suitable means. When a transversely broomed finish is used, the allowable variations noted herein shall be independent of the depth of the broom marks. No variations will be permitted that will tend to prevent complete drainage on all parts of the deck. The surface shall be corrected by grinding off the high spots, or other approved method, as may be required in order to conform to these limits. An edging tool shall be used at expansion joints and deck edges not armored.

Approach slabs to concrete bridges shall be finished to the tolerances specified for bridge decks.

FINISHING BRIDGE DECKS

A smooth riding surface of uniform texture, true to the required grade and cross section, shall be obtained on all bridge roadway decks. The Contractor may use hand tools, or finishing machines or a combination of both, conforming to the requirements specified herein for finishing bridge roadway deck concrete.

Finishing of concrete placed in bridge decks shall consist essentially of striking off the surface of the concrete as placed and floating with longitudinal floats the surface so struck off.

The placing of concrete in bridge roadway decks will not be permitted until the Engineer is satisfied that the rate of producing and placing concrete will be sufficient to complete the proposed placing and finishing operations within the scheduled time, that experienced finishing machine operators and concrete finishers are employed to finish the deck, that fogging equipment and all necessary finishing tools and equipment are on hand at the site of the work and in satisfactory condition for use. Finishing machines shall be set up sufficiently in advance of use to permit inspection by the Engineer during the daylight hours before each pour.

The adjustment and operation of deck finishing machines shall be verified by moving the machine over the full length of the deck section to be placed and traversing the float completely across all end bulkheads before placement of concrete is begun.

Unless adequate lighting facilities are provided by the Contractor, the placing of concrete in bridge decks shall cease at such time that finishing operations can be completed during daylight hours.

Supports for rails for the support of finishing machines shall be completely in place and firmly secured for such a length that will insure continuity of operations for concrete placement before placing of concrete will be permitted. Rails for finishing machines shall extend beyond both ends of the length of concrete placement to a distance that will permit the float of the finishing machine to fully clear the concrete to be placed. Rails shall be adjustable for elevation and shall be set to elevations, with allowance for anticipated settlement, camber, and deflection of falsework, as required to obtain a bridge roadway deck true to the required grade and cross section. Rails shall be of a type and shall be so installed that no springing or deflection will occur under the weight of the finishing equipment, and shall be so located that finishing equipment may operate without interruption over the entire bridge roadway deck being finished. Rails shall be adjusted as necessary to correct for unanticipated settlement or deflection which may occur during finishing operations.

Should settlement or other unanticipated events occur, which in the opinion of the Engineer would prevent obtaining a bridge deck conforming to the requirements of these specifications, placing of deck concrete shall be discontinued until corrective measures satisfactory to the Engineer are provided. In the event satisfactory measures are not provided prior to initial set of the concrete in the affected area, the placing of concrete shall be discontinued and a bulkhead installed at a location determined by the Engineer. All concrete in place beyond the bulkhead shall be removed.

Unless otherwise permitted by the Engineer, bridge deck concrete shall be placed and struck off in a uniform heading approximately parallel to the bridge pier or bent caps. The rate of placing concrete shall be limited to that which can be finished before the beginning of initial set, except that concrete for the deck surface shall not be placed more

than ten (10) feet ahead of strike off. Strike off and consolidation shall be completed within fifteen (15) minutes after the concrete is in place.

After the concrete has been placed and consolidated, the surface of the concrete shall be carefully struck off by means of a self-propelled mechanical finishing machine operating on rails.

Following strike off, longitudinal floating of the concrete shall be performed by means of a hand-operated pipe float or float board or a finishing machine equipped with a longitudinal float. The longitudinal float on the finishing machine shall have a length of not less than eight (8) feet nor more than twelve (12) feet.

Finishing machines used for strike off having a wheel base six (6) feet or less shall be followed by hand-operated longitudinal floating. All the provisions in this section pertaining to hand-operated float boards shall apply to float boards when used for longitudinal floating.

Longitudinal floats, either hand-operated or machine-operated, shall be used with the long axis of the float parallel to the centerline of the bridge roadway. The float shall be operated with a combined longitudinal and transverse motion planing off the high areas and floating the material removed into the low areas. Each pass of the float shall lap the previous pass by one-half the length of the float. Floating shall be continued until a smooth riding surface is obtained.

In advance of curing operations, the surface of the concrete shall be textured by brooming with a stiff bristled broom or by other suitable devices which will result in uniform scoring. Brooming shall be performed transversely from finishing bridges.

Hand-operated float boards shall be from twelve (12) feet to sixteen (16) feet long, ribbed and trussed as necessary to provide a rigid float and shall be equipped with adjustable handles at each end. The float shall be wood, not less than one (1) inch thick and from four (4) inches to eight (8) inches wide. Adjusting screws spaced not to exceed twenty-four (24) inches on centers shall be provided

between the float and the rib. The float board shall be maintained free of twist and true at all times.

Hand-operated float boards shall be operated from transverse finishing bridges. The finishing bridges shall span completely the roadway area being floated and a sufficient number of finishing bridges shall be provided to permit operation of the floats without undue delay. Not less than two transverse finishing bridges shall be provided when hand-operated float boards are used. When a finishing machine is used for longitudinal floating, one finishing bridge equivalent to the transverse finishing bridge specified herein shall be furnished for use by the Engineer.

All finishing bridges shall be of rigid construction and shall be free of wobble and springing when used by the operators of longitudinal floats and shall be easily moved.

Fogging equipment to be furnished shall be capable of applying water to the concrete in the form of a fine fog mist in sufficient quantity to curb the effects of rapid evaporation of mixing water from the concrete on the deck resulting from wind, high temperature or low humidity, or a combination of these factors. The fog mist shall be applied at the times and in the manner directed by the Engineer.

Immediately following completion of the deck finishing operations, the concrete in the deck shall be cured as specified in subsection 501.03.09, "Curing."

The finished surface of the concrete shall be tested by means of a straightedge twelve (12) feet long. The surface shall not vary more than 0.01 foot from the lower edge of the straightedge. All high areas in the hardened surface in excess of 0.01 foot as indicated by testing shall be removed by abrasive means. After grinding by abrasive means has been performed, the surface of the concrete shall not be smooth or polished but shall have a surface texture satisfactory to the Engineer. Ground areas shall be of uniform texture and shall present neat and approximately rectangular patterns.

Where the concrete of the bridge deck is to be covered by bituminous surfacing, earth, or other cover, one (1) inch or more in thickness, the surface of the concrete shall not

vary more than 0.03 foot from the lower edge of the twelve (12) foot straightedge.

Bridge deck surfaces under the curbs, railings, and sidewalks shall be struck off to the same plane as the roadway and left undisturbed when future widening is shown on the plans.

The top and face of the finished parapet and curb shall be true and straight, and the top surface shall be of uniform width, free from humps, sags, or other irregularities. When a straightedge twelve (12) feet long is laid on top of the face of the curb or on the face of the parapet, the surface shall not vary more than one-eighth (⅛) inch from the theoretical grade or alignment in twelve (12) feet, except that proper allowance shall be made for curves and camber.

502.03.17 Formed Surfaces Requiring Finishing. Surfaces requiring a "fine surface finish" (FSF) will be noted on the plans. All exposed surfaces of structures not requiring a fine surface finish shall be given an ordinary surface finish unless otherwise specified on the plans or in these specifications. Only exposed surfaces of structures, to one (1) foot below finished grade, will require finishing (ordinary or fine).

The inside of culvert barrels, except for a horizontal distance into the ends equal to the height when the end of culvert may be seen from a traveled way, will not be defined as an exposed surface.

502.03.18 Ordinary Surface Finish. The surface shall have all holes left by form ties and all other holes one-fourth (¼) inch or more in largest diameter repaired in accordance with subsection 502.03.15, "Patching." The surface shall be true and even, free from stone pockets, depressions or projections beyond the surface. All fins and projections shall be knocked off or ground flush. Offsets greater than one-eighth (⅛) inch shall be filled or tapered back to present a smooth appearance. All patches shall be of such color and appearance that will blend with the surrounding surface.

502.03.19 Fine Surface Finish. Where it is indicated on the plans that a fine surface finish is required, the finish shall conform to the requirements for "Bonded Grout Finish" as hereinafter set forth. Before the finish is applied, the surface shall be true and even and free from stone pockets, depressions or projections beyond the surface. All fins and projections shall be knocked off or ground flush. Offsets greater than one-eighth (⅛) inch shall be filled or tapered back to present a smooth appearance. All holes one-fourth (¼) inch or more in largest diameter shall be patched in accordance with subsection 502.03.15, "Patching."

Bonded Grout Finish. This finish shall be an application of grout consisting of sand and other pigments and mineral fillers combined with a suitable binder. The sand shall pass a No. 30 sieve. The binder shall be either an epoxy, acrylic, vinyl, or phenolic resin. This mixture may be thinned by not more than twenty-five (25) percent water by volume.

The finish shall be of such consistency and composition that it will provide a uniform appearance in color and texture when applied as specified below, and shall meet the requirements set forth in Section 727.

At least thirty (30) days in advance of placing bonded grout finish, the Contractor shall furnish the Engineer a quart sample or larger, of the completed mixture for testing. The Contractor shall also furnish two certificates, issued by the manufacturer, certifying that the product complies with the specifications. Said certificates shall be delivered to the Engineer at least thirty (30) days in advance of placing the material.

The grout shall be applied by spray, using conventional spray equipment with a one-fourth (¼) inch round spray head. Material is supplied by either a surge pump with a twelve (12) to one (1) ratio or an auger type pump, with air pressure sufficient to achieve uniform texture. Worn spray heads shall be replaced as required to achieve a uniform finish.

Application shall be at the rate of twenty-four to forty (25–40) square feet per gallon.

The finished surface shall present a uniform appearance.

Color of fine surface finish to be applied will be as shown on the plans. Where the color of the fine surface finish that is to be applied is not indicated on the plans it shall conform to Federal Color No. 37875 as shown in Table I of Federal Standard No. 595.

Surfaces of concrete shall be thoroughly cleaned just before applying fine surface finish. This may be accomplished by:

(a) Application of a ten (10) percent solution of muriatic acid or a twenty-five (25) percent zinc sulfate solution, which shall be applied as to completely remove any oily film and to lightly etch the surface, or

(b) Thorough cleaning by approved abrasive as required to remove all oily film.

Following cleaning, the surface shall be thoroughly rinsed with clean water. Surface to be finished need not be completely dry, but may be damp, prior to application of finish.

CAUTION: Do not apply finish unless temperature is at least forty (40) degrees Fahrenheit and is rising. Application shall be stopped if temperature is forty (40) degrees Fahrenheit and is dropping.

502.03.20 Live Loads. Live loads such as traffic or superimposed earth loads shall not be allowed on the structure until concrete has reached an age of fourteen (14) days and it has reached the twenty-eight (28) day strength required. Live loads may be allowed on the structure when the concrete has reached an age of eight (8) days and the twenty-eight (28) day strength required in cases where Type III (high-early strength) cement is used with the approval of the Engineer. Approach slabs shall be treated as concrete paving under Section 409.

In the event of cold weather, the above specified time requirement shall be increased one (1) day for every day the curing time is increased as prescribed in the subsection 501.03.10(b), "Cold Weather—General."

In case the concrete does not reach the desired strength

within the time specified, the Engineer shall determine when the strength is adequate to carry live loads.

METHOD OF MEASUREMENT

502.04.01 Measurement. The estimated quantity shown on the plans, plus or minus quantities covered by approved changes will be the quantity used for payment. The Engineer or the Contractor may however, request a final measurement. The Contractor's request for final measurement shall be in writing. Final measurement will be made according to the dimensions shown on the plans plus or minus approved changes and quantities derived therefrom will be the quantity used for payment. Each class of concrete will be considered separately.

Such box culverts, bridges, and such other miscellaneous concrete structures that are identified on the plans or in the special provisions as major structures will be paid for at the contract unit price bid for "Class ..... Concrete (Major)," or "Class ..... Concrete Modified (Major)," as the case may be.

Such pipe headwalls, endwalls, drop inlets, and such other miscellaneous concrete structures that are identified on the plans or in the special provisions as minor structures will be paid for at the contract unit price bid for "Class ..... Concrete (Minor)."

In the event any class of Portland cement concrete is placed and is shown by test to be below the specified twenty-eight (28) day compressive strength, a determination shall be made by the Engineer as to whether the concrete shall be removed and replaced or allowed to remain in place. This determination shall be based on an evaluation of the durability and other qualities of the concrete necessary to the integrity of the structure. If the concrete is allowed to remain in place, it is agreed by the parties to the contract that the Department will deduct from money due, or to become due the Contractor from the Department, a percentage of the contract unit bid price. This deduction shall be considered to be liquidated damages and shall be at a rate of five (5) percent of the contract unit bid price for each fifty (50) p.s.i. or portion

thereof below the specified minimum compressive strength, to a maximum of fifty (50) percent, as set forth in the following example for the class of concrete shown:

Specified 28 Day Compressive Strength—p.s.i.	Liquidated Damage (Per Unit Bid Price), Percent
3,000	0
2,999–2,950	5
2,949–2,900	10
2,899–2,850	15
2,849–2,800	20
2,799–2,750	25
2,749–2,700	30
2,699–2,650	35
2,649–2,600	40
2,599–2,550	45
Below 2,550	50

The reduced price shall apply to all concrete represented by the strength tests below the specified minimum compressive strength.

When a compressive strength test falls below the specified twenty-eight (28) day compressive strength, the Department may determine that an alternate strength test is required or the Contractor may request such a test. When the Department determines that an alternate strength test is required, the Contractor will not be liable for the cost of such test. In case the Department has not determined that an alternate strength test is necessary and the Contractor elects to have an alternate strength test made, the Department will then make such a test; however, should this test fail to indicate that the twenty-eight (28) day compressive strength requirements have been met, the cost thereof shall be deducted from any money due or to become due the Contractor from the Department. The cost of all other alternate strength tests made at the Contractor's request shall be borne by the Contractor. The alternate strength test shall consist of obtaining and testing three drilled core samples in accordance with Test Method No. Nev. T474. The test specimens will be taken at a single location approved by the Engineer, and shall be from the same area represented by the original strength test. The

cores shall be obtained and the test performed by the Department. The test shall be accomplished as soon as possible after the twenty-eight (28) day compressive strength test.

The average compressive strength of the three drilled core samples at the age tested shall be converted to a twenty-eight (28) day compressive strength as shown by Chart No. 1 in subsection 501.02.04. This calculated value shall be termed the "result of the core test." When the result of the core test validates the original twenty-eight (28) day strength test, the quality of the concrete shall be assessed on the basis of the original test. When the core test does not validate the twenty-eight (28) day strength, then the result of the core test shall be used to assess the quality of the concrete.

Concrete removed will not be paid for and the removal thereof will be at the Contractor's expense.

No measurements or other allowances will be made for work, material for forms, falsework, cofferdams, pumping, bracing, etc.

The quantity of concrete involved in fillets, scorings and chamfers two (2) square inches or less in cross sectional area shall be neglected. No deduction shall be made for the volume of concrete displaced by reinforcing steel, expansion joint material, drainage and weep holes. The volume of concrete displaced by pipes, conduits, ducts, and forms for voids embedded in concrete that are in excess of two (2) square inches in cross sectional area shall be deducted. Deduction shall also be made for the volume of timber piles, concrete piles and cast-in-place piles embedded in the concrete.

Each class of concrete will be considered separately, except where the Contractor elects to use either Class DA concrete in lieu of Class AA concrete or Class D concrete in lieu of Class A concrete, such Class DA concrete or Class D concrete shall be measured as Class AA concrete or Class A concrete.

Tremie seal concrete will be measured on the basis of batched volume placed.

The quantity of concrete barrier rail to be measured for payment will be the number of linear feet installed complete and in place.

The quantity of steel deck drain to be measured for payment will be the number of pounds of steel deck drain and pipe complete and in place within the structure, measured as provided in Section 506, "Steel Structures."

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

502.05.01 Payment. The accepted quantity of concrete measured as provided in subsection 502.04.01, "Measurement," will be paid for at the contract unit price bid per cubic yard for the class or type specified. Reinforcing steel will be paid for as provided in Section 505, "Reinforcing Steel." All metal parts, fabrics, pads, joint filler, and any other materials not specifically mentioned for payment herein, will be considered subsidiary to the other pay items of the work and no further compensation will be allowed therefor.

Steel deck drains measured as provided in subsection 502.04.01, "Measurement," will be paid for as "Structural Steel" as set forth in Section 506, "Steel Structures."

The accepted quantity of concrete barrier rail, measured as provided in subsection 502.04.01, "Measurement," will be paid for at the contract unit price bid per linear foot for the type of concrete barrier rail indicated in the proposal, which price shall be considered full compensation for furnishing all materials, labor, tools, supplies, equipment and incidentals necessary to construct the concrete barrier rail complete in place, including the base slab where required on the plans, excavation, backfill and all finishing as shown on the plans or as specified.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Class ..... Concrete (Major)	Cubic Yard
Class ..... Concrete (Minor)	Cubic Yard
Class ..... Concrete, Modified (Major)	Cubic Yard
Tremie Seal Concrete	Cubic Yard
Concrete Barrier Rail (Type)	Linear Foot
Precast Concrete Barrier Rail	Linear Foot

SECTION 503

PRECAST PRESTRESSED CONCRETE MEMBERS

DESCRIPTION

503.01.01 General. This work shall consist of furnishing and placing precast prestressed concrete members as specified in these specifications and the contract documents.

This work shall include the manufacture, transportation, and storage of girders, slabs, piling, and other structural members of precast prestressed concrete and shall also include the placing of all precast prestressed concrete members, except piling, which shall be placed as provided in Section 508, "Piling."

The members shall be furnished complete including all concrete, prestressing steel, bar reinforcing steel and incidental materials in connection therewith.

MATERIALS

503.02.01 General. Concrete shall conform to the applicable requirements of Sections 501, "Portland Cement Concrete," and 502, "Concrete Structures." Prestressing steel shall conform to the applicable requirements of Section 713, "Reinforcement."

If lightweight concrete is used, it shall conform to the applicable requirements of Section 504, "Lightweight Concrete for Structures."

CONSTRUCTION

503.03.01 Prestressing Methods. Prestressing shall be performed by either pretensioning or posttensioning methods. The method of prestressing to be used shall be optional with the Contractor, subject to the requirements specified in these specifications.

Prior to casting the precast members, the Contractor shall submit working drawings to the Engineer for approval giving complete details of the methods, materials and

equipment he proposes to use in the prestressing and construction and erection operations. Such details shall outline the method of prestressing, and shall include the arrangement of the prestressing steel and mild steel reinforcement in the members, anchoring stresses, sequence of stressing posttensioned prestressing steel, and the sequence of cutting or releasing pretensioned prestressing steel, type of posttensioning enclosures, and specifications and details of anchoring devices and distribution plates or assemblies, if required, for posttensioning and pressure grouting materials and equipment, together with complete drawings of the forms proposed for casting the precast members. Such drawings shall show complete details of the type of forms proposed for providing the cored holes and proposed method of supporting and anchoring such forms.

Working drawings shall be in accordance with subsection 105.02, "Plans and Working Drawings."

503.03.02 Forms. Concrete shall not be deposited in the forms until the Engineer has inspected the placing of the reinforcement, enclosure, anchorages, and prestressing steel.

The concrete shall be vibrated internally or externally, or both, as required to consolidate the concrete. The vibrating shall be done with care and in such a manner that displacement of reinforcement, enclosures, and prestressing steel will be avoided.

Holes for anchor bars, and for diaphragm dowels which pass through the member, openings for connection rods, recesses for grout, and holes for railing bolts shall be provided in the members in accordance with the details shown on the plans. Where diaphragm dowels do not pass through the member, the dowels may be anchored in the member by embedment in the concrete or by means of an approved threaded insert.

Forms for interior cells or holes in the members shall be constructed of a material that will resist breakage or deformation during the placing of concrete and will not materially increase the weight of the member.

Lifting anchors may be installed in members to be

placed in bridge decks provided that all of the anchor above the concrete is removed after the member is placed.

Side forms for prestressed members may be removed the next day after placing concrete therein, provided arrangements satisfactory to the Engineer are made for curing and protecting the concrete.

503.03.03 Anchorages and Distribution. All post-tensioned prestressing steel shall be secured at the ends by means of approved permanent type anchoring devices.

Anchorage devices shall hold the prestressing steel without slip of more than one-eighth (⅛) inch at a load of one hundred fifty (150) percent of the amount required for the initial stress. Steel distribution plates or assemblies for the distribution of the load from the anchorage devices shall be furnished and installed, except as hereinafter provided.

When headed wires are used, the outside edge of any hole for prestressing wire through a stressing washer or through an unthreaded bearing ring or plate shall not be less than one-fourth (¼) inch from the root of the thread of the washer or from the edge of the ring or plate.

The load from the anchoring device shall be distributed to the concrete by means of approved devices that will effectively distribute the load to the concrete.

Distribution plates or assemblies shall conform to the following requirements:

(a) The final unit compressive stress on the concrete directly underneath the plate or assembly shall not exceed three thousand (3,000) pounds per square inch.

(b) Bending stresses in the plates or assemblies induced by the pull of the prestressing steel shall not exceed the yield point of the material or cause visible distortion in the anchorage plate when one hundred (100) percent of the ultimate load is applied as determined by the Engineer.

(c) Materials and workmanship shall conform to the requirements in Section 506, "Steel Structures."

Should the Contractor elect to furnish anchoring devices of a type which are sufficiently large and which are used in conjunction with a steel grillage imbedded in the concrete that effectively distributes the compressive stresses

to the concrete, the steel distribution plates or assemblies may be omitted.

Where the end of a posttensioned assembly will not be covered by concrete, the anchoring devices shall be recessed so that the ends of the prestressing steel and all parts of the anchoring devices will be at least two (2) inches inside of the end surface of the members, unless a greater embedment is shown on the plans. Following post-tensioning, the recesses shall be filled with grout, and finished flush. The grout shall conform to the requirements of subsection 706.03.04, "Grout and Mortar Sand," and shall consist of one part cement and two parts sand.

503.03.04 Enclosures. Enclosures for prestressing steel shall be ferrous metal, mortar-tight, and accurately placed at the locations shown on the plans or approved by the Engineer.

In lieu of metallic enclosures, openings for prestressing steel may be formed by means of cores or ducts composed of rubber or other suitable materials which are removed prior to installing prestressing steel.

All enclosures or openings of anchorage assemblies shall be provided with pipes or other suitable connections for the injection of grout after prestressing.

503.03.05 Prestressing. All prestressing steel shall be tensioned by means of hydraulic jacks. Each jack shall be equipped with either a pressure gage or a load cell for determining the jacking stress, at the option of the Contractor. The pressure gage, if used, shall have an accurate reading dial at least six (6) inches in diameter. Each jack and its gage shall be calibrated as a unit with the cylinder extension in the approximate position that it will be at final jacking force, and shall be accompanied by a certified calibration chart. The load cell, if used, shall be calibrated and shall be provided with an indicator by means of which the prestressing force in the tendon may be determined. The range of the load cell shall be such that the lower ten (10) percent of the manufacturer's rated capacity will not be used in determining the jacking stress.

The tensioning of prestressing steel in any posttensioned member and the cutting or releasing of prestressing steel in any pretensioned member shall not be performed until tests on concrete cyclinders made of the same concrete and cured under conditions identical to the member has attained the minimum compressive strength value specified for detentioning or stressing of the steel.

When ordered by the Engineer, prestressing steel tendons in pretensioned members, if tensioned individually, shall be checked by the Contractor for loss of prestress not more than three (3) hours prior to placing concrete for the members. The method and equipment for checking the loss of prestress shall be subject to approval by the Engineer. All tendons which show a loss of prestress in excess of three (3) percent shall be retensioned to the original computed jacking stress.

When prestressing steel in pretensioned members is tensioned at a temperature appreciably lower than the estimated temperature of the concrete and the prestressing steel at the time of initial set of the concrete, the calculated elongation of the prestressing steel shall be increased to compensate for the loss in stress, but in no case shall the jacking stress exceed seventy-five (75) percent of the specified minimum ultimate tensile strength of the prestressing steel.

Subject to prior approval by the Engineer, a portion of the total prestressing force may be applied to a member when the strength of the concrete in the member is less than the value shown on the plans and the member may then be moved. Approval by the Engineer of such partial prestressing and moving shall in no way relieve the Contractor of full responsibility for successfully constructing the members.

The cutting and releasing of prestressing steel in pretensioned members shall be performed in such an order that lateral eccentricity of prestress will be a minimum. The prestressing steel shall be cut off flush with the end of the member and the exposed ends of the prestressing steel shall be heavily coated with roofing asphalt or coal tar enamel.

Posttensioning will not be permitted until it is demonstrated to the satisfaction of the Engineer that the prestressing steel is free and unbonded in the enclosure.

The tensioning process as applied to posttensioned members shall be so conducted that tension being applied and the elongation of the prestressing steel may be measured at all times. A record shall be kept of gage pressures and elongations at all times and shall be submitted to the Engineer for approval.

Prestressing steel in posttensioned members shall be tensioned by simultaneous jacking at each end of the assembly, except as provided in the following:

(a) Jacking from one end of the assembly will be permitted on simple span members under sixty-five (65) feet in length, provided the calculations show that the maximum temporary tensile stress at the center of the span will not be more than seventy (70) percent of the specified minimum ultimate tensile strength of the prestressing steel.

(b) For simple span members sixty-five (65) feet and over in length, jacking from one end will be permitted, provided the calculations and also field tests demonstrate that the maximum temporary tensile stress at the center of the span will not be more than seventy (70) percent of the specified minimum ultimate tensile strength of the prestressing steel.

Unless otherwise permitted by the Engineer, half of the prestressing steel in each member shall be stressed from one end of the span and the other half from the opposite end.

Determination of the jacking stresses shall be supported by calculations, or by calculations and field tests when so specified, prepared by the Contractor. The Contractor shall submit his calculations to the Engineer for approval, and prior to making field tests shall submit details of his proposed gages and load devices for determining the jacking load at each end of the test prestressing unit to the Engineer for approval. Unless otherwise permitted by the Engineer, a load cell shall be used at the end opposite the jacking end. Measurement of elongation and stress shall

agree within three (3) percent. The stress at the center will be calculated from the average of the end test loads. Jacking stresses within two (2) percent of the calculated required jacking stresses will be considered satisfactory.

The following friction coefficients shall be used in calculating friction losses. K represents the wobble of the ducts, and U represents the curvature in draped cables:

Type of Steel	Type of Duct	K	U
Bright metal wire or strand	Bright metal	0.002	0.30
	Galvanized	0.0015	0.25
Bright metal bars	Bright metal	0.0003	0.20
	Galvanized	0.0002	0.15

The maximum temporary tensile stress (jacking stress) in prestressing steel shall not exceed seventy-five (75) percent of the specified minimum ultimate tensile strength of the prestressing steel. The prestressing steel shall be anchored at stresses (initial stress) that will result in the ultimate retention of working forces of not less than those shown on the plans, but in no case shall the initial stress exceed seventy (70) percent of the specified minimum ultimate tensile strength of the prestressing steel.

The loss in stress in posttensioned or pretensioned prestressing steel due to creep and shrinkage of concrete, creep of steel, and sequence of stressing, shall be as indicated on the plans.

Longitudinal prestressing steel in pretensioned members shall not be cut or released until tests on concrete cylinders indicate that the concrete in the member has attained a compressive strength of not less than the value shown on the plans or the following values, whichever is the greater.

Diameter of Strand	Compressive Strength
3/8 inch	3,500 p.s.i.
7/16 inch	4,000 p.s.i.
1/2 inch	4,000 p.s.i.

The working force in the prestressing steel shall be not less than the value shown on the plans. Unless otherwise

specified or shown on the plans, the average working stress in the prestressing steel shall not exceed sixty (60) percent of the specified minimum ultimate tensile strength of the prestressing steel.

Working force and working stress will be considered as the force and stress remaining in the prestressing steel after all losses, including creep and shrinkage of concrete, elastic compression of concrete, creep of steel, losses in posttensioned prestressing steel due to sequence of stressing, friction and take up of anchorages, and all other losses peculiar to the method or system of prestressing have taken place or have been provided for.

503.03.06 Curing. Curing shall conform to the applicable provisions of subsection 501.03.09, "Curing," and in addition the following steam curing requirements shall apply.

Any steam curing operation which deviates from the procedure listed below shall be subject to the approval of the Engineer.

Steam curing shall be done under a suitable enclosure to contain the live steam in order to minimize moisture and heat losses. The initial application of the steam shall be from two (2) to four (4) hours after the final placement of concrete to allow the initial set of the concrete to take place. If retarders are used, the waiting period before application of the steam shall be from four (4) to six (6) hours. The steam shall be at one hundred (100) percent relative humidity to prevent loss of moisture and to provide excess moisture for proper hydration of the cement. Application of the steam shall not be directly on the concrete. During application of the steam the ambient air temperature shall increase at a rate not to exceed forty (40) degrees Fahrenheit per hour until a maximum temperature of from one hundred forty (140) degrees to one hundred sixty (160) degrees Fahrenheit is reached. The maximum temperature shall be held until the concrete has reached the desired strength. In discontinuing the steam, the ambient air temperature shall decrease at a rate not to

exceed forty (40) degrees Fahrenheit per hour until a temperature has been reached about twenty (20) degrees Fahrenheit above the temperature of the air to which the concrete will be exposed. The concrete shall not be exposed to temperatures below freezing for six (6) days after casting.

503.03.07 Shipping. For prefabricated tendons, the Contractor shall give the Engineer at least ten (10) days notice before commencing the installation of end fittings of the heading of wires. The Engineer will inspect end fitting installations and wire headings while such fabrication is in progress at the plant and will arrange for the required testing of the material to be shipped to the site.

No prefabricated tendon shall be shipped to the site without first having been released by the Engineer, and each tendon shall be tagged before shipment for identification purposes at the site. All unidentified tendons received at the site will be rejected.

The release of any material by the Engineer shall not preclude subsequent rejection if the material is damaged in transit or later damaged or found to be defective.

503.03.08 Handling. Extreme care shall be exercised in handling, storing, moving, and erecting precast prestressed concrete members to avoid twisting, racking, or other distortion that would result in cracking or damage to the members. Precast prestressed members shall be handled, transported, and erected in an upright position, and the joints of support and directions of the reactions with respect to the member shall be approximately the same during transportation and storage as when the member is in its final position.

503.03.09 Tolerances. Prestressed concrete members shall be fabricated to plan dimensions within the tolerances listed herein (tolerances are not to be considered accumulative). Members having dimensions outside the tolerance limits shall be subject to rejection.

(a) Precast Prestressed Concrete I-Beams:

Depth (flanges, web and fillets)	±¼ in.
Depth (overall)	+½ in. to —¼ in.
Width (flanges and fillets)	+⅜ in. to —¼ in.
Width (web)	+⅜ in. to —¼ in.
Length of Beam	±⅛ in. per 10 ft. or ½ in. whichever is greater
Exposed beam ends deviation from square or designated skew	Horiz. ±¼ in. Vertical ±⅛ in. per ft. of beam ht.
Side inserts (spacing between centers of inserts and from the centers of inserts to the ends of the beams)	±½ in.
Bearing Plates (spacing between the centers of bearing plates)	±⅛ in. per 10 ft. or ½ in. whichever is greater
Bearing Plate (spacing from the centers of bearing plates to the ends of the beams)	±½ in.
Bearing Plate or Bearing Area deviation from plane	±1/16 in.
Stirrup Bars—Projection above top of beam	±¾ in.
Stirrup Bars—Longitudinal Spacing	±1 in.
End Stirrup Bars—not more than 2 in. from the end of the beam	
Horizontal Alignment (deviation from a straight line parallel to the centerline of beam)	⅛ in. per 10 ft.
Camber differential between adjacent beams	⅛ in. per 10 ft. of span to maximum of 1 in.
Center of gravity of strand group	±¼ in.
Center of gravity of depressed strand group at end of beam	±½ in.
Position of posttensioning duct	±¼ in.
Position of hold-down points for depressed strands	±6 in.
Position of handling devices	±6 in.

(b) Precast Prestressed Concrete Box Beams and Flat Slabs:

Depth (top slab)	±½ in.
Depth (bottom slab)	+2 in. to —0 in.
Depth (overall)	±¼ in.
Width (web)	±⅜ in.
Width (overall)	±¼ in.
Length	±⅛ in. per 10 ft. or ½ in. whichever is greater ±½ in. from end of void to center tie hole
Void Position	±1 in. adjacent to end block
Square Ends (deviation from square)	±¼ in.
Skew Ends (deviation from designated skew)—	
Skew angle equal to or less than 30 degrees	±¼ in.
Skew angle greater than 30 degrees	±½ in.
Beam Seat Bearing Area (variation from plane surface when tested with a straight edge) through middle half of member	±1/16 in.
Horizontal Alignment (deviation from a straight line parallel to the centerline of member)	¼ in. to 40 ft. lengths ⅜ in. from 40 to 60 ft. lengths ½ in. above 60 ft. lengths
Dowel Tubes (spacing between the centers of tubes and from the centers of tubes to the ends and sides of member)	±½ in.
Tie Rod Tubes (spacing between the centers of tubes and from the centers of tubes to the ends of the member)	±¼ in.
Tie Rod Tubes (spacing from centers of tubes to the bottom of the beams)	±¼ in.
Total width of Deck	Theoretical width +½ in. per joint
Camber differential between adjacent units	½ in. max.
Camber differential between High and Low members in same span	1 in. max.
Side Inserts Positioning	Same as for I-beams
Stirrup Bar Positioning	Same as for I-beams

Tendon Positioning.....Same as for I-beams
Handling Device Positioning.....Same as for I-beams

(c) Precast Prestressed Concrete Piling:

Width or Diameter.....—¼ in. to +⅜ in.
Head out of square.....1/16 in. per 12 in. of width
Length of pile.....±1½ in.
Horizontal Alignment (deviation from a straight line parallel to the center-line of the pile).....⅛ in. per 10 ft.
Void location.....±½ in.
Stirrup Bars or Spiral Positioning.....Same as for I-beams
Tendon Positioning.....Same as for I-beams
Handling Device Positioning.....Same as for I-beams

METHOD OF MEASUREMENT

503.04.01 Measurement. Measurement will be made per each of the various sizes and types for furnishing and erecting precast prestressed concrete members complete and in place.

The length of the members shown in the estimate of quantities and/or in the proposal are nominal. For exact length see the drawing of the members shown on the plans.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

503.05.01 Payment. The accepted quantities of precast prestressed concrete members measured as provided in subsection 503.04.01, "Measurement," will be paid for at the contract unit prices bid for furnishing and erecting precast prestressed concrete members.

Payment therefor will be full compensation for all labor and for furnishing all items involved in the finished members.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
(size) Precast Concrete Members	Each

SECTION 504

LIGHTWEIGHT CONCRETE FOR STRUCTURES

DESCRIPTION

504.01.01 General. This work shall consist of furnishing and placing lightweight Portland cement concrete in bridges, culverts, and other types of concrete structures. The construction of conventionally reinforced lightweight concrete structures shall conform to the requirements of Sections 501, "Portland Cement Concrete," and 502, "Concrete Structures."

MATERIALS

504.02.01 General. The materials used shall be those prescribed for the several items which constitute the finished work and shall conform to the requirements for such materials in the following sections:

Portland Cement Concrete	Section 501
Concrete Structures	Section 502
Aggregate for Portland Cement Products	Section 706

Lightweight concrete shall be composed of an intimate mixture of Portland cement, water and lightweight aggregates, with or without natural sand of normal specific gravity, and an air-entraining admixture proportioned and mixed as hereinafter provided.

504.02.02 Admixtures. Admixtures shall conform to the applicable requirements of subsection 501.02.03, "Admixtures."

504.02.03 Concrete Making Properties. Lightweight concrete shall be subject to the following requirements and test methods:

Test	Test Designation	Requirements
Making Test Specimens (laboratory)	Nev. T455*	.....
Making Test Specimens (field)	Nev. T428	.....
Compressive Strength	Nev. T475	Table I
Unit Weight and Cement Factor (Wet)	Nev. T435	Table I
Tests for Popouts	Nev. T462	No surface popouts
Freezing and Thawing	Nev. T465	.....
Air Content	Nev. T431	Table I
Slump	Nev. T438	Table I
Air Dried Weight	Nev. T458	Table I
Coring Concrete	Nev. T474	Sec. 504.04.01

*The compressive strength requirements of Portland cement concrete shall be based on the strength test, which is defined as the average of the breaking strength of three standard cylinders at twenty-eight (28) days. The cylinder strengths shall be determined in accordance with Test Method No. Nev. T475.

A test, as defined above, will be required for each fifty (50) cubic yards, or portion thereof, placed each day. For large, continuous pours, one (1) test near the beginning of the pour, and one (1) test near the end of the pour may be substituted for the fifty (50) cubic yard requirement. In any case, there shall be at least one strength test made each day that concrete is placed, regardless of the volume placed. Other cylinders may be made and broken for information purposes.

CONSTRUCTION

504.03.01 General. Mixing water, storage of cement, measurement of materials, weighing and measuring equipment, condition of equipment, mixing conditions, and mixing equipment shall conform to the requirements of Sections 501, "Portland Cement Concrete," and 502, "Concrete Structures."

The Contractor shall notify the Engineer not less than thirty-two (32) calendar days in advance of use of the proposed sources of materials and shall make arrangements for the Engineer to obtain samples as required for testing purposes. Samples will not exceed five hundred (500) pounds for each separate grading. The Contractor shall furnish a written statement giving the cement factor in sacks per cubic yard, the proportions of cement and each

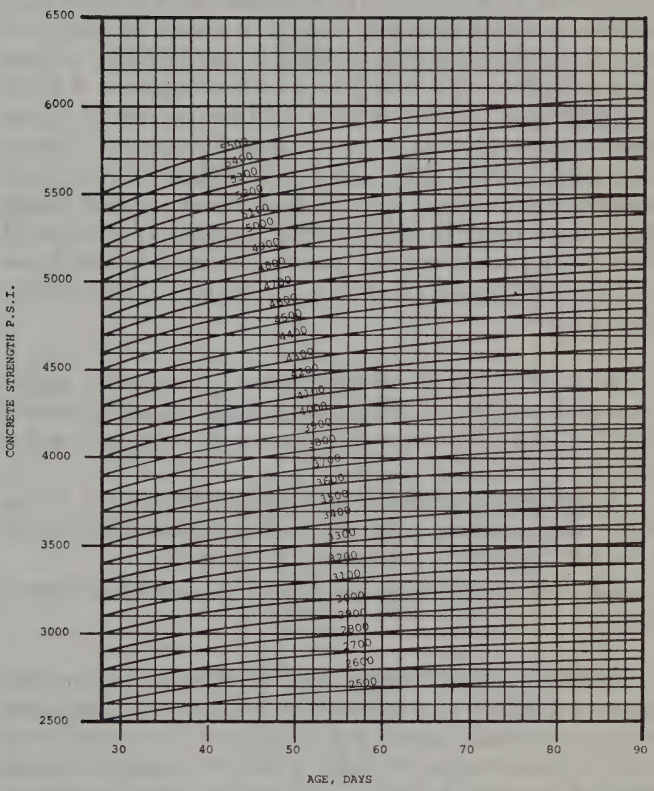
6500
6000
5500
5000
4500
4000
3500
3000
2500
CONCRETE STRENGTH P.S.I.
30
40
50
60
70
80
90
AGE, DAYS

CHART NO. 2

size of aggregate in a saturated surface dry condition, the slump, and the percentage of air in the concrete proposed for use in the work. If the Contractor proposes to use an admixture other than an air-entraining agent, he shall state its complete brand name and the quantity proposed to be used per sack of cement. The Engineer, after making such tests as he deems advisable, will either accept the proposed materials and proportions or suggest modifications needed for acceptance. After acceptance by the Engineer of batch proportions and materials, they shall not be altered during the course of the work except as found necessary to maintain yield, cement factor, and unit weight within specification requirements. In no case shall revised batch proportions result in concrete that contains an amount of total water per cubic yard greater than one hundred five (105) percent of that contained in concrete of the accepted proportions.

504.03.02 Storage of Aggregates. Storage of aggregates shall conform to the pertinent requirements of subsection 501.03.03, "Storage of Aggregates," except as noted below.

Lightweight aggregate shall be stockpiled on the job or at a central batching plant for a minimum time of twenty-four (24) hours prior to its use in the project.

Fine and coarse aggregates shall be stockpiled separately.

504.03.03 Classification and Proportions. Lightweight concrete shall be proportioned by weight, using the lightweight aggregates under test, such that the compressive strength requirements in Table I will be satisfied without falling below the minimum, or exceeding the maximum values given. The Contractor shall give the Engineer advance notice in writing when any changes are to be made in the batch proportions.

Batches of lightweight concrete placed on the work shall not vary more than plus or minus three (3) pounds per cubic foot in unit weight from the design mix. The cement factor of any individual batch placed in the work shall not

425

TABLE I

Class	Sacks Cement per Cu. Yd. Min.-Max.	Max. Water, Gal. per Sack Cement*	Min. Compr. Str. (28 day) p.s.i.	Slump Range, Inches	Entrained Air Range, Percent	Unit Wt. Variation	Air Weight, Max. Lbs./ Cu. Ft.
LA	6.0–7.0	6.0	3,000	1–4	0	±3 lbs.	115
LAA	6.0–7.0	5.5	3,000	1–4	4–7	±3 lbs.	115
Modified LA or LAA	6.0–8.0	6.0	Specified on plans	1–4	4–7	±3 lbs.	115

*Based on aggregate in a saturated surface—dry condition.

be more than 0.15 sack per cubic yard less nor more than 0.25 sack per cubic yard greater than the designated factor (sacks of cement per cubic yard). Aggregates shall be batched and reported to the Engineer by weight but the weights used may be varied as necessary to comply with the above tolerances in cement factor and unit weight.

At the option of the Contractor, natural fine aggregate may be substituted for lightweight fine aggregate provided such substitution does not result in producing concrete having a weight in excess of maximum.

504.03.04 Mixing. Lightweight aggregates in combination with natural sand, if used, shall be of such character that workable concrete of the properties specified herein will be obtained. Should premoistening be required, it shall be done uniformly at least twenty-four (24) hours in advance of batching.

The batch shall be so charged that three-fourths (¾) of the total mixing, water and admixtures be introduced in the mixer in advance of the aggregates. The aggregates shall then be introduced and mixed for a minimum of forty-five (45) seconds. The amount of absorption by the aggregate will be the determining factor in mixing time. The cement and final water shall be added and mixing completed. The total mixing time for stationary mixers shall not be less than three (3) minutes. Minimum mixing for concrete mixed in trucks shall be one hundred (100) revolutions of the drum.

The drum on truck mixers shall be operated at high speed while charging it with aggregate. Cement shall be introduced into the mixing drum while it is rotating at slow speed. Immediately prior to discharge of the concrete, the drum shall be rotated at high speed for at least sixty (60) seconds.

METHOD OF MEASUREMENT

504.04.01 Measurement. The quantity of lightweight concrete to be measured for payment will be the number of cubic yards complete and in place. The estimated quantity shown on the plans, plus or minus quantities covered by

change order, will be the quantity used for payment. The Engineer or the Contractor may, however, request a final measurement. The Contractor's request for final measurement shall be in writing. Final measurement will be made according to the dimensions shown on the plans plus or minus approved changes and quantities derived therefrom will be the quantities used for payment. Each class of lightweight concrete will be considered separately. Only those quantities complete and in place will be measured for payment.

In the event any class of Portland cement concrete is placed and is shown by test to be below the specified twenty-eight (28) day compressive strength, a determination shall be made by the Engineer as to whether the concrete shall be removed and replaced or allowed to remain in place. This determination shall be based on an evaluation of the durability and other qualities of the concrete necessary to the integrity of the structure. If the concrete is allowed to remain in place, it is agreed by the parties to the contract that the Department will deduct from money due, or to become due the Contractor from the Department, a percentage of the contract unit bid price. This deduction shall be considered to be liquidated damages and shall be at a rate of five (5) percent of the contract unit bid price for each fifty (50) p.s.i. or portion thereof below the specified minimum compressive strength, to a maximum of fifty (50) percent, as set forth in the following example for the class of concrete shown:

Specified 28 Day Compressive Strength p.s.i.	Liquidated Damage (Per Unit bid Price) Percent
3,000	0
2,999–2,950	5
2,949–2,900	10
2,899–2,850	15
2,849–2,800	20
2,799–2,750	25
2,749–2,700	30
2,699–2,650	35
2,649–2,600	40
2,599–2,550	45
Below 2,550	50

The reduced price shall apply to all concrete represented by the strength tests below the specified minimum compressive strength.

Concrete removed will not be paid for, and the removal thereof will be at the Contractor's expense.

When a compressive strength test falls below the specified twenty-eight (28) day compressive strength, the Department may determine that an alternate strength test is required or the Contractor may request such a test. When the Department determines that an alternate strength test is required, the Contractor will not be liable for the cost of such test. In case the Department has not determined that an alternate strength test is necessary and the Contractor elects to have an alternate strength test made, the Department will then make such a test; however, should this test fail to indicate that the twenty-eight (28) day compressive strength requirements have been met, the cost thereof shall be deducted from any money due or to become due the Contractor from the Department. The cost of all other alternate strength tests made at the Contractor's request shall be borne by the Contractor. The alternate strength test shall consist of obtaining and testing three drilled core samples in accordance with Test Method No. Nev. T474. The test specimens will be taken at a single location approved by the Engineer, and shall be from the same area represented by the original strength test. The cores shall be obtained and the test performed by the Department. The test shall be accomplished as soon as possible after the twenty-eight (28) day compressive strength test.

The average compressive strength of the three drilled core samples at the age tested shall be converted to a twenty-eight (28) day compressive strength as shown by Chart No. 1 in subsection 501.02.04 of these special provisions. This calculated value shall be termed the "Result of the core test." When the result of the core test validates the original twenty-eight (28) day strength test, the quality of the concrete shall be assessed on the basis of the original test. When the core test does not validate the twenty-eight (28) day strength test, then the result of the core test shall be used to assess the quality of the concrete.

No measurement or other allowance will be made for work, material for forms, falsework, cofferdams, pumping, bracing, etc.

The quantity of concrete involved in fillets, scorings, and chamfers two (2) square inches or less in cross sectional area shall be neglected. No deduction shall be made for the volume of concrete displaced by reinforcing steel, expansion joint material, drainage and weep holes, pipes, conduits, and ducts embedded in concrete. Deduction shall be made for the volume of timber piles, concrete piles, and cast-in-place piles embedded in the concrete.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

504.05.01 Payment. The accepted quantity of concrete measured as provided in subsection 504.04.01, "Measurement," will be paid for at the contract unit price bid per cubic yard for the class of lightweight concrete specified. Reinforcing steel will be paid for as provided in Section 505, "Reinforcing Steel." All metal parts, fabrics, pads, joint filler, drains, and any other materials not specifically mentioned for payment herein, will be considered subsidiary to the other pay items of the work and no further compensation will be allowed therefor.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Class (.....) Lightweight Concrete	Cubic Yard

SECTION 505

REINFORCING STEEL

DESCRIPTION

505.01.01 General. This work shall consist of furnishing and placing reinforcing steel and mesh reinforcing in accordance with these specifications and in conformity with the plans.

MATERIALS

505.02.01 General. Materials shall conform to the requirements specified in the following subsections:

Fabricated Steel Bar or Rod Mats Reinforcement	Subsection 713.03.02
Bar Steel Reinforcement	Subsection 713.03.01
Welded Steel Wire Fabric Reinforcement	Subsection 713.03.03

All bar steel reinforcement may be either Grade 40 or Grade 60 unless otherwise specified on the plans.

Spiral Reinforcement may be either bar steel reinforcement or steel wire of the equivalent size of the bar steel.

505.02.02 Samples. One extra bar of each diameter shall be furnished per contract for each one hundred (100) tons or fraction thereof. This bar shall be from the longest bar of each size so that it, or a portion of it, can be used to replace any bar of that diameter which is selected to be used as a field sample. The field sample must be of sufficient length to provide for two (2) two (2) foot samples of each diameter. The extra bars shall be indicated on the fabricator's details.

CONSTRUCTION

505.03.01 Bending Diagrams. Before placing reinforcing steel, two copies of a list of all reinforcing steel shall be furnished to the Engineer at the site for his use in

administering the contract. Furnishing such lists to the Engineer shall not be construed to mean that the lists will be reviewed for accuracy. The Contractor shall be wholly and completely responsible for the accuracy of the lists and for furnishing and placing all bar reinforcing steel in accordance with the details shown on the plans and as specified.

505.03.02 Protection of Materials. Reinforcing steel shall be protected at all times from damage. When placed in the work, the reinforcing steel shall be free from dirt, detrimental scale, paint, oil, or other foreign substance. However, when steel has on its surface loose mill scale or dust which is easily removable, it may be cleaned by a satisfactory method, if approved by the Engineer.

505.03.03 Bending. Bent bar reinforcement shall be cold bent to the shape shown on the plans; and unless otherwise provided on the plans or by authorization, bends shall be made in accordance with the ACI Manual of Standard Practice for Detailing Reinforced Concrete Structures.

505.03.04 Placing and Fastening. All bar reinforcement shall be accurately placed in the positions shown on the plans and firmly held during the placing and setting of concrete. When the spacing of bars exceeds one (1) foot in either direction, all intersections shall be tied. When the spacing of bars is one (1) foot or less in both directions, alternate intersections shall be tied.

Distances from the vertical and horizontal forms shall be maintained by means of stays, blocks, ties, hangers or other approved supports. Blocks used for holding reinforcing bars from contact with the forms or between layers of bars, shall be precast mortar blocks of approved shape and dimensions and shall have a compressive strength of not less than 3,000 p.s.i. Metal chairs which are in contact with the exterior surface of the concrete shall be fabricated of either galvanized steel, or have the steel tips plastic coated to at least three-fourths (¾) inch into

the concrete, or be of stainless steel conforming to the requirements of ASTM A493 Type 430. The use of pebbles, pieces of broken stone or brick, metal pipe, and wooden blocks will not be permitted. Reinforcement in any member shall be placed, and then inspected and approved by the Engineer, before the placing of concrete begins. Concrete placed in violation of this provision may be rejected and its removal required.

If mesh reinforcement is shipped in rolls, it shall be straightened into flat sheets before being placed.

505.03.05 Splicing. All reinforcement bars shall be furnished in the full lengths indicated on the plans. Splicing of bars, except where shown on the plans, will not be permitted without the written approval of the Engineer. Splices shall be staggered as far as possible. Unless otherwise shown on the plans, bars near the top of beams and girders having more than twelve (12) inches of concrete under the bars shall be lapped thirty-five (35) diameters and all other bars shall be lapped twenty (20) diameters to make the splice. In lapped splices, the bars shall be placed in contact and wired together. Welding of reinforcing steel shall be done only if detailed on the plans or authorized by the Engineer in writing. Welding shall conform to the specifications for Welded Highway and Railway Bridges of the American Welding Society.

Lapped splices in reinforcement shall not be used for sizes larger than No. 11.

Tensile reinforcement shall preferably not be spliced at points of maximum stress. The spliced bar shall develop the computed stress at the splice point without exceeding three-fourths (¾) of the permissible bond values given below. However, the length of lap for deformed bars shall not be less than twenty-four (24) and thirty-six (36) bar diameters for Grade 40 and Grade 60, respectively, nor less than twelve (12) inches.

Where lapped splices are used in reinforcement in which the critical design stress is compressive, the minimum amount of lap shall be: with concrete having a strength of 3,000 p.s.i. or more, the length of lap for

deformed bars shall be twenty (20) bar and twenty-four (24) bar diameters for Grade 40 and Grade 60, respectively, but not less than twelve (12) inches. When the specified concrete strengths are less than 3,000 p.s.i., the amount of lap shall be one-third (⅓) greater than the values given above.

Bond (for tension bars conforming to ASTM A615)

(a) Sizes No. 3 through No. 11 top bars*	$\frac{3.4\sqrt{f'_c}}{D}$	350 p.s.i. max.
Bars others than top bars	$\frac{4.8\sqrt{f'_c}}{D}$	500 p.s.i. max.
(b) Size No. 14 and No. 18 top bars*	$2.1\sqrt{f'_c}$	
Bars others than top bars	$3\sqrt{f'_c}$	
(c) For all deformed compression bars	$6.5\sqrt{f'_c}$	400 p.s.i. max.

*Top bars, in reference to bond, are horizontal bars so placed that more than twelve (12) inches of concrete is cast in the member below the bar.

Note: D=Nominal diameter of bar, inches.
f'_c=Unit ultimate compressive strength of concrete as determined by cylinder tests at the age of twenty-eight (28) days.

Splices in spiral steel shall be made by welding or by a lap of one and one-half (1½) turns.

Sheets of mesh reinforcement shall overlap each other sufficiently to maintain a uniform strength and shall be securely fastened at the ends and edges. The edge lap shall not be less than one (1) mesh in width.

505.03.06 Substitutions. Substitution of different size bars will be permitted only with specific authorization by the Engineer. The bars substituted shall have an area equivalent to the design area or larger.

METHOD OF MEASUREMENT

505.04.01 Measurement. The calculated quantity shown on the plans, plus or minus quantities covered by approved changes, will be the quantity used for payment. The Engineer or the Contractor may request final measurement if a possible error is suspected in the quantities shown on the plans. The Contractor's request for final measurement shall be in writing. Final measurement will be made according to the dimensions shown on the plans plus or minus approved changes and quantities derived therefrom will be the quantity used for payment. The quantity of reinforcing steel measured for payment will be the number of pounds complete and in place.

The calculated weights of the plain and deformed bars shall be based on the following table:

Size No.	Nominal Diameter in Inches	Weight per Foot in Pounds
2	0.250	0.167
3	0.375	0.376
4	0.500	0.668
5	0.625	1.043
6	0.750	1.502
7	0.875	2.044
8	1.000	2.670
9	1.128	3.400
10	1.270	4.303
11	1.410	5.313
14	1.692	7.650
18	2.256	13.600

The quantity of mesh reinforcement to be measured for payment will be the number of square yards complete and in place measured along the plane of placement. No allowance will be made for laps.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

505.05.01 Payment. The accepted quantity of reinforcing steel measured as provided in subsection 505.04.-01, "Measurement," will be paid for at the contract unit price bid per pound.

The accepted quantity of mesh reinforcement measured as provided in subsection 505.04.01, "Measurement," will be paid for at the contract unit price bid per square yard.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Reinforcing Steel	Pound
Mesh Reinforcing	Square Yard

SECTION 506

STEEL STRUCTURES

DESCRIPTION

506.01.01 General. This item shall consist of furnishing, fabricating, casting, machining, or otherwise preparing, transporting, erecting, and painting any or all structural steel, rivet and eyebar steel, steel forgings, castings, and any other metal of the type, shape, dimensions, and quality, required by these specifications or as shown on the plans.

MATERIALS

506.02.01 General. Materials shall meet the pertinent requirements of the following sections:

Structural and Eyebar Steel	Section 710
Aluminum for Bridge Rail	Section 711
Miscellaneous Metals	Section 712
Paint	Section 714
Galvanizing	Section 715
Elastomeric Bearing Pads	Section 725

Turned bolts shall meet the material specifications set forth for structural rivet steel. Anchor bolts, nuts and washers shall be of structural steel, galvanized in accordance with ASTM Designation A153. Bolts for fastening tubes to the rail posts sockets shall be stainless steel.

Steel bridge and pedestrian railing shall be primed and painted in accordance with Section 714, subparagraph (a).

Bridge or pedestrian rail and posts made of aluminum shall not be painted.

Shims shall be either aluminum alloy or asbestos sheet packing, at the Contractor's option. Aluminum Alloy Shims shall conform to ASTM Designation: B209 Alloy 1100–0. Asbestos sheet packing shall be composed essentially of asbestos fibers bonded together with a cementing medium rendering it tough and pliable. The deformation of the packing under a load of ten thousand (10,000) pounds per

square inch shall be less than sixteen (16) percent of the thickness and the loss on ignition shall not be more than twenty-five (25) percent.

Insulating material for insulating the bases of aluminum rail posts from concrete and from steel anchor bolts shall be an aluminum impregnated light colored caulking compound of the consistency of putty.

Shims for steel railing shall be galvanized steel plates.

All bolts, nuts and washers shall be either steel galvanized in accordance with ASTM Designation: A153; stainless steel conforming to ASTM Designation: A276; or steel, cadmium plated in accordance with ASTM Designation: A165, Type TS.

CONSTRUCTION

506.03.01 Shop Drawings. Shop drawings shall consist of shop detail erection and other working plans showing dimensions, sizes of material, details, and other information necessary for the complete fabrication and erection of the metal work. The drawings shall be prepared on sheets twenty-two (22) inches wide by thirty-six (36) inches. The original drawings may be made either on paper or on cloth, but the details must be drawn so that the prints will be clear and legible.

Unless otherwise requested, the Contractor shall submit to the Engineer, for approval, two (2) sets of checked drawings. The Engineer reserves the right to refuse prints of shop drawings which are not clear and legible. Upon approval the Contractor shall furnish the Engineer with the number of sets of shop drawings requested and the original tracings or Van Dyke negatives thereof. All shop plans shall be submitted for approval at least fifteen (15) days before fabrication is started and no material shall be fabricated until the plans have been finally approved by the Engineer. The shop drawings as approved by the Engineer shall become a part of the contract; provided, however, that any substitution of sections contemplated by the shop drawings different from sections shown on the plans shall be made only when approved by the Engineer and in such

case, the additional costs resulting from such substitution shall be borne by the Contractor.

After approval there shall be no deviation from the shop drawings or changes made thereon without the prior approval of the Engineer.

Approval of shop drawings shall be understood to be an acceptance of the character and sufficiency of the details and not a check of any dimensions. Checking shop drawings is intended as a means of facilitating the work and avoiding errors so far as possible, but it is expressly understood that it will not relieve the Contractor from the responsibility in regard to errors or omissions on said shop drawings.

The contract price shall include the cost of furnishing all shop drawings and the Contractor will be allowed no extra compensation for such drawings.

506.03.02 Notice of Beginning Work. The Contractor shall give the Engineer ample notice of manufacturing of material at the mill so that inspection may be provided. No material shall be manufactured or fabrication begun without authorization by the Engineer. The Engineer may inspect the material, as provided for in ASTM Designation A6, at his option. Material not inspected at the place of manufacture shall be subject to inspection as provided for in Section 506.03.03, "Mill," means any rolling mill or foundry where material for the work is to be manufactured. Prior to the beginning of fabrication, a fifteen (15) day written notice shall be provided, by the Contractor, to the Engineer. Any purchase of material prior to inspection at the mill or fabrication of any work without authorization from the Engineer shall be at the Contractor's risk.

506.03.03 Inspection and Testing. Inspection and Testing of Materials. The Engineer will examine and test as necessary all material before fabrication. Adequate facilities and free access to the necessary work areas will be provided to the Engineer by the manufacturer and fabricator. Required test samples will be furnished free of charge. Material not inspected at the place of manufacture shall be

subject to all chemical, physical, and workmanship requirements established for the material supplied. Materials or workmanship not in conformity with the specified product may be rejected. The Engineer may inspect and test all material by any visual, destructive or nondestructive method to evaluate the material for its specified properties. Mill orders and certificates, showing test values obtained, must be furnished in triplicate to the Engineer. All certified test values must include physical and chemical results and steel making process used. Test samples will be obtained from all steel not identified by mill heat numbers. Acceptance of any material at the mill or fabrication shop prior to incorporation into the work shall not prevent the rejection of the material or finished member if defects are discovered during the fabrication process.

Inspection in the fabrication shop is intended as a means of facilitating the work and avoiding errors so far as possible. It is expressly understood that shop inspection does not relieve the Contractor from responsibility for material or fabrication defects or errors and the necessity for replacement or correction of rejected materials and workmanship.

Shop inspection of rail pipe and tubes will in most cases be waived and the Contractor permitted to ship subject to inspection at the project site. The field inspection will cover the general appearance, size, thickness, etc., of the pipe and tubing. Conformance of chemical and mechanical properties to requirements of the specifications will also be considered before the material is approved. Shop inspection of rail posts will be made on the first few rail posts castings furnished for each project in order to establish a satisfactory class of finish and workmanship. When shop inspection is waived on a portion of the handrail posts for a project, a careful inspection will be made in the field to determine the acceptability of these posts on the basis of the finish and workmanship as compared to that of the other posts previously inspected and approved.

Fabrication of aluminum alloy material shall, in general, conform to or be equivalent to fabrication methods and

practices recommended in the handbooks of the major producers of aluminum materials and specifically the following requirements:

(a) Material shall be sawed, routed or milled.

(b) Flame cutting is not permissible.

(c) Tubing may be heated to a temperature not exceeding four hundred (400) degrees Fahrenheit for a period not exceeding fifteen (15) minutes to facilitate bending.

(d) Holes in pipe and tubing shall be drilled. Holes in castings shall be cored and reamed, or drilled from the solid. Seats for pipe shall be finished smooth.

The fabrication and handling of aluminum materials in the shop and field shall be performed in a manner to prevent scoring or marring of the surfaces. An objectionable appearance resulting from such scoring or marring shall be cause for rejection of the material. Sleeves and rails shall be fabricated in lengths indicated on the plans.

The finishing of rail posts shall be performed after fabrication is completed. All fins, pipes, and other casting irregularities and all drilling, reaming, and other fabrication marks shall be removed.

506.03.04 Storage. The loading, transporting, unloading, storing, and handling of structural steel shall be conducted so that the metal will be kept clean and free from injury. When unloaded, the material shall be placed on skids above the ground. All material for the project shall be stored separate from "in stock" materials. Girders and beams shall be placed upright and shored. Long members, such as columns and chords, shall be supported on skids placed near enough together to prevent injury from deflections. Different grades or classifications of material shall be color coded, as provided for in ASTM Designation A6. This color code must be transferred throughout fabrication. If the contract covering the erection of the steel does not include the fabrication, the Contractor shall check the material received by him and report promptly, in writing to the Engineer, any shortage or injury discovered.

506.03.05 Straightening. Rolled material before being

laid out or worked shall be straight. Subassemblies and completed members shall be straight before being incorporated into the work. If straightening is necessary, it shall be done by methods acceptable to the Engineer. Details of methods proposed for straightening shall be submitted in writing to the Engineer prior to their use. After straightening, evidence of fracture or other damage will be cause for rejection of the material. Dimensional tolerances and repairs of surface irregularities, described in ASTM Designation A6, shall govern for the acceptance of repaired material.

506.03.06 Rivet Holes. Rivet holes in carbon steel which is more than three-fourths (¾) inch in thickness shall be subpunched and reamed, subdrilled and reamed, or drilled full size from the solid. Unless otherwise specified, all rivet holes in such material which is three-fourths (¾) inch or less in thickness may be punched full size except where such holes match holes in thicker adjacent material. In such cases the holes in the thinner material shall be subpunched (or subdrilled) and reamed while the parts are assembled or drilled full size from the solid while the parts are assembled.

Rivet holes in material of alloy steels which is more than five-eighths (⅝) inch in thickness shall be subpunched and reamed, subdrilled and reamed, or drilled full size from the solid. Unless otherwise specified, all rivet holes in such material which is five-eighths (⅝) inch or less in thickness may be punched full size except where such holes match holes in thicker adjacent material. In such cases the holes in the thinner material shall be subpunched (or subdrilled) and reamed while the parts are assembled or drilled full size from the solid while the parts are assembled.

Where there are five (5) or more thicknesses of metal, all holes regardless of the thicknesses of the separate pieces shall be subpunched (or subdrilled) and reamed while the parts are assembled or drilled full size from the solid while the parts are assembled.

Full sized punched holes shall be one-sixteenth (1/16)

inch larger than the nominal diameter of the rivet. The diameter of the die shall not exceed the diameter of the punch by more than one-sixteenth (1/16) inch. If any holes must be enlarged to admit the rivets, they shall be reamed. Holes must be clean cut, without torn or ragged edges. Poor matching or mispunched holes will be cause for rejection.

Subpunched (or subdrilled) and reamed holes shall be punched or drilled not less than three-sixteenths (3/16) inch smaller than the nominal diameter of the rivet. After punching or drilling, the holes shall be reamed to a diameter of one-sixteenth (1/16) inch larger than the nominal diameter of the rivet. The punch and die shall have the same relative sizes as specified for full sized punched holes. Reamed holes shall be cylindrical and perpendicular to the member. Where practicable, reamers shall be directed by mechanical means. Burrs on the outside surfaces shall be removed. Poor matching of holes will be cause for rejection. Reaming of rivet holes shall be done with twist drills or with short taper reamers.

Full size drill holes shall be one-sixteenth (1/16) inch larger than the nominal diameter of the rivet. Burrs on the outside surfaces shall be removed.

All holes punched full size, subpunched or subdrilled shall be so accurately punched after assembly (before any reaming is done) a cylindrical pin one-eighth (1/8) inch smaller in diameter than the nominal size in the punched hole may be entered perpendicular to the face of the member, without drifting, in at least seventy-five (75) percent of the contiguous holes in the same plane. If the requirement is not fulfilled, the badly punched pieces shall be rejected.

When holes are reamed or drilled eighty-five (85) percent of the holes in any contiguous group shall, after reaming or drilling, show no offset greater than one thirty-second (1/32) inch between adjacent thicknesses of metal.

506.03.07 Rivets. Size of rivets called for on the plans shall be the size before heating.

Rivet heads shall be of standard shape unless otherwise specified, and of uniform size for the diameter of rivet.

They shall be full, neatly made, concentric with rivet holes, and in full contact with the surface of the member.

506.03.08 Shop Riveting. Rivets shall be heated uniformly to a "light cherry red color" and shall be driven while hot. Any rivet whose point is heated more than the remainder shall not be driven. When a rivet is ready for driving, it shall be free from slag, scale, or other adhering matter. Any rivet which, in the opinion of the Engineer, is scaled excessively, shall be rejected.

All rivets that are loose, burned, badly formed, or otherwise defective shall be removed and replaced with satisfactory rivets. Any rivet whose head is deficient in size or whose head is driven off center will be considered defective and shall be removed. Stitch rivets that are loosened by the driving of adjacent rivets shall be removed and replaced with satisfactory rivets. Caulking or recupping of rivet heads will not be permitted.

Shop rivets shall be driven by direct-acting rivet machines where practicable. Approved beveled rivet sets shall be used for forming rivet heads on sloping surfaces. When the use of a direct-acting rivet machine is not practicable, pneumatic hammers of approved size shall be used. Pneumatic bucking tools will be required when, in the opinion of the Engineer, the size and length of the rivets warrant their use.

Rivets may be driven cold provided their diameter is not over three-eighths (⅜) inch.

506.03.09 Subpunching, Drilling, and Reaming. Unless otherwise specified, rivet holes and connections and splices (shop and field) of main truss or arch members, continuous beams, plate girders and rigid frames and rivet holes in plate girder flanges, and stiffeners, intermediate stiffeners intended as supports for concentrated loads, and web splices shall either be subpunched (or subdrilled) and reamed while shop assembled or drilled to full size from the solid while assembled at the shop. The assembly, including camber, alignment, accuracy of holes and mill joints, shall be approved by the Engineer before reaming is commenced.

Unless otherwise specified, each individual (full length) truss, arch, continuous beam, or girder shall be assembled at the shop before reaming or drilling is commenced. During shop assembly all members shall be supported at such intervals and in such manner as is necessary to avoid undesirable deflections.

All holes for floor beams and stringer field end connections shall be subpunched and reamed to a steel template.

506.03.10 Bolts and Bolted Connections. (a) General. Bolted connections shall not be used unless called for in the contract documents. Where bolted connections are permitted, the bolts furnished shall be as hereinafter specified. Ribbed high-tensile bolts or high-tensile strength bolts may be substituted for field rivets in locations where, in the opinion of the Engineer, it is impractical to drive rivets. Bolts shall be of such length that they will extend entirely through the nut, but not more than three-eighths (⅜) inch beyond. The Contractor shall furnish sufficient bolts of each type for each size and length to bolt such connections as called for with an ample surplus to replace those lost or rejected.

The holes, except holes in end diaphragms, shall be truly cylindrical. Holes shall be at right angles to the surface of the metal so that both head and nut will bear squarely against the metal. Bolts shall be driven accurately into the holes without damaging the thread. A snap shall be used to prevent damaging the heads.

Bolt holes in end diaphragms shall be slotted one-half (½) inch in addition to the dimensions shown on the plans, in the direction to facilitate erection. At all locations where such slotted bolt holes are required, circular washers shall be placed on each side of the bolted connection, and the necessary bolt length adjusted accordingly.

Bolts in end diaphragms to girder connections shall not be tightened until the deck pour has been completed.

All bolted connections shall be fastened with high-tensile-strength bolts or ribbed high-tensile-strength bolts. The use of unfinished bolts or plain ribbed bolts will not be permitted.

(b) High-Tensile-Strength Bolts. The use of high strength bolts in structural connections shall comply with article 2.10.20, "Construction Using High Strength Bolts," of the current AASHTO Standard Specifications for Highway Bridges.

506.03.11 Shop Assembly. Shop assembly of trusses, arches, continuous beams, continuous plate girders, and rigid frames shall be according to subsection 506.03.09, "Subpunching, Drilling, and Reaming." All members shall be match marked before being disassembled.

Complete shop assembly of an entire structure, including floor system, which may be necessary in the case of complicated design or of skewed or super-elevated structure shall be done only if required by the special provisions.

The several component parts of a built-up member shall be straight and close fitting.

Surfaces of metal in contact shall be cleaned before assembling. The parts of a member shall be assembled, well pinned, and firmly drawn together with bolts before drilling, reaming, or riveting is commenced. Assembled pieces shall be taken apart, if necessary, for the removal of burrs and shavings produced by the operations. The member shall be free from twists, bends, and other deformations.

End connections, angles, stiffener angles, and similar parts shall be carefully adjusted to correct positions and bolted, clamped, or otherwise firmly held in place until riveted.

The drifting done during assembling shall be only such as to bring the parts into position, and not sufficient to enlarge the holes or distort the metal. If any holes must be enlarged to admit the rivets, they shall be reamed.

Parts not completely riveted in the shop shall be secured by bolts insofar as practicable to prevent damage in shipment and handling.

Connecting parts assembled in the shop for the purpose of reaming holes in field connections shall be match marked, and a diagram showing such marks shall be furnished to the Engineer.

506.03.12 Edge Planing. Sheared edges of plates more than five-eighths (⅝) inch in thickness and carrying calculated stress shall be planed to a depth of one-fourth (¼) inch. Re-entrant cuts shall be filleted to a radius of three-fourths (¾) inch.

506.03.13 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 Association surface roughness requirements as defined in ASA B46.1–55, Surface Roughness, Waviness and Lay, Part 1:

Steel slabs	ASA	2,000
Heavy plates in contact in shoes to be welded	ASA	1,000
Milled ends of compression members, stiffeners, and fillers	ASA	500
Bridge rollers and rockers	ASA	250
Pins and pin holes	ASA	125
Sliding bearings	ASA	125

Surfaces of bronze bearing plates intended for sliding contact shall be planed parallel to the movement of the spans and polished.

506.03.14 Abutting Joints. Abutting joints in compression members of trusses and in columns shall be milled.

Openings and abutting joints in tension members shall not exceed one-fourth (¼) inch.

Abutting joints of continuous I beam spans shall be square and tight fit.

Abutting joints in top and bottom flanges of plate girders shall be square and tight fit.

506.03.15 Flame Cutting. Preparation of material flame cutting. This work shall be in accord with the provisions of AWS D1.1–72 and revisions as modified by the AASHTO Standard Specifications for Welding of Structural Steel Highway Bridges.

506.03.16 End Connection Angles. Floorbeams, stringers, and girders having end connection angles shall be

built to exact length shown on the plans measured between the heels of the connection angles, with a permissible tolerance of plus zero (0) inch to minus one-sixteenth (1/16) inch. Where continuity is to be required, end connections shall be faced. The thickness of the connection angles shall not be less than three-eighths (⅜) inch, nor less than that shown on the detail drawings.

506.03.17 Lacing Bars. The ends of lacing bars shall be neatly rounded unless another form is required.

506.03.18 Web Plates. In girders having no cover plates and not to be encased in concrete, the top edge of the web plate shall not extend above the backs of the flange angles and shall not be more than one-eighth (⅛) inch below at any point. Any portion of the plate projecting beyond the angles shall be chipped flush with the backs of the angles. Web plates or girders having cover plates may be one-half (½) inch less in width than the distance back to back of flange angles.

Splices in webs of girders without cover plates shall be sealed on the top by welding.

At web splices, the clearance between the ends of the web plates shall not exceed three-eighths (⅜) inch. The clearance at the top and bottom ends of web splice plates shall not exceed one-fourth (¼) inch.

506.03.19 Stud Shear Connectors. (a) Stud shear connectors shall be of a design suitable for end welding and shall be end welded to steel beams, girders, or plates with automatically timed stud welding equipment. The type, size or diameter, and length of stud shall be as specified in the contract documents. (See AWS D1.1–72 and revisions thereto as modified by AASHTO Standard Specifications for Welding of Structural Steel Highway Bridges for allowable tolerances.) A maximum variation of one (1) inch from the location shown will be accepted provided the adjacent studs are not closer than two and one-half (2½) inches center to center. The clear distance between

the edge of a girder flange and the edge of the shear connectors shall be not less than one (1) inch. Adequate provision shall be made in the fabrication of structural members to compensate for loss of camber due to welding of the shear connectors.

(b) Studs shall not be painted or galvanized. The studs shall be free from rust, scale, rust pits, and oil at the time of welding and immediately before the concrete is placed. The beam surface to which the studs are welded shall be free from excessive mill scale, rust, dirt, paint, grease, or any other material which might impair the quality of the weld. When necessary to obtain satisfactory welds, the areas on the beam, girder, or plate to which the studs are to be welded shall be wire-brushed, peened, prick-punched, or ground free of scale or rust.

(c) The Contractor shall submit to the Engineer for approval, before installation, information on the studs to be furnished as follows:

1. The name of the manufacturer.
2. A detailed description of the stud and arc shield.
3. A certification from the manufacturer that the stud is qualified as specified in AWS D1.1–72 and revisions thereto as modified by AASHTO Standard Specifications for Welding of Structural Steel Highway Bridges. The certification must also indicate the heat from which the studs were manufactured.

Welding specifications and procedure requirements shall conform to AWS D1.1–72 and revisions thereto as modified by AASHTO Standard Specifications for Welding of Structural Steel Highway Bridges.

506.03.20 Welding. Welding of steel structures when authorized in accordance with the provisions contained herein, called for in the contract documents, or upon written permission from the Engineer shall conform to the requirements of the 1972 Edition of the American Welding Society Standard Specifications D1.1–72 and revisions thereto as modified by AASHTO Standard Specifications for Welding of Structural Steel Highway Bridges.

Inspection and testing shall also conform to the provisions of AWS D1.1–72 and revisions thereto as modified by AASHTO Standard Specifications for Welding of Structural Steel Highway Bridges and Nevada Test Methods NHD 900, 901, and 903 except as modified in this subsection.

All welding shall be performed in the fabrication shop, except as otherwise noted on the plans or permitted by the Engineer.

(a) Inspection and Testing of Shop Welds:

1. Radiographic Inspection: The procedure, techniques and standards of acceptance shall be in conformance with the current AWS D1.1–72 and revisions thereto as modified by AASHTO Standard Specifications for Welding of Structural Steel Highway Bridges. The Engineer will make all final interpretations of weld defects and film quality. All radiographs will be the property of the Department during and after completion of the project.

2. Ultrasonic: The procedure, techniques, and standards of acceptance shall be in conformance with the current AWS D1.1–72 and revisions thereto as modified by AASHTO Standard Specifications for Welding of Structural Steel Highway Bridges except as modified in this subsection.

3. Magnetic Particle Inspection: This procedure and technique shall be in conformance with the current ASTM E–109 "Dry Powder Magnetic Particle Inspection."

(b) Inspection and Testing of Field Welds:

The Department will make either magnetic particle inspection, ultrasonic inspection or radiographic inspection of field welds when so required by the plans or the special provisions and the acceptability of welds will be judged in accordance with the Inspection and Testing of Shop Welds for the type of inspection employed.

Welds shall be painted according to the applicable provisions of Section 614, "Painting."

All groove welds on primary members shall be finished smooth and flush with the base metal on all surfaces by grinding in the direction of applied stress, leaving surfaces

free from depressions. Chipping may be used provided it is followed by such grinding.

506.03.21 Fit of Stiffeners. End stiffeners of girders and stiffeners intended as supports for concentrated loads shall be milled or ground to secure an even bearing against the flange. Intermediate stiffeners shall fit sufficiently tight to exclude water after being painted. Fillers under stiffeners shall fit within one-fourth (¼) inch at each end.

Welding will be permitted in lieu of milling or grinding if noted in the contract documents. Where stiffeners are required on one side of the web only, they shall be welded to the compression flange.

506.03.22 Annealing and Stress Relieving. Members such as bridge shoes, pedestals, or other parts which are built up by welding sections of plate together, and stress relieving is called for in the contract documents, stress relieving shall be in accordance with the provisions of the American Welding Society.

506.03.23 Pins, Rollers, and Pin Holes. Rollers shall be of structural carbon steel, and pins shall be of carbon steel forgings meeting the requirements of subsection 710.-03.08, "Pins and Rollers." Pins and rollers shall be accurately turned to the dimensions shown on the drawings and shall be straight, smooth, and free from flaws. Final surface shall be produced by a finishing cut.

In pins larger than nine (9) inches in diameter, a hole not less than two (2) inches in diameter shall be bored full length along the axis after the forging has been cooled to a temperature below the critical range under suitable conditions to prevent injury by too rapid cooling, and before being annealed.

Pin holes shall be bored true to the specified diameter, smooth and straight, at right angles with the axis of the member and parallel with each other unless otherwise specified.

The distance outside to outside of holes in tension members and inside to inside of holes in compression

members shall not vary from that specified more than one thirty-second ($\frac{1}{32}$) inch. Boring of holes in built-up members shall be done after the riveting is completed.

The diameter of the pin hole shall not exceed that of the pin by more than one-fiftieth ($\frac{1}{50}$) inch for pins five (5) inches or less in diameter, or more than one thirty-second ($\frac{1}{32}$) inch for larger pins.

Screw threads for all bolts and pins for structural steel construction shall conform to the American National Coarse Thread Series, Class 2, free fit, except that pin ends having a diameter of one and three-eighths ($1\frac{3}{8}$) inches or more shall be threaded six (6) threads to the inch.

Pilot and driving nuts shall be used in driving pins. They shall be furnished by the Contractor without charge. Two pilot nuts and two drifting nuts for each size of pin shall be furnished, unless otherwise specified. Pins shall be so driven that the members will take full bearing on them. Pin nuts shall be screwed up tight and the threads burred at the face of the nut with a pointed tool.

506.03.24 Shop Painting. Unless otherwise provided the application of shop paints shall conform to the requirements of Section 614, "Painting."

Surfaces to be in contact after shop riveting is completed shall be cleaned but shall not be painted.

506.03.25 Marking and Shipping. Each member shall be painted or marked with an erection mark for identification and an erection diagram shall be furnished with erection marks shown thereon. Members weighing more than three (3) tons shall have the weight marked thereon. Structural members shall be loaded on trucks or cars in such a manner that they may be transported and unloaded at their destination without being excessively stressed, deformed or otherwise damaged. All girders must be shipped in a standing position which position shall be maintained in subsequent operations.

506.03.26 Erection Methods and Equipment. Before starting work, the Contractor shall inform the Engineer

fully as to the method of erection he proposes to follow and as to the amount and character of the equipment he proposes to use, the adequacy of which shall be subject to the approval of the Engineer. The approval of the Engineer shall not be considered as relieving the Contractor of the responsibility for the safety and adequacy of his methods or equipment or from carrying out the work in full accordance with the plans and specifications. No work shall be done without the sanction of the Engineer.

Spot welding for the purpose of eliminating field erection bolts or for holding steel parts together while riveting will not be permitted.

All work of erection shall be subject to inspection and the Contractor shall furnish facilities for such inspection of material and workmanship. Material and workmanship not previously inspected shall be inspected after its delivery to the site of the work.

The Contractor shall provide the falsework and all tools, machinery and appliances, including drift pins and fitting up bolts, necessary for the expeditious handling of the work.

Anchor bolts for rail posts shall be galvanized high-strength bolts set with suitable templates in exact position and securely fixed to prevent displacement during the concreting operations. The areas of concrete upon which posts are to be set shall be dressed by grinding or rubbing to a true plane for the proper seating of the posts. All surfaces of aluminum alloy posts and adjustment shims to be in contact with concrete or with the steel anchor bolts, nuts, and washers shall be coated with aluminum insulating compound.

Rail posts shall be erected in sections. Erection of sections of rails and posts shall continue successively until all or an approved portion of the required rail is erected. The rail shall then be aligned and the nuts on the anchor bolts tightened. In final adjustment no posts shall deviate more than one-eighth (⅛) inch from true alignment and there shall be no abrupt break in alignment at any location. Aluminum shims may be slotted for ease in placing if approved by the Engineer.

506.03.27 Falsework. The falsework shall be properly designed and substantially constructed and maintained for the loads which come upon it. The Contractor shall prepare and submit to the Engineer, for approval, plans for falsework or for changes in an existing structure necessary for maintaining traffic. Approval of the Contractor's plans shall not be considered as relieving the Contractor of any responsibility.

Upon completion of the erection and before final acceptance, the Contractor shall remove all falsework, excavated or useless materials, rubbish and temporary buildings, replace or renew any fences damaged, restore in an acceptable manner all property, both public and private, which may have been damaged during the prosecution of the work, and leave the structure site and adjacent highway in a neat and presentable condition satisfactory to the Engineer.

All excavated material or falsework placed in the stream channel before construction shall be removed by the Contractor before final acceptance.

506.03.28 Bearing and Anchorage. Masonry bearing plates shall not be placed upon bridge seat bearing areas which are improperly finished, deformed, or irregular. Bearing plates shall be set level in exact position and shall have a full and even bearing upon the masonry. Unless otherwise directed by the Engineer, they shall be placed on a layer of canvas and red lead applied as follows: Thoroughly swab the bridge seat bearing area with red lead paint and place upon it three (3) layers of twelve (12) to fourteen (14) ounce duck, each layer being thoroughly swabbed on its top surface with red lead paint. Place the superstructure shoes or pedestals in position while the paint is plastic. As an alternate to canvas and red lead, sheet lead may be used if called for on the plans.

The milled and finished surfaces of castings or bearing plates shall have the shop coat of tallow, white lead, or oil removed immediately prior to placing in the structure. Surfaces designed for sliding movement, one upon the

other, shall be given a field coat of graphite grease when placed in the structure.

The Contractor shall drill the holes and set the anchor bolts, except where the holes are formed or the bolts are built into the masonry. The bolts shall be set accurately and fixed with Portland cement grout, completely filling the holes. The location of the anchor bolts in relation to the slotted holes in the expansion shoes shall correspond with the temperature at the time of erection. The nuts on anchor bolts at the expansion ends of spans shall be adjusted to permit free movement of the span.

Elastomeric bearing pads shall conform to the requirements specified in subsection 502.03.13, "Expansion and Fixed Joints and Bearings."

506.03.29 Field Assembling and Riveting. The parts shall be accurately assembled as shown on the plans and match-marks shall be followed. The material shall be carefully handled so that no part will be bent, broken, or otherwise damaged. Hammering which will injure or distort the members shall not be done. Bearing surfaces and surfaces to be in permanent contact shall be cleaned before the members are assembled. Unless erected by the cantilever method, truss spans shall be erected on blocking so placed as to give the trusses proper camber. The blocking shall be left in place until the tension chord splices are fully riveted and all other truss connections pinned and bolted. Splices of riveted butt joints of compression members, in railings, and in other field splice connections shall have one-half (½) of the connection holes filled with bolts and cylindrical erection pins (half bolts and half pins) before riveting. Splices and connections carrying traffic during erection shall have three-fourths (¾) of the holes so filled.

Fitting-up bolts shall be of the same nominal diameter as the rivets, and cylindrical erection pins shall be one thirty-second ($\frac{1}{32}$) inch larger.

Pneumatic hammers shall be used for field riveting. Cup-faced dollies fitting the head closely to insure good bearing

shall be used. Connections shall be accurately and securely fitted up before the rivets are driven. Driftings shall be only such as to draw the parts into position and not sufficient to enlarge the holes or distort the metal. Unclear holes shall be reamed or drilled. Rivets shall be heated uniformly to a light "cherry-red" color and shall be driven while hot. They shall not be overheated or burned. Rivet heads shall be full and symmetrical concentric with the shank and shall have full bearing all around. They shall not be smaller than the heads of the shop rivets. Rivets shall be tight and shall grip the connected parts securely together. Caulking or recupping will not be permitted. In removing rivets, the surrounding metal shall not be injured; if necessary, they shall be drilled out.

Field driven rivets shall be inspected and accepted before being painted.

506.03.30 Misfits. The correction of minor misfits involving nonharmful amounts of reaming, cutting, and chipping shall 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 the 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 approval of the method of correction obtained. The correction shall be made in his presence. The Contractor shall be responsible for all misfits, errors, and injuries and shall make the necessary corrections and replacements.

506.03.31 Field Painting. Structural steel, unless otherwise specified, shall be painted as specified in Section 614, "Painting."

METHOD OF MEASUREMENT

506.04.01 Measurement. Measurement of structural steel will be either by the pound or lump sum as follows except that bridge and pedestrian rail may be measured by the linear foot.

(a) Pound basis. When structural steel is measured for payment by the pound, the calculated poundage shown on the plans, plus or minus quantities covered by approved changes, will be the quantity used for payment. The Engineer or the Contractor may request final measurement if a possible error is suspected in the quantities shown on the plans. The Contractor's request for final measurement shall be in writing. Final measurement will be made according to the dimensions shown on the plans plus or minus approved changes, and quantities derived therefrom will be the quantities used for payment.

The calculated weight shall be based on the following assumptions:

1. Unit weights, pounds per cubic foot:

Iron, malleable	470.0
Iron, wrought	487.0
Steel, rolled, cast, copper bearing, silicon, nickel, and stainless	490.0

The quantity of structural steel measured for payment will be the number of pounds complete and in place except that additional weight of substitutions made at the Contractor's request will not be included.

2. The weight of shop rivets will be computed on the basis of reasonable average lengths, in accordance with the following table:

Rivet Diameter (inches)	Pounds per 100 Rivets
½	20
⅝	30
¾	50
⅞	100
1	150
1⅛	250
1¼	325

The weight of bolts, cap screws, anchor bolts, nuts, washers and anchor pipe sleeves remaining in the finished structure will be computed on the basis of their nominal weight and dimensions.

3. The weight of paint will not be included in the computed weight of metals.

4. The weight of weld metal will be computed on the basis of the theoretical volume of the dimensions of the welds with no allowance for overrun.

(b) Lump sum basis. When specified, structural steel acceptably completed in the structure as shown on the plans will be measured for payment by the lump sum. There will be no change in measurement due to substitutions made at the Contractor's request.

If the proposal contains such an item, bridge rail shall be measured in linear feet between concrete posts in the completed work. Measurement will be made to the nearest linear foot of rail for each structure measured along the top of the parapet from concrete end post to concrete end post.

Pedestrian rail shall be measured by the linear foot of rail installed, complete in place.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

506.05.01 Payment. The accepted quantity of structural steel measured as provided in subsection 506.04.01, "Measurement," shall be paid for at the contract unit price bid per pound or lump sum for structural steel as set forth for the bid item in the proposal.

The additional steel in substitutions made at the Contractor's request will not be paid for.

The price per pound or lump sum shall constitute full compensation for doing all the work involved in furnishing, fabricating, delivering, erecting, and painting the steel work in accordance with the details shown on the plans and as herein specified, including furnishing of mill test reports and test specimens, except the specimens for full size tests. This price shall also include full compensation for furnishing and calibrating torque wrenches and/or power wrenches and all necessary equipment as required for testing high-strength bolt connections.

Unless otherwise specified and provided for in the proposal, the lump sum price shall include all specified and approved metal in the finished structure, including rivets,

bolts, anchor bolts, scuppers and floor drains, castings, pier nosing angles, plates, copper, bronze and copper-alloy plates, and anchorages; also duck material and preformed pads under bearings.

Bridge rail or pedestrian rail shall be paid for at the contract unit price bid per linear foot for the type specified whether it be constructed of steel or aluminum, which payment shall be full compensation for furnishing, fabricating, delivering, erecting, painting and for all labor, materials, tools, supplies, equipment and incidentals necessary to complete the item, and for furnishing of mill test reports and test specimens.

Full compensation for conforming to the welder qualification requirements of this section shall be considered as included in the contract price paid per pound or lump sum for structural steel and no separate payment will be made therefor.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Structural Steel	Pound or Lump Sum
Bridge Rail (type)	Linear Foot
Pedestrian Rail (type)	Linear Foot

SECTION 507

TIMBER STRUCTURES

DESCRIPTION

507.01.01 General. This item shall consist of furnishing, framing, and installing timber of the kind, sizes, and dimensions and in accordance with the lines, grades, and sections shown on the plans.

MATERIALS

507.02.01 General. Materials shall meet the requirements of the following sections:

Structural and Eyebar Steel	Section 710
Paint	Section 714
Miscellaneous Metals	Section 712
Hardware	Section 723
Timber	Section 718
Timber Preservative	Section 719

If material lists or order lists are sent by the Contractor to the Engineer for checking or approval, such checking or approval by the Engineer shall in no way relieve the Contractor of responsibility for the correctness of such lists. Any expenses incident to the revision of materials furnished in accordance with such lists to make them comply with the design drawings shall be borne by the Contractor.

All framing lumber and structural timber, unless otherwise specified or shown on the plans, shall be Douglas Fir or West Coast Hemlock or Larch.

CONSTRUCTION

507.03.01 Storage of Materials. Lumber and timber on the site of the work shall be stored in piles.

Untreated material shall be open-stacked at least twelve (12) inches above the ground surface and piled to shed water and prevent warping. When required by the Engineer, it shall be protected from the weather by suitable covering.

Treated timber and piling shall be close-stacked and piled to prevent warping.

The ground underneath and in the vicinity of all material piles shall be cleared of all weeds and rubbish.

507.03.02 Workmanship. Workmanship shall be first class throughout. None but competent bridge carpenters shall be employed, and all framing shall be true and exact. Unless otherwise specified, nails and spikes shall be driven with just sufficient force to set the heads flush with the surface of the wood. Deep hammer marks in wood surfaces shall be considered evidence of poor workmanship and sufficient cause for removal of the workman causing them. The workmanship on all metal parts shall conform to the requirements specified in Section 506, "Steel Structures."

507.03.03 Treated Timber. Treated timber and piling shall be carefully handled without sudden dropping, breaking of the outer fibers, bruising, or penetrating the surface with tools. It shall be handled with rope sling. Cant hooks, peaveys, pikes, or hooks shall not be used.

All cutting, framing, and boring of treated timbers shall be done before treatment insofar as is practicable.

All cuts in treated piles or timbers, and all abrasions, after being carefully trimmed, shall be covered with two applications of a mixture of sixty (60) percent creosote oil and forty (40) percent roofing pitch, or brush coated with at least two applications of hot creosote oil and covered with hot roofing pitch.

All bolt holes, bored after treatment, shall be treated with creosote oil by means of an approved pressure bolt hole treater. Unfilled holes, after being treated with creosote oil, shall be plugged with creosoted plugs.

Whenever, with the approval of the Engineer, forms or temporary braces are attached to treated timber with nails or spikes, the hole shall be filled by driving galvanized nails or spikes flush with the surface or plugging holes as required for bolt holes.

507.03.04 Untreated Timber. In structures of untreated timber the following surfaces shall be thoroughly

coated with two coats of hot creosote oil before assembling: Ends, tops, and all contact surfaces of sills, caps, floors, and stringers; and all ends, joints and all contact surfaces of bracing and truss members. The back faces of bulkheads and all other timber which is to be in contact with earth, metal, or other timber shall be similarly treated.

Unless untreated timber is to be used in the construction within three (3) days after date of delivery, it shall be painted on each end with a prime coat at time of delivery.

507.03.05 Holes for Bolts, Dowels, Rods, and Lag Screws. Holes for round drift-holes and dowels shall be bored with a bit one-sixteenth ($\frac{1}{16}$) inch less in diameter than the bolt or dowel to be used. The diameter of holes for square drift-bolts or dowels shall be equal to the least dimension of the bolt or dowel.

Holes for machine bolts shall be bored with a bit of the same diameter as the bolt.

Holes for rods shall be bored with a bit one-sixteenth ($\frac{1}{16}$) inch greater in diameter than the rod.

Holes for lag screws shall be bored with a bit not larger than the body of the screw at the base of the thread.

507.03.06 Bolts and Washers. A washer of the size and type specified shall be used under all bolt heads and nuts which would otherwise come in contact with wood.

The nuts of all bolts shall be effectively locked after they have been finally tightened.

Countersinking shall be done whenever smooth faces are required. Horizontal recesses formed for countersinking shall be painted with hot creosote oil, and after the bolts are screwed in place, shall be filled with hot pitch.

507.03.07 Framing. All lumber and timber shall be accurately cut and framed to a close fit in such manner that the joints will have even bearing over the entire contact surfaces. Mortises shall be true to size for their full depth and tenons shall fit snugly. No shimming will be permitted in making joints, nor will open joints be accepted.

Mud sills shall be firmly and evenly bedded to solid bearing and tamped in place.

Concrete pedestals for the support of framed bents shall be carefully finished so that the sills or posts will take even bearing on them. Dowels of not less than three-fourths (¾) inch diameter and projecting at least six (6) inches above the tops of the pedestals, shall be set in them when they are cast, for anchoring the sills or posts.

Sills shall have true and even bearing on mud sills, piles, or pedestals. They shall be drift-bolted to mud sills or piles with bolts of not less than three-fourths (¾) inch diameter and extending into the mud sills or piles at least six (6) inches. When possible, all earth shall be removed from contact with sills so that there will be free air circulation around them.

Posts shall be fastened to pedestals with dowels of not less than three-fourths (¾) inch diameter, extending at least six (6) inches into the posts.

Posts shall be fastened to sills by one of the following methods, as indicated on the plans:

(a) By dowels of not less than three-fourths (¾) inch diameter, extending at least six (6) inches into posts and sills.

(b) By drift-bolts of not less than three-fourths (¾) inch diameter driven diagonally through the base of the post and extending at least nine (9) inches into the sill.

507.03.08 Caps. Timber caps shall be placed to secure an even and uniform bearing over the tops of the supporting posts or piles and to secure an even alignment of their ends. All caps shall be secured by drift-bolts, as indicated on the plans, extending at least nine (9) inches into the posts or piles. Drift-bolts shall be approximately in the center of the post or pile.

507.03.09 Bracing. The ends of bracing shall be bolted through the pile, post or cap with a bolt of not less than five-eighths (⅝) inch diameter. Intermediate intersections shall be bolted and spiked with wire or boat spikes, as indicated on the plans. In all cases spikes shall be used in addition to the bolts.

507.03.10 Stringers. Stringers shall be sized at bearings and shall be placed in position so that knots near edges will be in the top portions of the stringers.

Outside stringers may have butt joints with the ends cut on a taper, but interior stringers shall be lapped to take bearing over the full width of the floor beam or cap at each end. The lapped ends of untreated stringers shall be separated at least one-half (½) inch for the circulation of air and shall be securely fastened by drift-bolts where specified. When stringers are two panels in length the joints shall be staggered.

Cross-bridging between stringers shall be neatly and accurately framed and securely toe-nailed with at least two nails at each end. All cross-bridging members shall have full bearing at each end against the sides of stringers. Unless otherwise specified in the contract, cross-bridging shall be placed at the center of each span.

507.03.11 Plank Floors. Unless otherwise specified, flooring plank shall be surfaced one side and one edge. Single plank floors shall consist of a single thickness of plank supported by stringers or joints. The plank shall be laid heart side down with one-fourth (¼) inch openings between them for locally seasoned material and with tight joints for unseasoned material. Each plank shall be securely spiked to each joist. The plank shall be carefully graded as to thickness and so laid that no two adjacent planks will vary in thickness more than one-sixteenth ($\frac{1}{16}$) inch.

Two-ply timber plank floors shall consist of two layers of flooring supported on stringers or joists. The lower course shall be pressure-treated with a creosote oil. The top course may be laid either diagonal or parallel to the centerline of the roadway, as specified, and each floor piece shall be securely fastened to the lower course. Joints shall be staggered at least three (3) feet. If the top flooring is placed parallel to the centerline of the roadway, special care shall be taken to securely fasten the ends of the flooring. At each end of the bridge these members shall be beveled.

507.03.12 Laminated Floors. Laminated floors shall

be composed of three (3) by six (6) inch or two (2) by six (6) inch timbers, as indicated on the plans, laid on edge at right angles to the centerline of the roadbed, unless otherwise shown on the plans.

The flooring may be of random length and multiples of the stringer spacing with no single piece less than six (6) feet long. All splices shall be made on the centerline of a stringer and shall not occur oftener than once in six (6) inches on any one stringer.

Laminations shall be laid with a finished edge down. Before laying, the tops of stringers shall be checked with a straightedge and adjacent stringers which vary more than one-eighth (⅛) inch from a true plane, except treated stringers, shall be surfaced to meet this requirement. Treated stringers which do not meet the requirements may be rejected but shall not be framed or adzed after treatment. Each piece of flooring shall be fastened to the preceding strip at each end and at approximately eighteen (18) inch intervals with spikes or nails driven alternately near the top and bottom edges. Spikes or nails shall be of sufficient length to pass through two strips and at least halfway through the third strip. If timber supports are used, each piece shall be toe-nailed to every other support with 20d or 30d nails. Care shall be taken to have each strip vertical and tight against the preceding one, and bearing evenly on all supports.

507.03.13 Trusses. Trusses, when completed, shall show no irregularities of line. Chords shall be straight and true from end to end in horizontal projection, and in vertical projection, shall show a smooth curve through panel points conforming to the correct camber. All bearing surfaces shall fit accurately. Uneven or rough cuts at the points of bearing shall be cause for rejection of the piece containing the defect.

Unless otherwise directed by the Engineer, housings and railings shall be built after the removal of the falsework and the adjustment of the trusses to correct alignment and camber.

507.03.14 Painting. Outside stringers, wheel guards, rails, rail posts, and exposed surfaces of scupper blocks, filler blocks, and flooring of untreated timber, or timber treated with preservative salts, shall be painted as specified in Section 614, "Painting."

Ends of all pieces of untreated timber not otherwise painted shall be painted with one prime coat.

Metal parts, except hardware, shall be painted as specified in Section 614, "Painting," and given the number of coats specified in subsection 714.03.01(b), "Miscellaneous Iron."

METHOD OF MEASUREMENT

507.04.01 Measurement. The quantity of timber and lumber to be measured for payment will be the number of thousand feet board measure (Mfbm) conforming to all the requirements in the completed work.

All measurements will be in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

507.05.01 Payment. The accepted quantity of materials measured as provided in subsection 507.04.01, "Measurement," will be paid for at the contract unit price bid per thousand feet board measure (Mfbm).

The above prices shall be full compensation for furnishing all materials, including hardware, treating, erecting, and for all incidentals necessary for doing all the work involved, as shown on the plans or established by the Engineer, all in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Type Lumber	Mfbm

SECTION 508

PILING

DESCRIPTION

508.01.01 General. This work shall consist of furnishing and driving bearing piles of the kind, shape, and size called for in the contract documents. It includes timber piles, precast or cast in place concrete piles, sheet piling, and steel piles as described herein and is also applicable to other types of bearing piles if called for in the contract documents.

MATERIALS

508.02.01 General. Materials shall conform to the requirements of the following sections and subsections:

Steel Shell for Piles	Subsection 712.03.08
Steel Piles ("H" piles, sheet piling)	Subsection 712.03.07
Reinforcement	Section 713
Timber Piles	Section 717

Materials for concrete shall conform to the requirements of Section 501, "Portland Cement Concrete."

The Contractor shall furnish the Engineer with copies of mill test reports on the steel shells and steel piles.

CONSTRUCTION

508.03.01 Determination of Length. Bearing piles of any material shall be of such length as is required to develop the specified bearing value, to obtain the specified penetration, and to extend into the cap or footing block as indicated on the plans, after cutoff of any damaged portion.

The Contractor shall be responsible for furnishing piling of sufficient length to obtain the penetration and bearing value required. For the purpose of determining the lengths of the piles required, the Contractor, at his expense, may

drive test piles, make borings or make such other investigations as may be necessary.

508.03.02 Test Piles. Test piles furnished and driven by the Contractor for his use in determining the lengths of piles to be furnished may be so located that they may be cut off and become a part of the completed structure provided that such test piles conform to the requirements for piling as specified in these specifications.

Test piles which are designated in the contract documents shall conform to the requirements for piling as specified in these specifications and shall be so located that they may be cut off and become a part of the completed structure.

Test piles that are to become a part of the completed structure shall be driven with the same type of equipment that is to be used for driving foundation piles.

Test piles which are not to be incorporated in the completed structure shall be removed to at least two (2) feet below the surface of the ground and the remaining hole shall be backfilled with earth or other suitable material.

When piles are shown on the plans or specified in the special provisions to be load tested, such piles shall be load tested in accordance with the provisions in subsection 508.03.07, "Load Testing."

508.03.03 Equipment. The driving equipment shall be in good operating condition.

The size of hammer shall be selected to suit the conditions that will be encountered. It shall neither be so small that its energy will be largely dissipated in lost energy during driving nor so great that it will cause too rapid penetration and damage to the pile. If the size of the hammer used is found to be unsatisfactory, it shall be replaced with a larger or smaller hammer or other corrective measures shall be used as required to produce satisfactory results.

All piles shall be driven with either single or double acting steam, air, or diesel hammers.

Precast concrete piles shall be driven with a steam, air

or diesel hammer which shall develop an energy per blow at each full stroke of the piston of not less than one (1) foot-pound for each pound of weight driven.

For cast-in-place concrete piles where a mandrel is used in driving the shell, the total weight of the mandrel and the shell shall be considered as the weight of the pile and the hammer shall meet the same requirements as for precast concrete piles.

Hammers for driving H-bearing steel piles and steel shells for cast-in-place concrete piles, which are driven without mandrel, shall be steam, air, or diesel hammers of sufficient capacity to drive the pile or shell to the required penetration and bearing value without appreciable distortion or distress to the pile or shell.

Steam or air hammers shall be furnished with boiler or air capacity at least equal to that specified by the manufacturers of the hammers to be used. The boiler or compressor shall be equipped with an accurate pressure gauge at all times. The valve mechanism and other parts of the steam or air hammer shall be maintained in first-class condition so that the length of stroke and number of blows per minute for which the hammer is designed will be obtained. Inefficient steam or air hammers shall be removed from the work. When necessary to obtain the required penetration, the Contractor shall supply and operate at his own expense, single or double water jets and pumps or furnish the necessary drilling apparatus and drill holes not greater than the diameter of the pile to the proper depth and drive the piles therein. If a pile is set in a drilled hole, it shall be driven sufficiently to fix the point firmly and secure full bearing. Except as described in subsection 508.03.04, "Driving of Piles," jets or drills may be used only when so specified or ordered in writing by the Engineer.

Diesel-powered hammers may be used provided the required energy per blow, as specified for steam hammers is delivered for the type of piling to be driven.

Driving leads shall be used and shall be constructed in such a manner as to afford freedom of movement of the hammer, and they shall be held in position by guys or

stiff braces to insure support to the piles during driving. Except where piles are driven through water, the leads shall be of sufficient length so that the use of a follower will not be necessary.

508.03.04 Driving of Piles. Unless otherwise permitted by the Engineer, piles shall not be driven until after the excavation is completed. Any material forced up between the piles shall be removed to correct elevation before masonry for the foundation is placed.

Care shall be exercised to prevent damage to the piles due to overdriving.

Piles shall be driven battered (sloped) if called for on the plans.

Piles, other than sheet piles, shall not be driven until the approach fills are compacted and in place to an elevation of one and one-half (1½) feet above the bottom of the concrete abutment, as indicated on the plans. When piles are to be driven through embankment and the depth of the embankment at the pile location is in excess of five (5) feet, the pile (other than sheet pile) shall be driven in a hole drilled through the embankment. The hole shall have a diameter large enough to allow a minimum of two (2) inch clearance around the pile. After driving the pile, the space around the pile shall be filled to ground surface with dry sand or pea gravel.

When an abutment area is to be surcharged, piles shall not be driven therein until the surcharge has been in place the required period of time.

All piles raised during the process of driving adjacent piles shall be driven down again.

Unless otherwise ordered, inclined leads shall be used in driving battered piles.

An adequate cushion cap shall be used in driving precast concrete piles. When driving timber piles a cushion cap shall be used and not less than two separate steel straps shall be placed within two (2) feet of the butt of each pile. Steel strapping shall conform to the requirements of A.W.P.I. specifications, except that the straps shall encircle the pile only once per strap. The top of the pile

and the cap shall be so shaped that the blow of the hammer will be uniformly distributed to the entire top surface of the pile.

When load tests are required, piling shall not be driven until after test loading has been completed, except in case of service piles driven to serve as anchor piles for the test loading.

If the top of a pile becomes broomed, split, or crushed during the driving, the driving shall be stopped until the pile has been repaired or replaced by a new one.

The driving heads shall closely fit the top of the steel pile or shall extend down over the sides of the pile at least four (4) inches.

Piles shall be driven to the position and line indicated on the plans. Piles out of position and line more than the diameter of the pile, shall be pulled and replaced unless otherwise approved by the Engineer. When the tops of foundation piles are incorporated in a concrete footing, the distance from the side of any pile to the nearest edge of the footing shall not be less than nine (9) inches. Any additional materials required because of out-of-line piles that are allowed to remain in place will be at the expense of the Contractor.

508.03.05 Bearing Value and Penetration. Piles shall be driven to a bearing value of not less than the design loading shown on the plans, and in addition shall penetrate at least to the specified tip elevation shown on the plans at any location where a specified tip elevation is shown, unless otherwise permitted in writing by the Engineer; or shall penetrate at least ten (10) feet into the natural ground when a tip elevation is not specified, unless a lesser penetration is approved by the Engineer.

Natural ground in any area or highway embankment shall be defined as the bottom of the highway embankment.

When the pile design loading is omitted from the plans, timber, steel, and concrete piles shall be driven to bearing values equal to the Maximum Design Loads for Piles, specified in the Standard Specifications for Highway

Bridges of the AASHTO. The bearing values for driven piles shall be determined from the following formula:

$$P = \frac{2E}{S + 0.1}$$

P=Safe bearing value in pounds.

E=The energy of the hammer blow in foot-pounds.

For drop hammers and single acting steam hammers, E=WH, where W is the weight of the striking parts of the hammer in pounds, and H is the height of fall of the striking parts in feet.

For double acting or differential steam hammers, E=The manufacturer's rated energy in foot-pounds.

For diesel hammers, E will be determined by the Engineer.

S=The average penetration in inches per blow for the last five to ten blows.

The above formula is applicable only when:

(a) The hammer has a free fall.

(b) The head of pile is not damaged.

(c) The penetration is reasonably quick and uniform.

(d) A follower is not used.

Twice the height of bounce shall be deducted from H to determine its value in the formula.

If the weight of the pile and the driving cap and all parts driven is greater than the weight of the striking parts of the hammer, the formula shall be multiplied by the factor $\frac{2W}{W + P}$ where P is the weight of the pile and cap.

In case jets are permitted in connection with the driving, the bearing power shall be determined by the above formula from results after the jets have been withdrawn.

508.03.06 Cut Off and Extensions. Timber piles which are to be capped shall be accurately cut off so that true bearing is obtained on every pile without use of shims. Other timber piles shall be cut off on the square at the elevation designated. Piles inaccurately cut off shall be replaced. Splicing of timber piles will not be permitted except upon the written permission of the Engineer. Concrete piles shall be cut off at such elevation that they will extend into the cap or footing as indicated on the plans.

Concrete piles may be cast the full length of the reinforcing bars, providing that the concrete is cut off to expose the steel as shown on the plans after the piles have been driven. When it is necessary, after driving, to increase the length of precast concrete piles, concrete shall be removed to expose sufficient reinforcing steel to permit a lap of at least forty diameters. The added length shall be sufficient to reach the elevation of the bottom of the cap and shall be of the same section and the same reinforcement as the pile itself.

When the cut off elevation for precast concrete pile is below the elevation of the bottom of the cap, the pile shall be built up from the butt of the pile to the elevation of the bottom of the cap by means of a reinforced concrete extension constructed as shown on the plans.

The work of cutting off precast concrete piles shall be performed in such a manner as to avoid spalling or damaging the pile below the cutoff. In case of such damage the pile shall be replaced or repaired as required by the Engineer.

All cut off lengths of piling shall remain the property of the Contractor and shall be disposed of outside the highway right of way in accordance with the provisions of subsection 107.14, "Disposal of Material Outside Highway Right of Way."

508.03.07 Load Testing. The number and location of the load tests shall be as noted on the plans or designated by the Engineer.

Unless otherwise specified, the Department will furnish the jacking equipment, suitable jacking beams and extensometers.

Piling to be load tested and any anchor piling required, which are not part of the permanent structure, shall be included as part of the "Load Test."

The method of load testing shall be as shown on the plans or as designated by the Engineer.

METHOD OF LOADING

Test loading shall consist of the application of incremental static loads to a pile and measuring the resultant

settlement. The loads shall be applied by a hydraulic jack acting against suitable anchorage, transmitting the load directly to the pile or other methods designated by the plans or approved by the Engineer.

The load shall be applied in increments of five (5) or ten (10) tons as directed by the Engineer. Gross settlement readings, loads and other data shall be recorded by the Engineer immediately before and after the application of each load increment.

Each load increment shall be held for an interval of two and one-half (2½) minutes. Each succeeding increment shall be as directed by the Engineer or as shown on the plans and shall be applied immediately after the two and one-half (2½) minute interval readings have been made.

When the load-settlement curve obtained from these test data shows that the pile has failed, i.e., the load can be held only by constant pumping and the pile is being driven into the ground, pumping shall cease. Gross settlement reading, loads and other data shall be recorded immediately after pumping has ceased and again after an interval of two and one-half (2½) minutes for a total period of five (5) minutes. All load shall then be removed and the member allowed to recover. Gross settlement readings shall be made immediately after all loads have been removed and at each interval of two and one-half (2½) minutes for a total period of five (5) minutes.

All test loads shall be carried to failure or to the capacity of the equipment, unless otherwise noted on the plans.

508.03.08 Timber Piles. The specie of timber used for timber piles shall be either Douglas Fir, Southern Yellow Pine, Larch, or Cedar as shown in the contract documents.

When treated piles are required they shall be given a preservative treatment of creosote by pressure process to retain at least ten (10) pounds of creosote per cubic foot.

Timber piles shall conform to the requirements of Section 717, "Timber Piles," and shall be inspected as therein provided.

Commercially treated piles from stock may be used for test piles when required. Where commercially treated piles are permitted, stamping the piles by the inspector before treatment will not be required.

Treated timber piles shall be carefully handled during and after unloading from cars. They shall not be dragged across the ground at any time and shall be handled only with rope slings or with wooden equipment. Sharp tools shall be permitted only when used for necessary field cutting and trimming. All places where the surface of creosoted piling is broken by cutting, boring, or otherwise, shall be thoroughly coated with at least three applications of hot creosote oil. Each application shall be allowed to become reasonably dry before the succeeding one is applied.

The piles in any one bent shall be carefully selected as to size, to avoid undue bending or distortion of the sway bracing. However, care shall be exercised in the distribution of piles of varying sizes to secure uniform strength and rigidity in the bents of any given structure.

Heads of piles, when the nature of the driving is such as to unduly injure them, shall be protected by caps of approved design.

When timber caps are specified, a coat of hot creosote oil shall be first applied to the head of the pile and a protective cap shall be built up by applying alternate layers of loosely woven fabric in a hot asphalt or tar using three layers of asphalt or tar and two layers of fabric. The fabric shall measure at least six (6) inches more in each direction than the diameter of the pile and shall be turned over the pile and the edges secured by binding with two turns of No. 10 galvanized wire. The fabric shall be wired in advance of the application of the final coat of asphalt or tar which shall extend down over the wiring.

In lieu of the above method of treatment, the sawed surface may be covered with three applications of a hot mixture of sixty (60) percent creosote oil and forty (40) percent roofing pitch, or thoroughly brush coated with three applications of hot creosote oil and covered with hot roofing pitch. A covering of galvanized sheet iron shall be

placed over the pitch coating and bent down over the sides of the pile to shed water.

The method to be used shall be at the option of the Contractor unless otherwise provided on the plans or in the special provisions.

508.03.09 Precast Concrete Piles. Precast concrete piles shall be constructed of Class A or AA Portland cement concrete proportioned and mixed in accordance with the requirements of Section 501, "Portland Cement Concrete," and placed in accordance with Section 502, "Concrete Structures," of these specifications. Reinforcing steel shall conform to the requirements of Section 505, "Reinforcing Steel," of these specifications.

Concrete for precast concrete piles shall be poured in smooth watertight forms, so supported as to prevent appreciable deformation or settlement during pouring or curing. When removed from the form, the piles shall present true, smooth even surfaces free from honeycombs and voids and shall be such that a line stretched from butt to tip on any face will not be more than one (1) inch from the face of the pile at any point.

Concrete piles shall be kept continuously wet for at least ten (10) days after pouring and shall be allowed to harden for at least thirty (30) days before being lifted or driven, except that this thirty (30) day requirement may be decreased if the specimen of concrete from which the piles were poured develops a strength of three thousand (3,000) pounds or more per square inch of compression.

When raising or transporting precast concrete piles, the Contractor shall provide slings or other equipment to avoid any appreciable bending of the pile or cracking of the concrete. Piles materially damaged in handling or driving shall be replaced. Concrete piles shall be so handled at all times as to avoid breaking or chipping of the edges.

508.03.10 Cast-In-Place Concrete Piles. Concrete filling for cast-in-place concrete piles shall be Class A or AA Portland cement concrete conforming to the requirements of Section 501, "Portland Cement Concrete," of these specifications. Reinforcement shall conform with the details

shown on the plans and the requirements of Section 505, "Reinforcing Steel." Cast-in-place concrete piles shall consist of one of the following: Steel shells driven permanently to the required bearing value and filled with concrete; or, drilled holes filled with concrete.

(a) Steel Shells. Steel shells shall be of sufficient strength and rigidity to permit their driving and to prevent distortion caused by soil pressures or the driving of adjacent piles until filled with concrete. The shells shall also be sufficiently watertight to exclude water during the placing of concrete.

The shells may be cylindrical or tapered, step tapered, or a combination of either with cylindrical sections. The tip diameter shall not be less than eight (8) inches and the butt diameter shall not be less than shown on the plans.

Shells to be driven without a mandrel shall be equipped with heavy steel driving ends and all joints in the shell shall be welded or adequately lock seamed.

After being driven and prior to placing concrete and reinforcing steel therein, the steel shells or casings shall be examined for collapse or reduced diameter at any point. Any shell or casing that is improperly driven or broken or shows partial collapse to such an extent as to materially decrease its bearing value will not be accepted and shall be replaced by the Contractor at his own expense. Driven shells or casings shall be clean and free from water before concrete and reinforcing steel are placed. The Contractor shall have available at all times a suitable light for the inspection of the shells, throughout the entire length, before they are filled with concrete and reinforcing steel.

Concrete shall be placed in steel shells so that it is dense and homogeneous. The upper portion of the shell shall be vibrated to a depth of not less than one-third (⅓) the length of the pile or ten (10) feet, whichever is the greater.

(b) Drilled Holes. Except for a minimum amount of water necessary for penetration of the drill, all holes for concrete piles cast in drill holes shall be drilled dry to the tip elevation shown on the plans or to the elevation determined by the Engineer. No standing water in the bottom of hole, after final drilling, will be permitted. All holes shall be examined for straightness and any hole which on visual

inspection from the top shows less than one-half (½) the diameter of the hole at the bottom of the hole shall be rejected. Suitable casings shall be furnished and placed when required to prevent caving of the hole before concrete is placed therein.

All loose material existing at the bottom of the hole after drilling operations have been completed shall be removed or compacted to the satisfaction of the Engineer before placing concrete in the hole.

Materials resulting from drilling holes shall be disposed of as provided in the last paragraph of subsection 206.-03.01, "General."

Surface water shall not be permitted to enter the hole and all water which may have infiltrated into the hole shall be removed before placing concrete therein.

Casing, if used in drilling operations, shall be removed from the hole as concrete is placed therein. The bottom of the casing shall be maintained not more than five (5) feet nor less than one (1) foot below the top of the concrete during withdrawal and placing operations unless otherwise permitted by the Engineer. The casing shall be hammered or the concrete vibrated during withdrawal of the casing.

Care shall be exercised to insure that the concrete in the hole is dense and homogeneous. Vibration of the concrete during placing will not be required. The concrete in the hole for the length of the reinforcing cage (bottom of spiral wire) shall be vibrated.

The reinforcing cage shall be placed and secured symmetrically about the axis of the pile and shall be securely blocked to clear the sides of the hole.

For either (a) or (b) the bottom of each shell casing or hole shall be filled with mortar to a depth of not less than two (2) feet immediately before placing the concrete filling materials. The mortar shall consist of one part Portland cement, three parts fine aggregate mixed to a suitable consistency or Class A or AA concrete with three-fourths (¾) inch or larger aggregate removed.

The length of steel shell to be ordered shall be determined by the Contractor. Should the Contractor elect to order piling in short lengths, all splices necessary to build

up these shorter lengths to the length required, other than those splices specified for payment in subsection 508.04.01 of these specifications, shall be at the Contractor's expense.

508.03.11 Steel Piles. Steel piles shall be H-bearing of the section shown on the plans.

The length of steel pile may be built up in sections either before or during the driving operations. The sections, unless otherwise shown on the plans, shall be identical in cross section. The connections shall be made by welding the entire cross section in conformance with the requirements of subsection 506.03.20, "Welding." Care shall be taken to properly align the sections connected so that axis of the pile will be straight. The number of welded connections in the length of a pile shall be preferably as few as practicable. If a welded splice is made during the driving operation, it shall be done when the top of the lower portion is at least three (3) feet above the ground to permit observation of the welded connection during several feet of driving.

Piling built up from structural steel plates welded together may be substituted for the rolled steel piling shown on the plans provided that the depth, width, average mean thicknesses and moments of inertia of the built-up sections are at least equal to those of the rolled section and the flanges are welded to the web with continuous fillet welds on each side of the web, and the welding conforms to Section 506.

METHOD OF MEASUREMENT

508.04.01 Measurement. The quantity of "Furnish (Type) Piles" to be measured for payment will be the number of linear feet of (type) pile complete and in place measured from the tip of the pile to the plane of pile cutoff.

The quantity of "Driving (Type) Piles" to be measured for payment will be the number of linear feet of (type) pile complete and in place measured from the tip of the pile to the plane of the pile cutoff.

If the Contractor casts concrete piles full length of the reinforcement bars to facilitate driving, no measurement

will be made for that portion where concrete must be removed in order that bars may project as shown on the plans.

Load tests will be measured per each and the number used in the work will be the number paid for.

The quantity of splices to be measured for payment will be limited to the number required to splice the pile if it becomes necessary to drive beyond "Design Pile Tip Penetration." Length of extensions will be determined by the Engineer. All splices necessary to drive to "Design Pile Tip Penetration" and for extensions made of shorter lengths than ordered by the Engineer will be at the Contractor's expense.

Metal pile shells driven with a removable core or mandrel shall be spliced according to the manufacturer's specifications. No splices will be measured and paid for when thin shell piles are used that do not require complete circumferential welding performed in the field.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

508.05.01 Payment. The accepted quantity of "Furnish (Type) Piles," measured as provided in subsection 508.04.01, "Measurement," will be paid for at the contract unit price bid per linear foot, which price shall be full compensation for furnishing all materials including Portland cement concrete, steel shells and reinforcing steel, placing filling materials, and disposing of all unused material.

The accepted quantity of "Driving (Type) Piles" measured as provided in subsection 508.04.01, "Measurement," will be paid for at the contract unit price bid per linear foot, which price shall be full compensation for doing all the work involved in driving, drilling holes, cutting off piles, excavation and backfill, and for filling the space remaining around the pile with sand or pea gravel; all to the required bearing and penetration as shown on the plans or ordered by the Engineer.

Test piles that become a part of the completed structure will be paid for at the contract prices for the type of piling used.

No payment will be made for piles driven out of place or for imperfect piles, or for piles which are damaged in handling or driving.

When, in addition to the requirements of the plans and specifications, brackets or plates are required on steel piles, or special driving shoes are required on timber piles, the Contractor shall furnish and place such devices and the cost thereof will be paid for as extra work as provided in subsection 104.03, "Extra Work."

The accepted quantity of load tests measured as provided in subsection 508.04.01, "Measurement," will be paid for at the contract unit price bid per each for load tests, which price shall be full compensation for all material, equipment, tools, and labor incidental to make the tests and to construct the loading platform, procuring and placing the loading material, and removing and disposing of platform material in a satisfactory manner.

The accepted quantity of splices measured as provided in subsection 508.04.01, "Measurement," will be paid for at the contract unit price bid per each for the splice, which price shall be full compensation for all material, equipment, tools, and labor incidental to make the splice.

Where piling built up from structural steel plates is substituted for the piling specified on the plans, the Contractor shall be entitled to no extra compensation for any excess thickness of steel furnished or for any extra work, materials, equipment, handling, or treatment required to construct such piling.

The accepted quantity of "Furnish Cast in Drilled Hole Concrete Piles," measured as provided in subsection 508.-04.01, "Measurement," will be paid for at the contract unit price bid per linear foot, which price shall be full compensation for drilling holes for piling and disposing of material resulting therefrom, and for furnishing and placing all materials including Portland cement concrete and reinforcing steel and for doing all the work necessary to install the

piling complete and in place as shown on the plans and as directed by the Engineer.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Furnish (type) Piles	Linear Foot
Drive (type) Piles	Linear Foot
Load Test	Each
Splices	Each

SECTION 601

PIPE CULVERTS—GENERAL

DESCRIPTION

601.01.01 General. These specifications include general requirements that are applicable to all type culvert pipes except structural plate pipe, irrespective of the material or culvert use.

This work shall consist of furnishing and installing pipe culverts, siphons, end sections, end walls, etc., as may be required to complete the work shown on the plans or established by the Engineer.

MATERIALS

601.02.01 General. The materials used shall be those prescribed or used for the several items which constitute the finished work and shall conform to the requirements in the following subsections:

Corrugated Metal Pipe and Pipe Arches	Subsection 709.03.01
Bituminous Coated Corrugated Metal Pipe and Pipe Arches	Subsection 709.03.02
Corrugated Aluminum Pipe	Subsection 709.03.03
Reinforced Concrete Pipe	Subsection 708.03.01
Nonreinforced Concrete Pipe	Subsection 708.03.02
Clay Pipe	Subsection 708.03.04
Grout and Mortar Sand	Subsection 706.03.04
Rubber Gaskets	Subsection 707.03.02

When the location of manufacturing plants allows, the plants will be inspected periodically for compliance with specified manufacturing methods, and material samples will be obtained for laboratory testing for compliance with materials quality requirements. This can be the basis for acceptance of manufacturing lots as to quality.

All materials will be subject to inspection for acceptance as to condition at the latest practicable time the Engineer has the opportunity to check for compliance prior to or during incorporation of materials in the work.

The lengths shown on the plans are approximate. The Contractor shall not order and deliver the culvert pipe until a list of sizes and lengths is furnished him by the Engineer.

For structural plate pipe and arches, attention is directed to Section 606, "Structural Plate Pipe, Pipe Arch, and Arch Culverts."

CONSTRUCTION

601.03.01 Earthwork. Excavation and backfill shall conform to the requirements of Sections 206, "Structure Excavation," and 207, "Backfill."

The pipe shall be bedded as shown in the standard sheets appended to the plans. When no bedding class is specified, the requirements for Class C bedding shall apply. The lines and grades will be established by the Engineer.

Where pipes are to be installed in new embankments on a steep slope or in a difficult location, the height of new embankments may be varied as directed by the Engineer before installing pipes.

When headwalls are not required and granular materials are used for backfilling, the fill at the ends of the structure shall be sealed against the infiltration of water by bedding the ends of the structure in well tamped clay as shown on the plans.

601.03.02 Headwalls. Where shown on the plans, inlet and outlet headwalls shall be constructed or installed in connection with culvert pipes. Where such headwalls are constructed or installed, the ends of pipes shall be placed flush or cut off flush with the headwall face, unless otherwise permitted by the Engineer. Headwalls are to be constructed to conform to the applicable requirements of Sections 501, "Portland Cement Concrete," and 502, "Concrete Structures."

601.03.03 End Sections. The bed for the end section shall be excavated to the required width and grade. For metal end sections with toe plates, a trench shall be excavated for the toe plate in a manner to permit the toe

plate being against the inner face of the trench when the end section is in its final position. After end sections have been properly secured to the pipe, this trench shall be backfilled and firmly compacted.

Precast concrete end section shall be placed with its tongue (or groove) fully entered in the grove (or tongue) of the pipe.

601.03.04 Jacked Pipes. Culvert pipe to be jacked in place between the limits shown on the plans shall conform to the requirements of the respective section of pipe culverts.

The strength of pipe or gage of pipe will be determined for vertical load only. Any additional reinforcement or strength required to withstand jacking pressure shall be determined and furnished by the Contractor at his expense.

Variation from theoretical alignment and grade at the time of completion of placing shall not exceed 0.2 foot for each twenty (20) feet of pipe placed.

The diameter of the excavated hole shall not be more than 0.1 foot greater than the outside diameter of the pipe. Sluicing and jetting with water will not be permitted. When the material tends to cave in from outside these limits a shield shall be used ahead of the first section of pipe or the face of excavation shall not extend beyond the end of the pipe greater than one and one-half (1½) feet unless permitted by the Engineer.

Areas resulting from caving or excavating outside the above limits shall be backfilled with sand or grout by a method which will fill the voids.

601.03.05 Laying Culvert Pipe. Laying of culvert pipe shall conform to the requirements of the respective sections of culvert pipe.

601.03.06 Extending Existing Culverts. Where shown on the plans or directed by the Engineer, existing culverts shall be extended in accordance with the provisions for installing new culverts and the following additional provisions.

Existing headwalls shall be demolished and removed and disposed of or moved to the extended location as indicated on the plans or ordered by the Engineer. Attention is directed to Section 202, "Removal of Structures and Obstructions."

A headwall that is not to be reset shall be demolished without injury to the existing culvert and removed and disposed of in accordance with the provisions of Section 202, "Removal of Structures and Obstructions." If shown on the plans or ordered by the Engineer, a new concrete headwall shall be constructed in accordance with the provisions of Section 501, "Portland Cement Concrete," of these specifications, or a flared end section shall be attached thereto.

METHOD OF MEASUREMENT

601.04.01 Measurement. The materials to be paid for under these specifications will be listed in the contract items by size, class, type gage, or whatever information is necessary for identification.

The quantity of culvert pipe to be measured for payment will be the actual number of linear feet of pipe including the stub on end sections, complete and in place. When pipes are cut to fit a structure or slope, the quantity to be paid for will be the length of pipe necessary to be placed before cutting, measured in even two (2) foot increments.

Attention is especially directed to plan sheets titled "Standard Details—Structure Excavation and Backfill—Method of Measurement," which shall pertain.

Culvert pipe bends, wyes, tees, and other branches will be measured and paid for by the linear foot for the sizes of pipes involved. Wyes, tees, eccentric reducers, and other branches will be measured along centerlines to the point of intersection.

Structure excavation and structure backfill, Portland cement concrete and reinforcement required for headwalls, endwalls, structures, and other items of work required by the plans and special provisions to complete the work,

will be measured and paid for as separate items as provided for under their respective sections of these specifications, or the contract documents. Structure excavation and backfill will not be measured for payment on preformed end sections.

No separate measurement or payment will be made for constructing jacking pits and backfilling all pits after the pipe is jacked, nor for excavation and backfill between the limits shown on the plans for jacking the pipe. Full compensation therefor will be considered as included in the price paid for jacked pipe.

Culvert pipe to be placed outside the limits for jacked pipe shall conform to the requirements of the respective section of pipe culverts. The limits for payment of structure excavation and backfill will be the original ground line before jacking pits are excavated.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

601.05.01 Payment. The accepted quantities of culvert pipe measured as specified in subsection 601.04.01, "Measurement," will be listed under the respective sections of pipe culverts.

When any of the various sizes, types, and gages of pipe are installed by the jacking method, the contract price paid per linear foot for jacked pipe shall include full compensation for furnishing the pipe, excavating, jacking, furnishing and placing backfill material, and all incidentals and for doing all the work involved in jacking the pipe, as specified.

Full compensation for furnishing pipe with end finish, including distortion if required, will be considered as included in the price paid per linear foot for the pipe involved and no additional compensation will be allowed therefor. Full compensation for Class "B" and Class "C" bedding will be considered included in the price paid per cubic yard for backfill or granular backfill as the case may

be and such payment shall include compensation for all the materials, labor, tools, and incidentals necessary to complete the work.

Class "A" bedding will be paid for at the contract unit bid price per cubic yard for Class "C" or "CA" concrete. When Class "C" or "CA" concrete is not an item on the bid schedule, Class "A" bedding will be paid for at the contract unit bid price per cubic yard for Class "A" or Class "AA" concrete. Payment as stated above shall be full compensation for all the materials, labor, tools, and incidentals necessary to complete the work.

Provisions for handling of whatever water may be encountered at the site shall be an obligation of the Contractor and payment therefor shall be considered as subsidiary to the items involved and no further compensation will be allowed therefor.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

SECTION 602

NONREINFORCED CONCRETE AND CLAY PIPE

DESCRIPTION

602.01.01 General. This work shall consist of furnishing and installing nonreinforced concrete pipe or clay culvert pipe of the kind, sizes, and dimensions shown on the plans or established by the Engineer and in accordance with the requirements of these specifications.

MATERIALS

602.02.01 General. Materials and their use shall conform to the applicable requirements of subsection 603.02.01 of Section 603, "Reinforced Concrete Pipe," and subsection 601.02.01 of Section 601, "Pipe Culverts—General."

CONSTRUCTION

602.03.01 General. The construction requirements shall be as prescribed in subsections 603.03.01 through 603.03.06 of Section 603, "Reinforced Concrete Pipe," with the following modifications:

(a) External bands of mortar shall be placed around the pipe joints as herein specified. Several sections of pipe shall be joined before commencing banding operations, but the placing of external bands shall never be more than five (5) lengths of pipe behind joining operations.

Immediately in advance of placing external band mortar, the external surface of the pipe sections at the joint shall be thoroughly cleaned and wetted to insure proper bonding of the band mortar with the pipe. Care shall be exercised to make a union between the band and the mortar which was placed under the joint before the pipe sections were abutted. The band shall not be less than three-eighths (⅜) inch thick at the pipe joint and shall be approximately four (4) inches wide, overlapping the abutting ends of the pipe sections approximately two (2)

inches. The edges of the band shall adhere to the pipe surface to prevent peeling and shall be finished in a workmanlike manner.

(b) When irrigation or sewer pipe is placed beyond the limits of roadway excavation or embankment, the initial covering of backfill material shall be fine earth or sand approved by the Engineer. Placing the remainder of the trench backfill in layers and compacting to a relative compaction of ninety (90) percent will not be required.

(c) Openings shall be cut into irrigation or sewer pipe and connections made thereto as shown on the plans or directed by the Engineer.

Openings shall be cut to proper sizes. Connections shall be cut to fit closely and shall be strongly cemented to the pipe with banding mortar. In all cases, the area of pipe where the connection is made shall be clean and wet when the mortar is applied.

METHOD OF MEASUREMENT

602.04.01 Measurement. Method of measurement shall conform to the requirements of subsection 601.04.01, "Measurement," with the exception that backfill will not be measured for payment when placed beyond the limits of roadway excavation or embankment.

BASIS OF PAYMENT

602.05.01 Payment. Payment shall conform to the requirements of subsection 601.05.01, "Payment," and in addition thereto, the following requirements shall apply.

The accepted quantities of nonreinforced concrete or clay pipe will be paid for at the conrtact bid price per linear foot for the types and sizes specified.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
(size) Nonreinforced Concrete Pipe (type)	Linear Foot
(size) Clay Pipe (type)	Linear Foot

SECTION 603

REINFORCED CONCRETE PIPE

DESCRIPTION

603.01.01 General. This work shall consist of furnishing and installing circular or oval shaped reinforced concrete pipe, siphons, and conduits of the size, kinds, and dimensions and at locations shown on the plans or established by the Engineer and in accordance with the requirements of these specifications.

MATERIALS

603.02.01 General. Materials and their use shall conform to the applicable requirements of subsection 601.02.01 of Section 601, "Pipe Culverts—General," and in addition thereto, the following requirements shall apply.

Circular reinforced concrete pipe shall conform to the specifications of AASHTO Designation: M170 for the specified diameters and strength classes.

Oval reinforced concrete pipe shall conform to the specifications of AASHTO Designation: M207 for the specified span and rise for either horizontal or vertical elliptical pipe classes.

Oval shaped pipe, within the meaning of these specifications, shall be pipe having major and minor internal axial dimensions as designated in the contract item. The length of the minor axis shall be between sixty (60) percent and sixty-five (65) percent of the length of the major axis. The first dimension designated will represent the axis that is to be placed horizontally and the second dimension will represent the vertical axis. The dimension, in feet, of the horizontal axis shall be the basis for calculating the strength of the pipe. The inside perimeter of oval pipes shall form either an ellipse, or an approximation thereof, as described by smooth, compounded circular arcs.

Flared end sections (precast) shall conform to the details and dimensions shown on the plans and except for shape,

shall conform to the requirements of this section for reinforced concrete pipe.

Concrete pipe shall be carefully handled in unloading, transporting, and laying.

No pipe shall be laid which is cracked, checked, spalled, or damaged, and all such sections of pipe shall be permanently removed from the work. Pipes which show defects due to handling shall be rejected at the site of the installation regardless of prior acceptance.

Rubber gaskets shall conform to the requirements of subsection 707.03.02, "Rubber Gaskets."

Joint mortar shall be composed of one part Portland cement and two parts sand by volume.

Sand shall conform to the requirements of subsection 706.03.04, "Grout and Mortar Sand," of these specifications.

The materials shall be mixed to a consistency suitable for the purpose intended. All mortar shall be used within thirty (30) minutes after the mixing water has been added.

Admixtures of hydrated lime, fire clay, diatomaceous earth, or other approved inert material may be used in the mortar to facilitate workability if the Contractor elects. The amount of admixture to be added shall be the quantity permitted by the Engineer.

CONSTRUCTION

603.03.01 General. Construction methods shall conform to the requirements of subsections 601.03.01 through 601.03.06 of Section 601, "Pipe Culverts—General," and in addition thereto, shall meet the following requirements.

603.03.02 Earthwork. Where pipes are to be installed in new embankment (projection), the embankment shall first be constructed to the required elevation as set forth in the following methods "A" or "B." Method "A" shall be followed unless otherwise specified in the contract documents, and with the further exception that when the pipe is to be installed on a steep slope or at a difficult location, the height of embankment to be constructed in advance of

installing the pipe may be varied when permitted by the Engineer.

Method A

In the case of pipes twenty-four (24) inches or less in diameter the roadway embankment shall be constructed to an elevation of six (6) inches above the grade proposed for the top of the pipe, after which the trench shall be excavated and the pipe installed.

In the case of pipes more than twenty-four (24) inches in diameter the roadway embankment shall be constructed to an elevation of thirty (30) inches above the grade proposed for the bottom of the pipe, after which the trench shall be excavated and the pipe installed.

Method B

The new embankment shall be constructed and compacted to an elevation above the top of the pipe equal to the external diameter of the pipe plus one (1) foot and to a width each side of the pipe of not less than five (5) times the diameter of the pipe. The trench shall then be excavated to the bottom of the pipe and to a width of the inside diameter plus three (3) feet.

After the pipe has been installed, backfill shall be placed in the trench to an elevation of one (1) foot above the top of the pipe. Backfill to be placed in accordance with the requirements of Section 207, "Backfill." The lower one-third of the remaining trench shall then be filled with loose straw, hay, brush, sawdust, or other highly compressible material and the remainder of the trench shall then be filled in a normal manner. The embankment may then be constructed in the normal manner.

When pipe having bells or hubs is used, cross trenches shall be excavated for them to prevent nonuniform loading of the joints. The cross trenches shall not be more than two (2) inches wider than the width of the bell or hub.

603.03.03 Laying Culvert Pipe. The Contractor shall determine his source of supply of sand for use in mortar a

sufficient time in advance of pipe laying operations to permit sampling and testing before use, and no mortar shall be used until the sand has been approved by the Engineer.

The consistency of joining mortar shall be such as to adhere to the ends of the pipe while being laid and may be easily squeezed out of the joint when the pipe sections are pressed together.

In advance of joining sections of pipe, the ends of each section shall be washed clean with a wet brush and immediately prior to placing mortar and joining the sections, the ends shall be thoroughly wetted.

Pipe sections shall be checked for alignment and grade at the time of joining the sections. If an adjustment in alignment or grade is necessary after making the joint, additional mortar shall be firmly pressed into the joint, and in the case of pipes less than twenty-four (24) inches in diameter, the internal and external surfaces of the joints shall be brushed.

The interior of the pipe shall be kept free of dirt, excess mortar, and other foreign material as the pipe laying progresses, and left clean at the completion of the work. Any pipe which is not in true alignment or which shows any undue settlement after laying, or is damaged, shall be taken up and relaid at the Contractor's expense.

The first section of pipe to be laid shall be firmly placed to the designated line and grade at the outlet end with the groove end or bell end pointing in the direction to be followed by the pipe laying.

Abutting ends of the sections of pipe to be jointed shall then be cleaned and wetted, after which joining mortar shall be firmly placed into the lower half of the groove end of the previously laid section. Joining mortar shall be firmly placed on the top half of the tongue end of the section to be jointed which shall then be inserted truly and snugly into the groove end of the section previously laid so as to completely fill the joint.

The interior joint shall then be either brushed or pointed and all surplus mortar removed from the pipe. The external space between the ends of the jointed pipe shall be firmly filled from the outside with laying mortar.

When pipe with self-centering joints and without an inside pointing recess is furnished, the inside shoulder of the groove end of each section shall first be lightly plastered or buttered with joining mortar after which the pipe ends shall be firmly fitted together in such a way that the tongue end of each section fits snugly into the groove end of the preceding section in order to center the joint and form a true flow line. The inside joints shall be trowled or brushed smooth and excess mortar removed from the pipe. The outside joint recesses shall then be filled with mortar, after which backfilling shall be performed as specified.

When pipe is furnished with self-centering joints with both inside and outside pointing recesses, the pipe shall be firmly fitted together in such a way that the tongue end of each section fits snugly into the groove end of each preceding section in order to center the joint and to form a true flow line, after which the inside joint recess shall be firmly filled with pointing mortar and then troweled or brushed smooth and excess mortar removed from the pipe, after which backfilling shall be performed as specified.

Backfill of the pipe trench may be completed while the joint mortar is still plastic. Should the joint mortar become set before the backfill is placed, backfilling of the trench shall not be commenced within sixteen (16) hours of jointing the pipe sections. When the pipe is not backfilled while the mortar is plastic, the mortar shall be cured in accordance with subsection 501.03.09, "Curing."

Free water shall not be allowed to come in contact with the pipe line until the mortar in the joints has set at least twenty-four (24) hours.

Concrete pipe with elliptical reinforcing shall be suitably marked to clearly indicate the top and bottom of the pipe.

Prior to placing backfill material, all handling holes in concrete culverts shall be completely filled with grout.

603.03.04 Rubber Gasketed Joints. Reinforced concrete culvert pipe, connected by flexible, watertight, rubber or neoprene gasketed joints, may be used in lieu of other types of joints.

All rubber gaskets shall be stored in as cool a place as practicable, preferably at seventy (70) degrees Fahrenheit or less, and in no case shall the rubber gaskets be exposed to the direct rays of the sun for more than seventy-two (72) hours.

Rubber gaskets of the type requiring lubrication shall be lubricated with the lubricant recommended and supplied by the manufacturer of the pipe.

After the pipe has been laid, the outer and inner annular space between pipe sections shall be completely filled with cement mortar, except that no mortar shall be required if the space is three-sixteenths ($\frac{3}{16}$) inch or less in width. Where reinforced concrete collars or bells with rubber gaskets are used at the pipe joints, mortar will not be required in the outer annular space. Where pipes are used with exposed metal surfaces at the joint, both the inner and outer annular joint spaces between pipe sections must be completely filled with cement mortar, except that pipes less than twenty-four (24) inches in diameter may be jointed inside by brushing smooth and removing all surplus mortar. The rubber gasket shall be the sole element depended upon to make the joint watertight for the purposes intended.

603.03.05 Siphons and Pressure Pipe. Reinforced concrete pipe used for siphons or pressure pipe shall be laid in accordance with the above provisions, be connected by flexible, watertight rubber gasketed joint, and prior to backfilling, be subject to the following hydrostatic test:

The pipe line shall be filled with water at a hydrostatic head of ten (10) feet above the highest point of the pipeline. The pressure head shall be maintained for a period of not less than twenty-four (24) hours and any visible leak or other defects which develop under test shall be corrected by the Contractor at his expense. Sweating that does not develop into a flow or drip will not be considered as leakage. The test shall be repeated until all leaks or other defects are eliminated.

METHOD OF MEASUREMENT

603.04.01 Measurement. Method of measurement shall conform to the requirements of subsection 601.04.01, "Measurement," and in addition thereto, the following requirements shall apply.

The quantity of precast end sections, culvert pipe or oval pipe measured for payment will be the number of units of each size of each class complete and in place.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

603.05.01 Payment. Payment shall conform to the requirements of subsection 601.05.01, "Payment," and in addition thereto, the following requirements shall apply.

The accepted quantities of reinforced concrete pipe measured as specified in subsection 603.04.01, "Measurement," will be paid for at the contract unit price bid per linear foot for reinforced concrete pipe of the class and size specified, which payment shall include mortar and joints. End sections will be paid for at the contract unit price bid per each for the kind and sizes specified complete and in place, which payment shall include structure excavation and backfill for precast end sections.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
(size) Reinforced Concrete Pipe (class)	Linear Foot
(size) Oval Reinforced Conc. Pipe (class)	Linear Foot
(size) Reinforced Conc. Siphon Pipe (class)	Linear Foot
(size) Reinforced Conc. Pipe (class) Jacked	Linear Foot
(size) Precast End Section	Each
(size) Precast Oval End Section	Each

SECTION 604

CORRUGATED METAL PIPE AND METAL ARCH PIPE

DESCRIPTION

604.01.01 General. This work shall consist of furnishing and installing corrugated metal pipe, corrugated metal arch pipes and nestable corrugated metal pipe and the relaying of old corrugated metal pipe and pipe arches at locations shown on the plans, or established by the Engineer, and in accordance with the requirements of these specifications.

MATERIALS

604.02.01 General. Materials and their use shall conform to the applicable requirements of subsection 601.-02.01 of Section 601, "Pipe Culverts—General," and in addition thereto, the following requirements shall apply.

Annular corrugated steel pipe shall be fabricated from sheets having either 2⅔″ x ½″ or 3″ x 1″ corrugations.

Aluminum corrugated metal pipe and end sections conforming to the requirements of Section 605 may be furnished in lieu of steel corrugated metal pipe and end sections at the locations shown on the plans. Aluminum corrugated metal pipe shall be fabricated at the gage of material required for the height of fill as set forth on the plans. Aluminum end sections shall be fabricated of the gage of material as set forth in the plans for metal end sections. Aluminum pipe and end sections shall be bituminous coated as set forth in subsection 709.03.02. At each location where corrugated metal pipe is installed, the pipe and all accessories shall be fabricated of the same material.

Flared end sections (metal headwalls) shall conform to the details and dimensions shown on the plans and, except for shape, shall conform to the requirements of this section for corrugated metal pipe culverts.

Culverts shall be shipped and handled in such a manner as to prevent bruising, scaling, or breaking of the spelter coating. Damaged spelter coating in lieu of the requirements of AASHTO Designation M36, may be repaired by thoroughly wire brushing the damaged area and removing all loose and cracked spelter coating after which the cleaned area shall be painted with two coats of zinc oxide-zinc dust paint conforming to the requirements of Federal Specification MIL–P–15145. The paint shall be properly compounded in a suitable vehicle in the ratio of one (1) part zinc oxide to four (4) parts zinc dust by weight.

CONSTRUCTION

604.03.01 General. Construction methods shall conform to the requirements of subsection 601.03.01 through 601.03.06 of Section 601, "Pipe Culverts—General," and in addition thereto shall meet the following requirements.

604.03.02 Laying Culvert Pipe. All pipes shall be laid upgrade, unless otherwise permitted by the Engineer.

Corrugated metal pipe shall be so laid that flow is over the lap of the sheets. Field joints shall be made by butting the ends of pipe together and the sections joined with a band bolted firmly in place. Pipes of a diameter of forty-eight (48) inches or more shall be elongated vertically five (5) percent before placement of fill. Elongation of the vertical diameter may be accomplished by jacking in the field or by prefabrication. The method of jacking shall be subject to the approval of the Engineer. A tolerance of twenty-five (25) percent above or below the specified amount will be allowed. Where preformed elliptical pipe is used and strutting is specified, further distortion is not required but the struts shall be wedged tightly in place.

Strutting shall be carried uniformly from end to end of pipes where headwalls are not used. When headwalls are used, the amount of jacking and the length of struts may be reduced gradually under the side slopes of the embankment so that the ends of the pipe at the headwalls are

circular. The struts shall be left in place until the embankment is complete and compacted, unless otherwise directed by the Engineer.

All pipes shall be laid true to the designated line, grade, and camber. They shall be fitted and matched so that when laid in the work they will form a smooth and uniform invert.

All possible care shall be used in fitting sections of pipes together so that the joint openings will not be unnecessarily large.

604.03.03 Siphons. Corrugated metal pipe for use as siphons shall be close riveted and soldered and so fabricated as to require a minimum number of field connections. All rivets on circumferential seams shall be spaced at approximately two and one-half (2½) inch centers with a maximum spacing of three (3) inches. The circumferential and longitudinal seams on the outside of the pipe where the edges of the sheets lap, shall be soldered in a workmanlike manner, solder being sweated into the joints by means of a torch properly regulated for the purpose. Soldering irons shall not be used on factory seams.

Except as provided hereinbefore, siphons shall conform to the requirements for corrugated metal pipe culverts of this section.

Field joints for close riveted and soldered corrugated metal pipe shall be approved watertight couplings consisting of a corrugated collar drawn tight by means of threaded rods and silo-type lugs. To permit the band to fit snugly into the corrugated ends of the pipe, rivets in the longitudinal seam shall be omitted and the seams adequately soldered.

Before placing the band, the ends of the pipe and the bands shall be cleaned and an amount of plastic bituminous impregnated fibre sufficient to make a rope-like section approximately three-fourths (¾) inch in diameter shall be carefully and evenly compressed into the last two valleys of the corrugation at the ends of the pipe. After placing the connecting band the entire circumference and assembly shall be hammered with a rubber or wooden

mallet during the tightening of the bolts and lugs. Other approved types of water tight pipe and joints may be used.

The Contractor at his expense prior to backfilling, shall completely fill the siphon with water and repair any leaks developing therein.

604.03.04 Relay Culvert Pipes. Corrugated metal culvert pipe, previously removed under the provisions of subsection 202.03.05, "Salvage," and designated for relaying, shall be cleaned and relayed at points called for on the plans or ordered by the Engineer.

The pipe shall be thoroughly cleaned to remove all foreign matter.

METHOD OF MEASUREMENT

604.04.01 Measurement. Method of measurement shall conform to the requirements of subsection 601.04.01, "Measurement," and in addition thereto, the following requirements shall apply.

The quantity of corrugated metal end sections for culvert pipe or pipe arch measured for payment will be the number of units of each size of each class complete and in place.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

604.05.01 Payment. Payment shall conform to the requirements of subsection 601.05.01, "Payment," and in addition thereto, the following requirements shall apply.

The accepted quantities of corrugated metal pipe, measured as specified in subsection 604.04.01, "Measurement," will be paid for at the contract unit price bid per linear foot for the types and sizes specified. End sections will be paid for at the contract unit price bid per each for the kind and size specified, which payment shall include structure excavation and backfill for fabricated end sections.

Where the Contractor elects to furnish aluminum corrugated metal pipe and end sections in lieu of steel corrugated metal pipe and end sections, such aluminum

corrugated metal pipe and end sections shall be measured as corrugated metal pipe and end sections.

When culvert pipe is designated to be relayed, hauling of the pipe from the site of removal or from the place where stored to the point or points at which they are to be reinstalled shall be considered subsidiary to the pipe item and no further compensation will be allowed therefor.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
(size) Corrugated Metal Pipe ((type)	Linear Foot
(size) Corrugated Metal Pipe (type) Jacked	Linear Foot
(size) Relay Culvert Pipe (type)	Linear Foot
(size) Corr. Metal Arch Pipe (type)	Linear Foot
(size) Corr. Metal Siphon Pipe (type)	Linear Foot
(size) Corr. Metal Nestable Pipe (type)	Linear Foot
(size) Corr. Metal End Section (type)	Each
(size) Corr. Metal Arch End Section (type)	Each

SECTION 605

ALUMINUM CORRUGATED METAL PIPE AND ALUMINUM ARCH CULVERTS

DESCRIPTION

605.01.01 General. This work shall consist of furnishing and installing corrugated aluminum culvert pipe and pipe arches at the location shown on the plans, or established by the Engineer, and in accordance with the requirements of these specifications.

MATERIALS

605.02.01 General. Materials and their use shall conform to the applicable requirements of subsection 601.02.01 of Section 601, "Pipe Culverts—General."

CONSTRUCTION

605.03.01 General. The construction requirements shall be as prescribed in subsections 604.03.01 through 604.03.04 of Section 604, "Corrugated Metal Pipe and Metal Arch Pipe."

Aluminum corrugated metal pipe shall comply to the gages set forth on the plans.

METHOD OF MEASUREMENT

605.04.01 Measurement. Method of measurement shall conform to the requirements of subsection 601.04.01, "Measurement."

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

605.05.01 Payment. Payment shall conform to the requirements of subsection 601.05.01, "Payment," and in addition thereto, the following requirements shall apply.

The accepted quantities of corrugated aluminum pipe and aluminum arch pipe will be paid for at the contract price per bid linear foot for the types and sizes specified.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
(size) Corrugated Aluminum Pipe	Linear Foot
(size) Corrugated Aluminum Arch Pipe	Linear Foot

SECTION 606

STRUCTURAL PLATE PIPE AND PIPE ARCH CULVERTS

DESCRIPTION

606.01.01 General. This work shall consist of furnishing and installing structural plate pipe and pipe arch culverts conforming to the requirements of these specifications, and of the sizes and dimensions required in the plans, and installing such structures at locations designated in the plans or established by the Engineer, and in conformity with the lines and grades established by the Engineer. The work shall also include the reinstallation of salvaged structural plate pipe and pipe arch culverts.

Plates for a pipe arch shall form a cross section made up of four (4) circular arcs tangent to each other at their junctions and symmetrical about the vertical axis. The top shall be an arc of not more than one hundred eighty (180) degrees nor less than one hundred fifty-five (155) degrees. The bottom shall be an arc of not more than fifty (50) degrees nor less than ten (10) degrees. The top shall be joined at each end to the bottom by an arc having a radius between sixteen (16) and twenty-one (21) inches and of not more than eighty-seven and one-half (87½) degrees or less than seventy-five (75) degrees.

MATERIALS

606.02.01 General. Materials shall meet the requirements specified in subsection 709.03.08, "Structural Plate Pipe and Pipe Arches."

If called for in the bid schedule, plates for pipes and pipe arches shall be bituminous coated in accordance with AASHTO Designation: M190, Type A, B, or C.

When bituminous coating is applied to plates for structural steel plate pipe, arches and pipe arches, each plate shall have the thickness painted on the inner surface so that the plate thickness can be readily identified.

The portion of all nuts and bolts, used for assembly of bituminous coated structural steel plate pipes, arches and pipe arches projecting outside the pipe shall be bituminous coated after installation. The portion of the nuts and bolts projecting inside the pipe need not be bituminous coated.

Damaged bituminous coating shall be repaired by the Contractor by applying bituminous material conforming to the provisions of AASHTO Designation: M190 or other approved material.

The bottom plates of structural plate pipes and arches shall be one gage heavier than the gage specified in the bid schedule, which will apply to top and side plates. When gage one is specified, the bottom plates shall also be gage one.

Plates shall be shipped and handled in such a manner as to prevent bruising, scaling, or breaking of the spelter coating. Damaged spelter coating in lieu of the requirements of AASHTO Designation M36 may be repaired by thoroughly wire brushing the damaged area and removing all loose and cracked spelter coating after which the cleaned area shall be painted with two coats of zinc oxide-zinc dust paint conforming to the requirements of Federal Specification MIL–P–15145. The paint shall be properly compounded in a suitable vehicle in the ratio of one (1) part zinc oxide to four (4) parts zinc dust by weight.

Planned lengths and sizes are approximate. The Contractor shall not order and deliver the plates until a list of sizes and lengths is furnished him by the Engineer.

CONSTRUCTION

606.03.01 Plate Description. Plates shall consist of structural units of galvanized corrugated metal. Single plates shall be furnished in standard sizes to permit structure length increments of two (2) feet. (Plates have approximately a two (2) inch lip beyond each end crest, which results in the actual length of a given structure being approximately four (4) inches longer than the nominal length, except when skewed or beveled.)

The plates at longitudinal and circumferential seams shall be connected by bolts. Joints shall be staggered so that not more than three plates come together at any one point. Each plate shall be curved to one or more circular arcs.

606.03.02 Fabrication. Plates shall be formed to provide lap joints. The bolt holes shall be so punched that all plates having like dimensions, curvature, and the same number of bolts per foot of seam shall be interchangeable. Each plate shall be curved to the proper radius so that the cross sectional dimensions of the finished structure will be as specified.

Unless otherwise specified, bolt holes along those edges of the plates that will form longitudinal seams in the finished structure shall be staggered in rows two (2) inches apart, with one row in the valley and one in the crest of the corrugations. Bolt holes along those edges of the plates that will form circumferential seams in the finished structure shall provide for a bolt spacing of not more than twelve (12) inches. The minimum distance from center of hole to edge of the plate shall be not less than one and three-fourths (1¾) times the diameter of the bolt. The diameter of the bolt holes in the longitudinal seams shall not exceed the diameter of the bolt by more than one-eighth (⅛) inch.

Burnt edges shall be free from oxide and burrs and shall present a workmanlike finish. Damaged spelter on the surface of the plates and the edges of cuts shall be repaired as set forth in subsection 606.02.01, "General," within twenty-four (24) hours after the cuts are made. Each cut plate shall be legibly identified to designate its proper position in the finished structure.

606.03.03 Field Inspection. The Engineer shall be furnished with an itemized statement of the number and length of the plates in each shipment by the manufacturer. Each plate included in a shipment shall conform to the requirements of these specifications. If twenty-five (25)

percent or more of the plates in any shipment fail to conform to the requirements, the entire shipment may be rejected.

606.03.04 Earthwork. Excavation and backfill shall conform to the requirements of Sections 206, "Structure Excavation," and 207, "Backfill."

The pipe shall be laid in a trench excavated to the lines and grades established by the Engineer. The bottom of the trench shall be graded and prepared to provide full contact with the pipe throughout its entire length.

Where pipes are to be installed in new embankments on a steep slope or in a difficult location, the height of new embankments may be varied when permitted by the Engineer before installing pipes.

When headwalls are not required and granular materials are used for backfilling, the fill at the ends of the structure shall be sealed against the infiltration of water by bedding the ends of the structure in well tamped clay as shown on the plans.

When the pipe is laid in rock, hard clay, shale, or other hard material, a space below the pipe shall be excavated and replaced with a bed of compacted sand or compacted earth fill. In no place shall the pipe be laid directly on the rock, hard clay, shale, or other hard material.

When sand or compacted fill is used, the depth of the sand or compacted fill below the pipe shall not be less than one-third (⅓) the inside diameter of the pipe with a minimum of four (4) inches and a maximum of twelve (12) inches with the exception that an extra one-half (½) inch shall be added for every foot the trench exceeds sixteen (16) feet in depth. This bed shall extend at the sides of the pipe at least a distance of one-fourth (¼) the outside diameter of the pipe.

606.03.05 Assembling. The structural plate structures shall be assembled in accordance with the manufacturer's assembly instruction. The unsupported edges of all plates shall be held in position by temporary props. Each row of side plates shall extend far enough to support the

plate above until the first complete ring has been assembled. A sufficient number of bolts shall be progressively installed to hold the plates in position. Bolts shall not be tightened until tightening will not interfere with the adjustment and matching of additional plates and sections. Special care shall be exercised in the use of drift pins or pry bars to prevent chipping or injury to the galvanized or other protective coating, and such injury shall be repaired as set forth in subsection 606.02.01, "General," at the Contractor's expense. After all plates are in place, the bolts shall be progressively and uniformly tightened from one end of the structure, and the tightening operation repeated to be sure that all bolts are tight. Bolts shall be tightened to a minimum of (a) one hundred (100) foot-pounds of torque for plates of 7 gage and lighter, and (b) one hundred fifty (150) foot-pounds of torque for plates of 5 gage and heavier, and shall be rechecked and retightened as necessary just prior to backfilling.

The elliptical-shaped pipes shall be installed with their long diameter vertical, and pipe arches shall be installed with their span width horizontal.

606.03.06 Strutting. When specified, structural plate pipes which are not fabricated out of round before erection shall be timber strutted vertically three (3) percent out of round before placement of the embankment.

The pipe shall be deformed to the required degree by means of suitable jacks. The method of jacking shall meet with the approval of the Engineer. A tolerance of twenty-five (25) percent above or below the specified elongation will be permitted.

Strutting shall be carried uniformly from end to end of the pipe. The struts shall be left in place until the embankment is complete and compacted, unless otherwise ordered by the Engineer.

In lieu of strutting structural plate pipe, the Contractor may furnish structural plate pipe with the vertical axis fabricated out of round five (5) percent of the nominal diameter from end to end of the pipe. A tolerance of twenty-five (25) percent above or below the specified

elongation will be permitted. The elongation shall be made by approved shop methods, and any coating damaged or destroyed shall be repaired or replaced satisfactorily.

606.03.07 Workmanship. It is the essence of these specifications that, in addition to compliance with the details of construction, the completed pipe shall show careful, finished workmanship in all particulars. Structural plates on which the spelter coating has been bruised or broken or which shows defective workmanship, shall be rejected, except as herein otherwise specified. The requirement applies not only to the individual plates, but to the shipment on any contract as a whole. Among others, the following defects are specified as constituting poor workmanship and the presence of any or all of them in any individual culvert plate, or in general in any shipment, shall constitute sufficient cause for rejection:

(a) Uneven laps.

(b) Variation from a straight centerline.

(c) Ragged edges.

(d) Loose, unevenly lined or spaced bolts.

(e) Bruised, scaled or broken spelter coating. (See subsection 606.02.01 for exception.)

(f) Dents or bends in the metal itself.

606.03.08 Headwalls. Where shown on the plans, inlet and outlet headwalls shall be constructed or installed in connection with structural plate pipe. Where such headwalls are constructed or installed, the ends of pipes shall be placed flush or cut off flush with the headwall face, unless otherwise permitted by the Engineer. Headwalls to be constructed to conform to the applicable requirements of Sections 501, "Portland Cement Concrete," and 502, "Concrete Structures."

606.03.09 Extending Existing Structural Plate Pipe and Pipe Arch Culverts. In case the plans provide for the extension of any old or existing structural plate pipe or pipe arch culverts, the connection of the old and new sections shall be made by punching any necessary bolt

holes, furnishing bolts, nuts and washers, changing location of individual plates on pipe arches, and any other work required in the completion of the connection in a workmanlike manner. In all cases where an existing headwall is in place, the concrete shall be completely removed in accordance with the provisions of Section 202, "Removal of Structures and Obstructions."

METHOD OF MEASUREMENT

606.04.01 Measurement. The materials to be paid for under these specifications will be listed in the contract items by the various sizes, types, and gages necessary for identification.

The quantity of structural plate pipe or pipe arches measured for payment will be the number of linear feet complete and in place. The number of linear feet shall be the average of the top and bottom centerline lengths for structural plate pipe and pipe arches.

Structure excavation and structure backfill, Portland cement concrete and reinforcement required for headwalls, structures, and other items required to complete the work will be measured and paid for under their respective sections of these specifications.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

606.05.01 Payment. The accepted quantities of structural plate pipe and pipe arches measured as specified in subsection 606.04.01, "Measurement," will be paid for at the contract unit price bid per linear foot for the types and sizes specified.

Full compensation for furnishing structural plate pipe and pipe arches with end finish, including distortion, if required, will be considered as included in the price paid per linear foot for the plates and pipe involved and no additional compensation will be allowed therefor.

Provisions for handling of whatever water may be

encountered at the site shall be an obligation of the Contractor, and payment therefor shall be considered as subsidiary to the items involved and no further compensation will be allowed therefor.

It is understood that the gage of metal in the bottom plates of pipes and pipe arches is to be of a gage heavier than that specified in the bid schedule as set forth in subsection 606.02.01, "General," unless otherwise specified. No separate or additional compensation will be made by reason of supplying the heavier gage but compensation therefor shall be considered an integral part of the contract price paid for the gage specified.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
(size) Structural Plate Pipe (type) (gage)	Linear Foot
(size) Structural Plate Pipe Arch (type) (gage)	Linear Foot

SECTION 607

UNDERDRAINS

DESCRIPTION

607.01.01 General. This work shall consist of constructing underdrains using pipe and drain backfill in accordance with these specifications and in reasonably close conformity with the lines and grades shown on the plans or established by the Engineer.

MATERIALS

607.02.01 General. Materials shall meet the requirements specified in the following subsections:

Corrugated Metal Pipe for Underdrains	Subsection 709.03.05
Bituminous Coated Corrugated Metal Pipe for Underdrains	Subsection 709.03.06
Perforated Concrete Pipe	Subsection 708.03.03
Clay Pipe	Subsection 708.03.04
Corrugated Aluminum Pipe for Underdrains	Subsection 709.03.07
Drain Backfill	Subsection 704.03.01

When the location of manufacturing plants allows, the plants will be inspected periodically for compliance with specified manufacturing methods, and materials samples will be obtained for laboratory testing for compliance with materials quality requirements. This can be the basis for acceptance of manufacturing lots as to quality.

All materials will be subject to inspection for acceptance as to condition at the latest practicable time the Engineer has the opportunity to check for compliance prior to or during incorporation of materials into the work.

The Contractor shall not order and deliver the pipe until a correct list of sizes and lengths is furnished him by the Engineer.

Pipe shall be shipped and handled in such a manner as to prevent bruising, sealing, or breaking. Corrugated metal pipe with damaged spelter coating may be repaired in accordance with subsection 604.02.01 of Section 604,

"Corrugated Metal Pipe." Concrete or clay pipe which is cracked, checked, spalled, or damaged shall not be laid. Pipes which show defects due to handling shall be rejected at the site of the installation regardless of prior acceptance.

CONSTRUCTION

607.03.01 Earthwork. Excavation and drain backfill shall conform to the requirements of Sections 206, "Structure Excavation," and 209, "Drain Backfill," with the following modifications:

(a) Trenches shall be excavated to the dimensions and grade required by the plans or as directed. A minimum three (3) inch bedding layer of drain backfill material shall be placed in the bottom of the trench for its full width and length.

(b) The space below the pipe shall be filled with the required drain backfill throughout its entire length, and brought to a uniform grade. All material excavated from trenches, not required for backfilling, nor usable in the roadway, shall be removed and disposed of by the Contractor.

(c) If an item for grouting drain backfill is shown in the proposal, drain backfill shall be covered with a thick grout not less than one (1) inch in thickness. The grout shall be composed of one (1) part Portland cement and five (5) parts sand. This grout shall be thoroughly tamped to provide an impervious layer over the entire surface of the drain backfill.

607.03.02 Laying Pipes. Bell and spigot tile shall be laid upgrade with the bell end upgrade and the spigot end not quite fully entered in the adjacent bell. Pipe shall be laid true to line and grade with a uniform bearing under the full length of the barrel. The pipe joints shall then be covered with two-ply tar paper strips not less than six (6) inches in width and of sufficient length to permit the ends being turned outward and laid flat on the bottom course of drain backfill on either side of the pipe for a distance of three (3) inches.

Perforated pipe shall be laid with the perforations at the bottom of the pipe and the sections joined with band couplers. The pipe shall be firmly bedded throughout its length.

607.03.03 Underdrain Outlets. Trenches for underdrain outlets shall be excavated to the width and depth shown on the plans. 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 structure backfill material in layers and compacted as provided in Section 209, "Drain Backfill."

METHOD OF MEASUREMENT

607.04.01 Measurement. The materials to be measured for payment under these specifications will be listed in the contract items by size, class, type gage, or whatever information is necessary for identification.

The quantity of underdrain pipe measured for payment will be the actual number of linear feet of pipe complete and in place. Underdrain pipe bends, wyes, tees, and other branches will be measured along centerlines to the point of intersection.

The quantity of grouted drain backfill measured for payment will be the number of linear feet of drain grouted, measured along the longitudinal axis of the drain, in the completed work.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

607.05.01 Payment. The accepted quantities of underdrain pipe measured as specified in subsection 607.04.01, "Measurement," will be paid for at the contract unit price bid per linear foot for the types and sizes specified.

The accepted quantity of grouted drain backfill measured as provided in subsection 607.04.01, "Measurement,"

will be paid for at the contract unit price bid per linear foot for grouting drain backfill.

Structure excavation and drain backfill will be measured and paid for as separate items as provided in Sections 206, "Structure Excavation," and 209, "Drain Backfill."

Provisions for handling of whatever water may be encountered, at the site, shall be an obligation of the Contractor and payment therefor shall be considered as subsidiary to the items involved and no further compensation will be allowed therefor.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
(size) Perforated Corrugated Metal Pipe for Underdrains (type)	Linear Foot
(size) Nonperforated Corrugated Metal Pipe for Underdrains (type)	Linear Foot
Perforated Concrete Pipe for Underdrains (type)	Linear Foot
(size) Clay Pipe for Underdrains (type)	Linear Foot
(size) Corrugated Aluminum Pipe for Underdrains (type)	Linear Foot
Grouting Drain Backfill (width)	Linear Foot

SECTION 608

DOWNDRAINS

DESCRIPTION

608.01.01 General. This work shall consist of furnishing and installing embankment protectors, flume downdrains, anchor assemblies, slip joints, and bituminous concrete downdrains to collect and carry surface drainage down the roadway slopes.

MATERIALS

608.02.01 General. The materials used shall be those prescribed or used for the several items which constitute the finished work and shall conform to the requirements in the following sections and subsections:

Corrugated Metal Pipe for Downdrains	Subsection 709.03.04
Corrugated Aluminum Pipe	Subsection 709.03.03
Surfacing Miscellaneous Areas	Subsection 401.03.14
Grouted Riprap	Subsection 610.03.04
Concrete	Section 501
Reinforcing Steel	Section 505
Frames for Grates	Section 609

Pipe for crossbars shall be unpainted standard weight black pipe conforming to the requirements of ASTM Designation: A53 or A120.

Downdrain metal products shall be fabricated in accordance with the details and dimensions shown on the plans, except that minor variations may be accepted at the discretion of the Engineer to permit the use of manufacturers' standard jigs and templets in the fabrication. Metal shall not be less than the gage shown on the plans.

Each separate downdrain installation shall be assembled from one material only. Ferrous metal and aluminum shall not be used in the same installation except that the anchor assemblies as shown on the plans may be used with an aluminum installation provided the anchor assemblies are electrically insulated.

Corrugated metal parts with damaged spelter coating shall be repaired in accordance with subsection 604.02.01 of Section 604, "Corrugated Metal Pipe."

CONSTRUCTION

608.03.01 Metal Downdrains. The embankment protector outlet pipe shall be connected to a downdrain pipe of the dimensions shown on the plans by means of a band coupler or a slip joint.

Embankment protectors shall be installed at the outside edge of the embankment gutters or in shoulder dikes to carry drainage from the roadbed down the embankment slopes to protect the slopes and shoulders from erosion. The entrance device shall be so installed as to prevent water from percolating around the structure and care shall be taken to prevent the structure from being undermined. The seal between the structure and the surrounding earth shall be made watertight. The embankment protectors shall be placed in such a manner that the lower edge of the opening will be from three (3) inches to six (6) inches below the bottom of the gutter flow lines.

608.03.02 Bituminous Mixtures and Grouted Riprap. Bituminous mixture and grouted riprap downdrains, when called for, shall be placed in accordance with the provisions in subsection 401.03.14, "Surfacing Miscellaneous Areas," or subsection 610.03.04, "Grouted Riprap."

METHOD OF MEASUREMENT

608.04.01 Measurement. The materials to be measured for payment under these specifications will be listed in the contract items by size, type, etc., or whatever information is necessary for identification.

The quantity of embankment protectors, slip joints, and anchor assemblies will be measured as units complete and in place.

Type 1 and 3 embankment protectors shall include the length of the tapered section and the length of tail pipe shown on the plans and this length of tail pipe will not be measured as downdrain pipe.

Type 2 embankment protectors shall include the length of tapered section and a five (5) inch flume stub and said stub will not be measured as flume downdrain.

An anchor assembly shall consist of pipe stakes, rods, and hardware for fastening downdrain pipe or flume downdrain as shown on the plans. For payment purposes a flume downdrain anchor assembly shall include two pipe stakes with necessary clip brackets and bolts.

The quantity of corrugated metal pipe downdrains measured for payment will be the number of linear feet complete and in place, exclusive of the length of tail pipe attached to the entrance taper as provided above for entrance tapers. Pipe placed in excess of the length designated will not be measured for payment unless pipes are cut to fit a structure or slope. When pipes are cut to fit a structure or slope, the quantity to be paid for will be the length of pipe necessary to be placed before cutting, measured in even two (2) foot increments.

Type 4 embankment protectors shall be measured as units complete in place as shown on the plans and as approved by the Engineer, except corrugated metal pipe downdrain shall be measured for payment including the length of pipe cast into the Type 4 embankment protector.

The quantity of elbows, wyes, tees, and other branches measured for payment will be the number of linear feet for the size and type of pipe involved, complete and in place. Wyes, elbows, tees, and other branches will be measured along centerlines to the point of intersection.

The quantity of corrugated metal flume downdrain measured for payment will be the number of linear feet complete and in place.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

608.05.01 Payment. The accepted quantities of embankment protectors, slip joints and anchor assemblies measured as specified in subsection 608.04.01, "Measurement," will be paid for at the contract unit price bid per each for the types and sizes specified.

The accepted quantities of downdrain pipe or downdrain flume, measured as specified in subsection 608.04.01, "Measurement," will be paid for at the contract unit price bid per linear foot for downdrain pipe or flume for the types and sizes specified.

Payment for structure excavation and structure backfill will be considered subsidiary to the items of embankment protectors and downdrain pipe or flume and no further compensation will be allowed therefor.

Plantmix bituminous mixture used in downdrains will be paid for as provided in Section 401, "Plantmix Bituminous Pavements." The cost incurred for preparing the ditch and all incidentals not specifically mentioned herein will be paid for on a square yard basis as provided in Section 402, "Plantmix Bituminous Surface." Drainage excavation will not be paid for on plantmix bituminous downdrains.

Quantities of grouted riprap placed for downdrains will be paid for according to the provisions of Section 610, "Riprap."

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Embankment Protector (type)	Each
Slip Joints	Each
Anchor Assembly	Each
(size) Downdrain Pipe (type)	Linear Foot
Downdrain Flume	Linear Foot

SECTION 609

CATCH BASINS, MANHOLES, AND INLETS

DESCRIPTION

609.01.01 General. This work shall consist of constructing or reconstructing catch basins, manholes, inlets, and similar structures, consisting of Portland cement concrete with necessary reinforcement, metal frames, grates, and lids, including required excavation and backfilling.

MATERIALS

609.02.01 General. Materials shall conform to the requirements specified in the following sections and subsections:

Portland Cement Concrete	Section 501
Reinforcing Steel	Section 505
Miscellaneous Metals	Section 712
Gray Iron Castings	Subsection 712.03.02

Portland cement concrete shall be Class A or Class AA unless otherwise provided.

Casting shall be true to pattern in form and dimensions, free from pouring faults, sponginess, cracks, blow holes, and other defects in positions affecting strength and value for the service intended. Casting shall be boldly filleted at angles and the arrises shall be sharp and perfect. Casting shall be sand blasted or otherwise effectively cleaned of scale and sand so as to present a smooth, clean, and uniform surface.

Mortar for setting grates shall be mixed in the proportions of one (1) part cement to three (3) parts of fine aggregate.

Pipe crossbars for drop inlets shall be unpainted standard weight black pipe conforming to the requirements of ASTM Designation: A53 or A120. Straps shall be unpainted A36 steel.

CONSTRUCTION

609.03.01 General. Catch basins, inlets, and manholes shall be constructed in accordance with all of the requirements of Section 501, "Portland Cement Concrete." Inlet and outlet pipes shall be placed prior to pouring concrete.

Grates shall be set in full mortar beds or otherwise secured as shown on the plans. Grates shall be set accurately to the final elevations so that no subsequent adjustments will be necessary. Concrete covers, when indicated on the plans, shall be constructed in such manner that they will fit snugly and be readily removable. Structural steel grates shall be painted as specified in Section 614, "Painting."

Pipe or tile placed in masonry for inlet or outlet connections shall extend through the walls and beyond the outside surfaces of the walls a sufficient distance to allow for connections with conduits and the masonry shall be carefully constructed around them so as to prevent leakage around their outer surfaces.

Commercially prefabricated frames and grates of equal or greater capacity and strength may be substituted for the design shown on the plans for drop inlets provided prior approval is obtained in writing from the Engineer.

Frames and grates shall be matchmarked in pairs before delivery to the work and grates shall fit into their frames without rocking.

609.03.02 Adjusting Catch Basin, Manhole, and Inlet Covers. Unless otherwise provided on the plans or by the contract, existing covers, including frames, grates, or lids shall be adjusted to the required elevation by removing such existing covers and adjusting the top of the existing structures by removing or adding concrete, brick masonry, or concrete block masonry, as the case may be, reinstalling the fixtures by supporting them on a satisfactory collar of concrete masonry, Class A or AA so constructed as to hold them firmly in place.

609.03.03 Clean Out. All catch basins, manholes,

inlets, and similar structures shall be thoroughly cleaned of any accumulations of silt, debris, or foreign matter of any kind, and shall be clean of such accumulations at the time of final inspection.

609.03.04 Earthwork. Structure excavation and structure backfill shall conform to the requirements of Sections 206, "Structure Excavation," and 207, "Backfill."

METHOD OF MEASUREMENT

609.04.01 Measurement. The quantities of castings and structural steel grates measured for payment will be the number of pounds complete and in place. The weight of castings shall be computed from the dimensions shown on the approved shop drawings, assuming the cast iron to weigh four hundred fifty (450) pounds per cubic foot, with an allowance of ten (10) percent for fillets and overrun. The weight of structural steel grates shall be computed from the dimensions shown on the approved shop drawings, in accordance with Section 506, "Steel Structures." Certified shop weights will be acceptable in lieu of computed weights.

Adjusting covers for catch basins, manholes, and inlets will be measured per each complete and in place.

Precast manholes of the type and dimensions shown on the plans will be measured per each complete and in place.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

Pipe crossbars and straps for drop inlets shall be included in the measurement for payment by the contract bid price per pound for structural steel grates.

BASIS OF PAYMENT

609.05.01 Payment. The accepted quantities of grates measured as provided in subsection 609.04.01, "Measurement," will be paid for at the contract unit price bid per pound for types and sizes specified.

The work for adjusting covers measured as specified in subsection 609.04.01, "Measurement," will be paid for at

the contract unit price bid per each for adjusting covers for catch basins, manholes, and inlets, which price shall be full compensation for furnishing all materials, tools, incidentals, and labor required to adjust the covers.

Portland cement concrete used in new structures of catch basins and inlets will be paid for as specified in Section 502, "Concrete Structures."

Reinforcing steel in catch basins and inlets will be paid for as specified in Section 505, "Reinforcing Steel."

The accepted quantity of precast manholes measured as provided in subsection 609.04.01, "Measurement," will be paid for at the contract unit price bid per each for types and sizes specified. This price shall be full compensation for furnishing all materials including structure excavation and structure backfill, Portland cement concrete, steel, castings, and incidentals necessary to complete the work.

Structure excavation and structure backfill for catch basins and inlets will be paid for as specified in Sections 206, "Structure Excavation," and 207, "Backfill."

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Castings	Pound
Structural Steel Grates	Pound
(size) Precast Reinforced Concrete Manhole (type)	Each
Adjusting Covers	Each

SECTION 610

RIPRAP

DESCRIPTION

610.01.01 General. This work shall consist of furnishing and placing riprap (with or without grout), heavy riprap, or sacked Portland cement concrete riprap, as the case may be, in accordance with the requirements of the plans and these specifications.

MATERIALS

610.02.01 General. All materials shall conform to the requirements specified in the following sections and subsections:

Water	Section 722
Stone for Masonry and Riprap	Subsection 706.03.05
Portland Cement	Section 701
Grout and Mortar Sand	Subsection 706.03.04

When so provided, waste concrete slabs may be substituted for the above-designated stone. In such case, the concrete shall be sound and the slabs shall meet the size requirements as specified for stone.

Grout shall be composed of one (1) part by volume of Portland cement and three (3) parts by volume of sand and shall be of such consistency that it will fill voids in the riprap.

The mixed concrete shall contain three hundred seventy-six (376) pounds (four sacks) of Portland cement per cubic yard.

The amount of water added at the time of mixing shall be such as will produce a mixture with a slump of from three (3) inches to five (5) inches when tested in accordance with the method described in Section 501 of these specifications.

Unless otherwise provided in the special provisions, aggregate for use in sacked concrete riprap shall consist of river run material of a sandy, gravelly nature, clean and

free from roots, vegetable matter, and other deleterious substances. When tested on laboratory sieves, river run material shall conform to the following grading requirements:

Passing a 2-inch sieve	80 to 100 percent
Passing a No. 200 sieve	0 to 4 percent

The nominal sizes of the various stones used will be as follows:

(a) Size of Riprap. Individual stones shall have a thickness of not less than eight (8) inches and a width of not less than one and one-half (1½) times the thickness. No stones except headers shall have a length less than one and one-half (1½) times their width. The stones shall decrease in thickness from the bottom to the top of the wall.

(b) Size of Heavy Riprap. Size of riprap stone shall be as large as can be conveniently placed in layer thickness specified. In layers two (2) feet or less in thickness, the stones, excepting spalls used to chink interstices, shall weigh not less than fifty (50) pounds, and at least sixty (60) percent of them shall weigh more than one hundred (100) pounds each. In layers more than two (2) feet in thickness at least fifty (50) percent of the mass shall be stones having a volume of two (2) cubic feet or more.

CONSTRUCTION

610.03.01 Earthwork. The bed for the riprap shall be properly trimmed and shaped. Excavations for trenches, footings, cutoff walls, etc., shall conform to the requirements of Section 206, "Structure Excavation." Gradation and compaction requirements on structure backfill will not apply.

610.03.02 Riprap. Stone placed below the water line shall be distributed so that the minimum thickness of the riprap is not less than that specified.

Stone placed above the water line shall be placed by hand. It shall be laid with close, broken joints and shall be firmly bedded into the slope and against the adjoining stones. The stones shall be laid perpendicular to the slope

with the ends in contact. The riprap shall be thoroughly compacted as construction progresses and the finished surface shall present an even, tight surface. The larger stone shall be placed in the lower courses. Interstices between stones shall be chinked with spalls firmly rammed into place.

610.03.03 Heavy Riprap. Heavy riprap may be placed by any mechanical means that will produce a complete job within reasonable tolerances of the typical section shown on the plans. Hand work will be limited to the amount necessary to fill large voids or to correct segregated areas.

610.03.04 Grouted Riprap. When grouted riprap is specified, the stone shall be laid as set forth above for riprap placed above the water line. The spaces between the stones shall then be filled with grout. Sufficient grout shall be used to completely fill all voids, except that the face surface of the stone shall be left exposed. After grouting is completed, the surface shall be cured as specified in Section 502, "Concrete Structures," for a period of at least three (3) days.

610.03.05 Sacked Concrete Riprap. Sacks for concrete riprap shall be made of at least ten (10) ounce burlap and shall be approximately nineteen and one-half (19½) inches by thirty-six (36) inches measured inside the seams when the sack is laid flat. The capacity of each sack shall be approximately one and twenty-five hundredths (1.25) cubic feet. Sound reclaimed sacks may be used. The sacks shall be filled with concrete, loosely placed so as to leave room for folding at the top, the fold to be just enough to retain the concrete at the time of placing. Not more than one (1) cubic foot of concrete shall be placed in each sack. Immediately after being filled with concrete, the sacks shall be placed and lightly trampled to cause them to conform with the earth face and with adjacent sacks in place.

The slopes on which the sacked concrete riprap is to be placed shall be finished true to line and grade. The first

course shall consist of a double row of stretchers laid in a neatly trimmed trench, and the second course shall consist of a single row of headers. The third and remaining course shall consist of stretchers and shall be placed in such a manner that joints in succeeding courses are staggered. All dirt and debris shall be removed from the top of the sacks before the next course is laid thereon. Stretchers shall be placed so that the folded ends will not be adjacent. Headers shall be placed with the folds toward the earth face. Not more than four vertical courses of sacks shall be placed in any tier until initial set has taken place in the first course of any such tier.

When, in the opinion of the Engineer, there will not be proper bearing or bond for the concrete due to delays in placing succeeding layers of sacks or due to the work having been hampered by storms or mud or for any cause, a small trench shall be excavated back of the row of sacks already in place, which trench shall be filled with fresh concrete before the next layer of sacks is laid.

Sacked concrete riprap shall be cured by covering with a blanket of wet earth or by sprinkling with a fine spray of water every two (2) hours during the daytime for a period of four (4) days.

METHOD OF MEASUREMENT

610.04.01 Measurement. The quantity of riprap, heavy riprap, and grouted riprap measured for payment will be the number of cubic yards complete and in place.

The quantity of sacked concrete riprap to be measured for payment will be the number of cubic yards at the mixer. Only work placed within the dimensions shown on the plans or ordered by the Engineer will be measured for payment.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

610.05.01 Payment. The accepted quantities of riprap, heavy riprap, grouted riprap, and sacked concrete

riprap measured as provided in subsection 610.04.01, "Measurement," will be paid for at the contract unit price bid per cubic yard for the type specified.

Structure excavation for trenches, footings, cutoff walls, etc., will be paid for in accordance with Section 206, "Structure Excavation." Backfill will be considered as included in the price paid for structure excavation and no separate payment will be made therefor.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Riprap	Cubic Yard
Heavy Riprap	Cubic Yard
Grouted Riprap	Cubic Yard
Sacked Riprap	Cubic Yard

SECTION 611

CONCRETE SLOPE PAVING

DESCRIPTION

611.01.01 General. This work shall consist of constructing concrete slope paving and concrete mortar slope paving including aprons and cutoff walls in connection therewith, to the lines and grades established by the Engineer in accordance with the design shown on the plans.

MATERIALS

611.02.01 General. Materials shall conform to the requirements specified in the following sections:

Portland Cement Concrete	Section 501
Reinforcing Steel	Section 505

Concrete slope paving and aprons and concrete cutoff walls shall be Class A or Class AA Portland cement concrete.

Concrete mortar slope paving shall consist of a mixture of one (1) part Portland cement to four (4) parts sand, thoroughly mixed in a dry state prior to mixing with water. Measurement may be either by volume or weight. Before placing all lumps three-eighths (⅜) inch or over shall be removed by screening. Sand shall conform to the requirements of subsection 706.03.03, "Fine Aggregate." An air-entraining admixture shall be added to the concrete mortar at a rate of four to seven (4–7) percent.

Mesh reinforcing for ditch lining and slope paving reinforcement shall be of the sizes shown on the plans, fabricated of cold drawn steel wire and need not be galvanized. Mesh reinforcing shall conform to the requirements of Section 505 of the Standard Specifications.

Header boards consisting of two (2) inch by four (4) inch redwood lumber furnished and placed in the grooved concrete or mortar slope paving shall be as shown on the

plans. Lumber used in the construction of header boards shall be commercial grade heart redwood, S4S.

Nails used in construction of header boards shall be commercial quality galvanized nails.

CONSTRUCTION

611.03.01 Earthwork. The subgrade for paved ditches and slope paving shall be formed by excavating to the required depth below the prepared finish surface grade in accordance with dimensions and design indicated on the plans or as directed by the Engineer.

The subgrade shall be thoroughly compacted. Any soft, spongy or other unsuitable material shall be removed to such depth as directed and backfilled with suitable material and thoroughly compacted. Water shall be sprinkled on the subgrade during compaction and the subgrade shall be sufficiently moist prior to placing concrete or mortar to prevent absorption.

Excavations for trenches, footings, cutoff walls, etc., shall conform to the requirements of Section 206, "Structure Excavation." Gradation and compaction requirements on structure backfill will not apply.

611.03.02 General. Concrete, after spreading, shall be tamped until it is thoroughly compact and mortar flushes to the surface. If the slope is too steep to permit the use of concrete sufficiently wet to flush with tamping, the concrete may be tamped until consolidated and a mortar surface one-fourth (¼) inch thick troweled on immediately. The mortar shall consist of one (1) part Portland cement and three (3) parts of clean, sharp sand. The mortar surface shall be considered as a part of the concrete and no additional allowance will be made therefor.

After striking off to grade, the concrete shall be hand floated with wooden floats not less than four (4) inches in width and not less than thirty (30) inches in length. Care shall be taken to prevent rotary marks of the hand floats. The entire surface shall be broomed with a fine texture hair push broom to produce a uniform surface and eliminate

float marks. Brooming shall be done when the surface is sufficiently set to prevent deep scarring and shall be accomplished by drawing the broom down the slope leaving the marks parallel to the edges of the panel. Joints shall be edged with a one-fourth (¼) inch radius edger prior to the brooming.

All concrete or mortar for slope paving, except that used in ditch lining, shall have an integral color pigment added. The color pigment shall consist of a synthetic mineral oxide specifically manufactured for coloring concrete. The integral concrete coloring shall be obtained by mixing the pigment material with the Portland cement, aggregates, and water in a sequence and by methods that will result in a uniform mixture.

The color of the finished slope paving surfaces shall conform to Federal Standard Color No. 30324 as shown in Table II of Federal Standard No. 595. The color shall conform to the referee color except that minor deviations in color and tint representative of the method of mixing and applying the slope paving, will be acceptable.

Prior to placing slope paving for use in the work, the Contractor shall construct sufficient test panels to assure the Engineer that the proper color has been obtained and the final panel shall be at least four (4) feet by six (6) feet in size. The panels shall be constructed at the construction site and shall be placed by a method to be used in placing slope pavement.

The Engineer shall be the sole judge of compliance of the test panel construction with the texture and color requirements of these specifications.

Materials for mortar that have been mixed for more than forty-five (45) minutes and have not been incorporated in the work shall not be used unless otherwise permitted by the Engineer.

Concrete or mortar shall not be placed against frosted or frozen surface. If concrete or mortar is placed during cold weather it shall be heated and protected during placing and curing as set forth in Section 501, except concrete or mortar shall be maintained at a temperature of not less than fifty (50) degrees Fahrenheit for seventy-two (72)

hours after placing and at not less than forty (40) degrees Fahrenheit for an additional four (4) days.

The slope paving shall be constructed without expansion joints.

The mesh reinforcing shall be placed so as to be in the approximate center of the concrete or mortar. All joints shall be lapped six (6) inches and run continuously throughout paving or between headers.

Concrete slope paving, aprons, and cutoff walls shall be cured as specified in Section 502, "Concrete Structures."

METHOD OF MEASUREMENT

611.04.01 Measurement. The quantity of concrete slope paving or concrete mortar slope paving including concrete or concrete mortar aprons and cutoff walls measured for payment will be the number of cubic yards complete and in place.

The quantity will be computed from measurements of the actual areas placed based on the theoretical thickness shown on the plans. No additional allowance will be made for additional concrete placed by reason of low subgrades.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

611.05.01 Payment. The accepted quantities of concrete slope paving and concrete mortar slope paving as well as aprons and cutoff walls in connection therewith, measured as provided in subsection 611.04.01, "Measurement," will be paid for at the contract unit price bid per cubic yard for the material and class specified, which payment shall be full compensation for excavation, backfill, furnishing and installing redwood headers, color pigment, concrete or mortar, and all labor, tools, equipment and incidentals, and for doing all the work involved in placing the concrete slope pavement (including subgrade preparation forms and curing), complete in place, as shown on the plans, as specified herein, and as directed by the Engineer.

Reinforcement shall be measured and paid for as specified in Section 505 of the Standard Specifications.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
(class) Concrete Slope Pavement	Cubic Yard
(class) Concrete Aprons	Cubic Yard
Concrete Mortar Slope Pavement	Cubic Yard

SECTION 612

METAL BIN–TYPE RETAINING WALLS

DESCRIPTION

612.01.01 General. This work shall consist of furnishing and installing metal retaining walls of the bin type at the locations shown on the plans or designated by the Engineer and in reasonably close conformity to the lines, grades, basic designs, and dimensions shown on the plans or established by the Engineer.

The bin-type wall comprises prefabricated members with fittings and appurtenances for complete assembly in the field. The basic design of the wall refers to the length of wall spacers affecting depth of wall.

MATERIALS

612.02.01 General. The galvanized sheets used in fabricating the several members shall conform to the applicable requirements of AASHTO M36 (Corrugated Metal Culvert Pipe). Bolts, nuts, and miscellaneous hardware shall be galvanized.

The various members shall be fabricated from specified metal of the respective gages shown on the plans, but not lighter than 16 gage. In the absence of given gages or dimensions for any member, fitting, or appurtenance, the gage of metal or dimensions thereof shall be as required to fully develop the strength of the members whose gages and dimensions are given and which are used in structural combination.

All members, fittings, and appurtenances shall be designed as integral units or parts of the whole assembly.

CONSTRUCTION

612.03.01 Fabrication. Metal bin-type retaining walls shall consist of a purality of pairs of columns, one column of each pair being in the plane of the front and the other

column being in the plane of the rear of the wall, with the pairs of columns spaced longitudinally with overlapping S-shaped facing and rear members (stringer) and transversely with overlapping U-shaped tie members (spacers). The necessary bolts and appurtenances shall be furnished for complete assembly of the units into a continuous closed face wall of connected bins.

All members shall be so fabricated that members of the same nominal size shall be fully interchangeable. The members shall be so fabricated and punched that no drilling, punching, or drifting to correct defects in manufacture will be required during field assembling and any members having improperly punched holes will be rejected and shall be replaced with properly punched members.

612.03.02 Earthwork. Rough excavation for the site of the wall shall be made to the elevation of the finished ground line at the face of the wall. Below this point, trenches eighteen (18) inches in width shall be excavated for the four (4) sides of the bin. The bearing of the base of the bin shall be firm and shall be approved by the Engineer before erection of the wall.

Structure excavation and backfill for the interior of the bin and behind the wall shall conform to the requirements of Sections 206, "Structure Excavation," and 207, "Backfill." Backfilling behind the wall shall progress with the filling of the bins and shall not be carried ahead of the binfill. Existing slopes, which are shaped so as to cause a wedge action in the backfill, shall be step-cut or benched before backfilling. The limiting dimensions of structure backfill behind the wall shall be the same as those prescribed in subsection 207.04.01 for walls and abutments, or as otherwise shown on the plans.

612.03.03 Assembly. In the construction of a wall on a curve the proper curvature for the face shall be obtained by the use of shorter stringers in the front or rear panels of retaining walls as designated in the plans or by the Engineer.

The wall height and depth may be varied. Two or more designs of retaining walls may be incorporated in the same wall by the use of standard split columns to make the connection on the step-back.

The units shall be erected as shown on the plans. Members shall be handled carefully and any which are damaged shall be removed and new members substituted at the Contractor's expense.

METHOD OF MEASUREMENT

612.04.01 Measurement. The quantity of metal bin-type retaining wall measured for payment will be the number of square feet shown on the plans for each design type of wall, complete and in place.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

612.05.01 Payment. The accepted quantities of metal bin-type retaining walls measured as provided in subsection 612.04.01, "Measurement," will be paid for at the contract unit price bid per square foot for the type specified.

Structure excavation and structure backfill will be paid for in accordance with Sections 206, "Structure Excavation," and 207, "Backfill."

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Metal Bin-Type Retaining Wall (type)	Square Foot

SECTION 613

CONCRETE CURBS, GUTTERS, AND SIDEWALKS

DESCRIPTION

613.01.01 General. This work shall consist of constructing curbs, gutters, sidewalks, local depressions, and driveways of the form and dimensions shown on the plans of Class A or Class AA concrete as shown in the proposal, mixed and placed as provided in Sections 501, "Portland Cement Concrete," and 502, "Concrete Structures," of these specifications with the following modifications and additional requirements.

MATERIALS

613.02.01 General. Materials shall conform to the applicable requirements of Sections 501, "Portland Cement Concrete," 502, "Concrete Structures," and 505, "Reinforcing Steel."

CONSTRUCTION

613.03.01 Earthwork. The subgrade shall be constructed true to grade and cross section as shown on the plans or established by the Engineer. It shall be thoroughly watered and rolled or hand tamped until the subgrade reaches the compaction required for the adjacent roadway or base course. All soft and spongy material shall be removed to a depth of not less than six (6) inches below subgrade elevation for curbs, gutters, local depressions, and driveways and three (3) inches below for sidewalks, and the resulting space filled with earth, sand, or gravel of a quality that, when moistened and rolled or tamped, will form a firm and solid foundation.

The completed subgrade shall be tested for grade and cross section by means of a template extending the full depth and supported on the side forms. The subgrade and

forms shall be thoroughly watered in advance of placing concrete.

613.03.02 Existing Curbs, Gutters, and Sidewalks. Where the plans provide for reconstruction of existing curb and sidewalk and the limit of new work specified does not fall on a scoring line, the entire section shall be removed and the new curb and sidewalk shall join the old curb and sidewalk at the first scoring line beyond said specified limit.

613.03.03 Forms. The depth of forms for curbs shall be equal to the full depth of the curb. The depth of outside forms for concrete gutters shall be equal to the full thickness of the gutter. Timber forms, if used, shall be surfaced on the side placed next to the concrete, and shall have a true smooth upper edge, and shall not be less than one and five-eighths (1⅝) inches thick after being surfaced. Warped forms and forms not having a smooth, straight upper edge shall not be used.

Benders or thin plank forms, rigidly placed, shall be used on curves, grade changes, or for curb returns. Steel forms shall not be used on radii less than two hundred (200) feet.

Back forms for curb returns shall be made of one-half (½) inch benders, for the full height of the curb, cleated together. Forms shall be carefully set to alignment and grade and to conform to the dimensions required. Forms shall be held rigidly in place by the use of pairs of iron stakes placed at intervals not to exceed four (4) feet. If metal forms are used, iron stakes shall not be spaced more than six (6) feet apart. Clamps, spreaders, and braces shall be used where required to insure rigidity in the forms.

Forms shall not be removed until concrete has set sufficiently to prevent distorting or cracking.

All forms shall be cleaned thoroughly each time they are used and coated with a light oil as often as necessary to prevent the concrete from adhering to them.

613.03.04 Curb and Gutter Joints. Expansion joints one-half (½) inch wide shall be constructed in curbs and

gutters at ninety (90) foot intervals, at each side of structures and at the ends of all curb returns except that expansion joints shall not be installed within twenty (20) feet of an island nose. Expansion joints shall be filled with joint filler strips one-half (½) inch thick conforming to the requirements of Section 707, "Joint Material," of these specifications. Expansion joint filler shall be shaped to the cross section of the curb and gutter.

Expansion joints shall be constructed at right angles to the line of the curb and gutter.

613.03.05 Sidewalk Expansion Joints. Transverse expansion joints one-half (½) inch wide shall be constructed at all sidewalk returns and opposite expansion joints in adjacent curb. Where curb is not adjacent, expansion joints shall be constructed at intervals of thirty (30) feet.

Expansion joints shall be filled with joint filler strips one-half (½) inch thick conforming to the requirements of Section 707, "Joint Material," of these specifications.

The joint filler shall be placed with the top edge one-fourth (¼) inch below the surface and shall be held in place by means of steel pins driven into the subgrade and spaced sufficiently close to prevent warping of the filler during floating. Upon completion of floating, the pins shall be removed and a suitable metal channel having legs not over three-fourths (¾) inch long shall be fitted snugly over the joint filler. The metal channel shall remain in place until the finishing operations have been completed, after which it shall be removed and the joint edged with an edging tool having a radius of one-eighth (⅛) inch.

613.03.06 Curb and Gutter Construction. In constructing curbs, entrances for garages or driveways shall be constructed according to the dimensions shown on the plans.

With the approval of the Engineer, the curb may be constructed by the use of a curb forming machine.

The installation of precast concrete curbing shall meet the requirements herein prescribed.

Where plantmixed surfacing is to be placed around or adjacent to manholes, drop inlets, or catch basins in gutter, local depression, or driveway areas, such structures shall not be constructed to final grade until after the curbs and gutters have been constructed for a reasonable distance, as directed by the Engineer, on each side of the structure, in order to maintain a true grade for the surfacing to match.

Where Portland cement concrete pavement is to be placed around or adjacent to manholes, drop inlets, or catch basins in gutter, local depression, or driveway areas, such structure shall not be constructed to final grade until after the concrete pavement has been constructed.

Concrete curbs to be constructed over an existing pavement shall be anchored to the pavement by means of steel dowels firmly grouted, with 1:1 Portland cement grout, in holes drilled in the pavement. Dowels shall conform to the requirements of bar reinforcing steel of these specifications and shall be spaced and be of the size and length as shown on the plans. Approved expansion bolts may be used in lieu of dowels, at the option of the Contractor.

The forms shall be filled to the top and the concrete shall be so handled that there will be no rock pockets. Concrete may be compacted by means of mechanical vibrators approved by the Engineer. Immediately after removing the front curb forms, the face of the curb shall be troweled smooth to a depth of not less than two (2) inches below the flow line or to the flow line of integral curb and gutter, and then finished with a steel trowel. The top shall be finished and the front and back edges rounded as shown on the plans.

After the face of the curb has been troweled smooth, it shall be given a final fine brush finish with brush strokes parallel to the line of the curb.

The top and face of the finished curb shall be true and straight, and the top surface of curbs and gutters shall be of uniform width, free from humps, sags, or other irregularities. When a straightedge ten (10) feet long is laid on the top or face of the curb or on the surface of gutters, the surface shall not vary more than one-eighth (⅛) inch

from the edge of the straightedge, except at grade changes or curves.

The exposed surfaces shall be cured in accordance with the requirements of Section 502, "Concrete Structures."

613.03.07 Sidewalk Construction. The structures shall be finished to smooth and uniform texture by troweling and by floating with wooden floats, and, if so directed by the Engineer, by cross-brooming or burlap-finishing. The surface shall be lightly grooved or marked into squares or other shapes to match other such markings on similar existing structures in the vicinity, or as designated by the Engineer.

When a ten (10) foot straightedge is placed on the sidewalk, the surface shall not vary more than one-eighth (⅛) inch from the edge of the straightedge, except at grade changes, and the finished surface shall be free from blemishes.

Immediately after the surface of the sidewalk is finished, the concrete shall be cured in accordance with the requirements of Section 502, "Concrete Structures."

METHOD OF MEASUREMENT

613.04.01 Measurement. The quantity of curb, gutter, shoulder strip, mountable curb, and combination curb and gutter measured for payment will be the number of linear feet along the base of the curb face or along the flow line of the gutter, and such measurement shall be continuous along such line extended across driveway and alley entrance returns.

The quantity of sidewalk, driveway, loading zone, and steps shall be measured for payment by area in square yards.

In the case of integral curb and walk, the width of the walk shall extend to the back face of the curb. In the case of steps, the area measured shall be the summation of the areas of the treads, computed by multiplying the width of the tread by the length of the tread out to out of integral wall, if any.

All quantities measured for payment herein will be complete and in place.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

613.05.01 Payment. The accepted quantities of concrete measured as provided in subsection 613.04.01, "Measurement," will be paid for at the contract unit price bid per linear foot for curb, gutter, shoulder strip, or mountable curb and per square yard for sidewalk, driveway, loading zone, or steps as the case may be.

All excavation and base course work required for and performed during construction of the items of this section will be paid for as provided in the respective sections of the specifications; however, when the contract does not provide bid items for excavation or base course, such work required and performed will be considered subsidiary to the pay item contained herein and no further payment will be made therefor.

Any excavation or backfill required other than roadway quantities will be considered subsidiary to the major items of work and no further payment will be made therefor.

Reinforcing steel placed in curbs and gutters as shown on the plans or ordered by the Engineer will not be paid for directly but the cost thereof shall be considered as included in the contract bid prices for other items of work.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
(class) Concrete Curb	Linear Foot
(class) Concrete Gutter	Linear Foot
(class) Concrete Curb and Gutter	Linear Foot
(class) Concrete Sidewalk	Square Yard
(class) Concrete Driveway	Square Yard
(class) Concrete Sidewalk and Driveway	Square Yard
(class) Concrete Scored Shoulder Strip	Linear Foot
(class) Concrete Mountable Curb	Linear Foot
(class) Concrete Loading Zones	Square Yard

SECTION 614

PAINTING

DESCRIPTION

614.01.01 General. This work shall consist of the preparation of surfaces to be painted and the application, protection, and drying of the required number of coats of paint of the kinds and at the points specified or ordered by the Engineer.

MATERIALS

614.02.01 General. All materials shall meet or exceed the minimum standards hereinafter set forth:

(a) Raw Materials. American Society for Testing Materials (ASTM) and Federal Specifications.

(b) Prepared Paints. Federal Specifications are specified to designate the type of material and standard of quality. Manufacturer's standard, first grade materials meeting or exceeding these requirements may be used if approved by the Engineer. Materials not bearing manufacturer's identification as a standard, first grade product, of his regular line, will not be considered.

(c) Proprietary materials when specified hereinafter by the manufacturer's trade name designate the standard of quality and type of material required. When the quality or type of material required is not specified, the Contractor shall apply for directions as to selection of materials and receive approval thereof from the Engineer before proceeding; only the best quality of such materials shall be used, as determined by the Engineer.

(d) Materials lists shall be submitted to the Engineer for approval and none shall be used until such approval has been obtained. All materials proposed for use shall be delivered to the site in original containers, seals unbroken, stored where directed, and one may be used until approved by the Engineer. Materials that are not approved must be immediately removed from the jobsite.

614.02.02 Number of Coats. Unless otherwise required in the contract documents, the number and kinds of coats of paint shall be as set forth in Section 714, "Paint."

CONSTRUCTION

614.03.01 Weather Conditions. Paint shall be applied only on thoroughly dry surfaces and during periods of favorable weather. Except as provided below, painting will not be permitted when weather conditions during applications are such that the atmospheric temperature is at or below forty (40) degrees Fahrenheit or when freshly painted surfaces may become damaged by rain, wind, dust, or condensation, or when it can be anticipated that the atmospheric temperature will drop below forty (40) degrees Fahrenheit, during the drying period. If fresh paint is damaged by the elements it shall be replaced by the Contractor at his expense.

Subject to the approval of the Engineer in writing, the Contractor may provide suitable enclosures to permit painting during inclement weather. Provisions must be made to control atmospheric conditions artificially inside the enclosures within the limits suitable for painting throughout the painting operation. The cost of providing and maintaining such enclosures shall be considered as included in the prices paid for the various contract items of work and no additional payment will be made therefor.

614.03.02 Application—General. All work shall be done by painters and finishers of established status and reputation for executing their work by the very best methods for each kind or type. Painting shall not be done except when the surface is dry and when weather conditions are satisfactory as set forth above.

Strict adherence to these specifications and the recommendations of the manufacturer whose materials are used shall be followed in the application. The Contractor shall use such skills, equipment, materials, and give his thorough attention to details as will provide thoroughly workmanlike and satisfactory results throughout.

Work which shows carelessness, lack of skill and execution, or which is defective due to any other cause shall be removed and refinished or repainted as directed without additional cost to the State.

On all surfaces which are inaccessible for brushing, the paint shall be applied by sheepskin daubers especially constructed for the purpose, or by other means approved by the Engineer.

If spray methods are used, the operator shall be thoroughly experienced. Runs, sags, thin areas in the paint coat, or skips and holidays shall be considered as evidence that the work is unsatisfactory and the Contractor may be required to apply the remainder of the paint by brush.

Mechanical mixers shall be used to mix the paint. The paint shall be mixed a sufficient length of time, prior to use, to thoroughly mix the pigment and vehicle together. Paint shall be kept thoroughly mixed while being applied, to keep the pigments in suspension.

Paint specified or formulated shall be ready for application and thinning will be allowed only on direction of the Engineer.

The Contractor shall protect all parts of the structure being painted against disfigurement by spatters, splashes, and smerches of paint or paint materials. When paint is being applied on structures carrying public traffic, the Contractor shall be responsible for any damage caused by his operations to passing vehicles or persons and may be required to use canvas shields or other protective means to guard against such damage.

Paint stains which result in an unsightly appearance shall be removed by the Contractor at his own expense.

614.03.03 Surface Preparation of Steel. The following methods of surface preparation apply to steel surfaces. Unless otherwise specified, the sandblasting method shall be used.

(a) Sand Blasting. All dirt, mill scale, rust, stain, old paint, and other foreign material shall be removed from steel surfaces by an approved blast cleaning apparatus. Blast cleaning shall be sufficient to give the surface the

appearance of unpolished cast aluminum and/or commercial blast cleaning according to Steel Structure Painting Council, SSPC Specification SP–6, Photo Vis 1# B Sa 2 Commercial.

Abrasives used for such blast cleaning shall be either clean dry sand, mineral grit, steel shot, or steel grit, at the option of the Contractor, and shall be of a grading suitable to produce satisfactory results. The use of abrasives other than those specified herein will not be permitted unless approved in writing by the Engineer.

When sandblasting is being performed on structures open to traffic, the Contractor shall provide suitable protective devices to prevent damage to traffic.

When sandblasting is being performed near machinery, all journals, bearings, motors and moving parts shall be sealed against entry of sand dust before sandblasting begins.

Unless otherwise authorized by the Engineer, sandblasted surfaces shall be primed or treated the same day sandblasting is done. If cleaned surfaces rust before painting is accomplished, they shall be recleaned by the Contractor.

(b) Washes. Rust-inhibitor chemical washes shall be applied to freshly sandblasted steel surfaces prior to the application of the first undercoat of paint, except whenever the first undercoat of paint is applied to the cleaned surfaces within a four (4) hour period after cleaning, washes will not be required. Washes shall be applied in not more than four (4) hour intervals. If in the opinion of the Engineer, atmospheric conditions are such that corrosion products form on freshly sandblasted surfaces in less than four (4) hours, treatment may be required at more frequent intervals.

Rust-inhibitor chemical washes may be applied by brush or spray, and they shall be applied in a careful manner to insure that all surfaces are covered.

During the application of the rust-inhibitor chemical wash no sandblasting will be permitted to the areas being treated.

No paint shall be applied until after the treated surfaces have thoroughly dried.

The first undercoat of paint shall be applied to the treated surfaces the same day that cleaning and washing have been done.

(c) Steam Cleaning. All dirt, grease, loose chalky paint, or other foreign material which has accumulated on the previously painted surfaces shall be removed with an approved steam cleaning apparatus which shall precede all other phases of cleaning.

It is not intended that sound paint be removed by this process. Subsequent painting shall not be performed until the cleaned surfaces are thoroughly dry and in no case in less than twenty-four (24) hours after cleaning.

A detergent soap consisting of forty-five (45) percent sodium metasilicate, forty-three (43) percent sodium sesquisilicate, ten (10) percent sodium tetraphosphate and two (2) percent Naccanol shall be added to the feed water of the steam generator at the approximate rate of one (1) pound of detergent per two hundred (200) pounds of water.

Any residue which may accumulate on cleaned surfaces shall be removed by flushing with fresh water but washing down the cleaned surfaces will not otherwise be required.

(d) Hand Cleaning. All dirt, loose rust, and mill scale, dead paint, or paint which is not firmly bonded to the metal surfaces shall be removed by wire brushes, either hand or powered, hand scraping tools or sandpaper.

Pneumatic chipping hammers will not be allowed unless authorized in writing by the Engineer. Hand cleaning shall be sufficient to remove all loose material which would prevent the bond of succeeding coats of paint.

If the amount of steel to be painted exceeds one hundred (100) tons the surface shall be prepared by method (a), "Sand Blasting;" however, if the amount to be painted is one hundred (100) tons or less the surface may be prepared by method (d), "Hand Cleaning."

614.03.04 Painting Structural Steel.

(a) Paint. Unless otherwise required in the contract

documents, the paints to be applied to steel surfaces shall conform to the requirements of Section 714, "Paint." The undercoats shall consist of a minimum dry film thickness of one (1) mil per coat. The finish coat shall consist of a minimum dry film thickness of one (1) mil. The total thickness of all coats shall be not less than three (3) mils.

Excessively thick coats of paint will not be permitted. The thickness of each coat shall be limited to that which will result in uniform drying throughout the paint film.

(b) Field Cleaning. Unless otherwise specified in the contract documents, after erection and riveting or welding, all surfaces of unpainted structural steel which will be exposed to air, shall be sandblasted in accordance with the requirements of subsection 614.03.03, "Surface Preparation of Steel."

Any damage to sound paint, on areas not designated for treatment, resulting from the Contractor's operations, shall be repaired to the satisfaction of the Engineer.

(c) Painting. Painting of structural steel prior to erection will be limited to surface preparation and one undercoat of paint. Any deficiencies in the first coat of paint shall be corrected to the satisfaction of the Engineer, prior to the application of succeeding coats of paint.

Surfaces exposed to the atmosphere which would be inaccessible for painting after erection shall be painted the full number of coats prior to erection.

The surface of the paint coat being covered shall be free from moisture, dust, grease, or any other deleterious material which would prevent the bond of the succeeding paint coats. In spot painting, any old paint which lifts after application of the first spot coat shall be removed by scraping and the area repainted before application of the next coat.

The application of the finish coat will not be permitted until the required total film thickness of the undercoats of paint, as described in (a), above, is obtained.

Open seams at contact surfaces of built-up members which would retain moisture shall be caulked with red lead paste before applying the second undercoat of paint.

Metal surfaces embedded in concrete need not be painted.

(d) Machine Finished Surfaces. With the exception of abutting chord and column splices and column and truss shoe bases, machine finished surfaces shall be coated with a rust inhibitor which can be easily removed. Surfaces of iron and steel castings which have been machine finished shall be painted with a coat of shop paint.

(e) Frames and Grates. Prior to installation, all surfaces of frames and grates exposed to the atmosphere shall be painted with two (2) coats of paint. Unless otherwise specified in the contract documents, the exposed surfaces shall be painted after installation with one finish coat as specified for structural steel.

614.03.05 Painting Timber.

(a) Paint. All new timber requiring painting shall be painted with three (3) coats of paint. The paint used for various coats will be as specified in these specifications or in the contract documents.

(b) Preparation of Surfaces. All cracked or peeled paint, loose chalky paint, dirt, and other foreign matter shall be removed by wire brushing, scraping, or other approved means immediately prior to painting. Unpainted timber shall be thoroughly dry before paint is applied.

(c) Painting. When permitted in writing by the Engineer, the first coat of paint may be applied prior to erection.

After the first coat has dried and the timber is in place, all cracks, checks, nail holes, etc., shall be puttied flush with the surface and allowed to dry before the second coat is applied.

Skips, holidays, thin areas, or other deficiencies in any one coat of paint shall be corrected to the satisfaction of the Engineer before the succeeding coat is applied.

The surface of the paint coat being covered shall be free of any deleterious material before any additional paint is applied.

BASIS OF PAYMENT

614.05.01 Payment. No direct payment will be made for painting, cleaning structural steel, or preparing surfaces for painting. Compensation for this work shall be considered as included in the contract unit prices bid for the particular item requiring painting.

SECTION 615

PRESERVATIVE TREATMENTS FOR TIMBER

DESCRIPTION

615.01.01 General. This work shall consist of preservative treatment for lumber, timber, and piles as herein specified.

MATERIALS

615.02.01 General. The materials used shall be those prescribed for the several items which constitute the finished work and shall comply with all the requirements for such materials as set forth in these specifications.

Attention is directed to Section 719, "Timber Preservatives."

CONSTRUCTION

615.03.01 Treatment. All structural timber, piling, and other lumber shall be thoroughly seasoned or conditioned before treatment by air seasoning, kiln drying, steaming, or heating in the preservative, either at atmospheric pressure or under a vacuum, or by a combination thereof that will not cause damage. The moisture remaining in the wood, prior to treatment, shall be reduced so that the injection and proper distribution of the required amount of preservative will be obtained. The method of seasoning, conditioning and treating used shall conform to the Federal Specification TT–W–571.

615.03.02 Amount of Preservative. The minimum amount of preservative retained per cubic foot of timber, lumber, or piling shall conform to the minimum specification requirements of the Federal Specification TT–W–571.

Unless otherwise specified, material treated with pentachlorophenol shall have a minimum retention of eight (8) pounds unless it is to be painted, then six (6) pounds will be the minimum retention.

Material to be treated with Ammoniacal Copper Arsenite shall have a net retention of dry salts of not less than 0.3 pounds.

615.03.03 Preservative Treatment by the Hot-Cold Soaking Method. When called for on the plans, all lumber and timber to be treated by the hot-cold soaking method must be reasonably well seasoned and free from outer and inner bark, dirt, grease, or other objectionable matter which will in any way hinder the free penetration of the preservative. All lumber and timber of two (2) inch dimensional stock or larger shall be incised and all framing shall be done before treatment.

The preservative used shall be a five (5) percent concentration of pentachlorophenol.

The tanks used shall be of sufficient size to permit complete submergence of the largest timber in any operation and to allow free circulation of the liquid around the timber being treated. Sufficient liquid shall be maintained in the tank to completely submerge the timber to a minimum depth of six (6) inches. When a number of pieces are being treated at one time, each piece shall be separated from the others on all sides by spacers not less than one-fourth (¼) inch in least dimension. Suitable weights or cross bracing shall be provided to keep the material submerged.

The timber or lumber shall be submerged in the cold solution as previously described. The temperature shall be slowly increased for a period of not less than five (5) hours to a minimum temperature of one hundred eighty (180) degrees Fahrenheit and not exceeding two hundred ten (210) degrees Fahrenheit. After five (5) hours and attaining the minimum specified temperature, the timber or lumber shall be permitted to cool in the solution until such time as the minimum specified quantity of preservative is absorbed by the wood.

Timber for minor irrigation structures, unless otherwise shown on the plans, shall be No. 1 common grade of the species permitted, and shall be treated in accordance with the Hot-Cold Soak Process. The species permitted and the

minimum retention in pounds per cubic foot required are as follows:

Species	Min. Retention per Cubic Foot (pounds)
Douglas Fir (Rocky Mountain, Inland, or Coast)	2.0
Pine, Yellow (Pinus Ponderosa)	4.0
Pine, Lodge Pole (Pinus Contorta)	4.0
Cottonwood, Northern Black (Populus Trichocarpa Hastata)	4.0

615.03.04 Inspection. All timber and piling, untreated or to be treated, shall be inspected before treatment by an inspector designated by the Engineer. The inspector shall stamp each piece of timber accepted with a stamp making a legible mark designating the inspector.

All timber and piling shall be inspected after treatment by an inspector designated by the Engineer. The inspector shall stamp each piece accepted with a stamp making a legible mark designating the inspector.

All materials and processes used in the manufacture of material shall be subjected to inspection, acceptance, or rejection at the manufacturer's plant, which shall be equipped with all the necessary gages, appliances and facilities to enable the inspector to satisfy himself that the requirements of the specifications have been fulfilled.

The treated timber and piling shall be free from heat checks, water bursts, excessive checking, results of chafing or from other damage or defects which would impair its usefulness or durability.

BASIS OF PAYMENT

615.05.01 Payment. Full compensation for treatment of lumber, timber, and piles as herein specified shall be considered as included in the price paid for the particular item of work in which the treated lumber, timber, or piling is used and no additional allowance will be made therefor.

SECTION 616

FENCING

DESCRIPTION

616.01.01 General. This work shall consist of furnishing and erecting new standard fence, chain-link fence, gates, or reconstructing fences previously removed in conformity with these specifications and the plans.

New standard fence shall consist of galvanized barbed wire, galvanized farm fence or both fastened to wood posts or metal posts or to a combination of the two kinds of posts as shown on the standard plans.

Chain-link fence shall consist of galvanized chain-link fabric attached to metal posts and fastened to a top tensioning cable and a bottom tensioning wire. The height of chain-link fences shall be as designated in the contract documents.

MATERIALS

616.02.01 General. Materials shall conform to the requirements specified in Sections 724, "Fence Materials," and 501, "Portland Cement Concrete."

CONSTRUCTION

616.03.01 General. All trees, brush, and other obstructions which interfere with proper construction of fences shall be removed and disposed of in accordance with the requirements of Section 201, "Clearing and Grubbing," of these specifications except that no payment will be made for such work. When constructing chain-link fence, rocks and other surface irregularities that require moving in order to maintain a nearly smooth surface, shall be removed and no direct payment will be made therefor.

Fence construction operations shall be so conducted as to prevent the escape of livestock. Existing cross fences shall be connected to the new fence. Corner posts, with braces for every direction of strain, shall be placed at the

junction with existing fences and the wire in both fences properly fastened to the posts. At bridges and cattle passes, and at culverts if shown on the plans or ordered by the Engineer the new fence shall be connected to the structure in such a manner as to permit the free passage of livestock through or under the structure.

Barbed wire, farm fence, and chain-link fence fabric shall be fastened on the side of the posts opposite the highway centerline unless otherwise directed by the Engineer.

Post holes for metal posts that are drilled or dug shall be backfilled with Class A or AA concrete or grout.

Each strand of barbed wire shall be securely fastened to a braced post at each intermediate braced post assembly be wrapping twice around the post then securing to that part of the same wire stretched between posts. The remaining wire shall be cut off and the tie shall present a neat and workmanlike appearance.

Galvanized pipe brace rail shall not be spliced.

The first line of barbed wire above wire mesh shall be tied to the top wire of the wire mesh, midway between posts, with 12 gage galvanized steel wire or 9 gage aluminum hog rings.

Intermediate Braced Post Assemblies—Timber: The horizontal brace shall be placed six (6) inches below the tops of the brace posts and properly fitted and connected to them by two three-eighths (⅜) inch by four (4) inch steel dowels. The dowel pins shall extend two (2) inches into each brace and brace post. Two strands of 8 gage galvanized wire shall be run as a brace diagonally from four (4) inches above ground line on each brace post to four (4) inches below the top of the other brace post. An extra loop shall be made around each post at the point of attachment and the wire firmly stapled to the post. These brace wires shall then be twisted until the assembly is rigid.

Corner post assemblies shall be constructed as indicated on the standard fence details and the end post assemblies shall be composed of end posts and brace posts installed and braced as indicated for timber corner braces.

At the option of the Contractor, timber line posts may be installed by tamping firmly in place in drilled or dug holes or by driving, provided the method of driving does not damage the posts or cause the posts to be deflected from line and plumb. All other timber posts shall be installed in drilled or dug holes and tamped firmly in place. Round timber posts installed in drilled or dug holes shall have the butt end placed downward. Timber line posts which are to be driven, shall be machine pointed at the plant before being treated. The small end of driven round timber posts shall be pointed.

Each strand of barbed wire shall be securely fastened to a corner post, end post, or intermediate braced post assembly by wrapping twice around the post and securing to that part of the same wire stretched between the posts. The remaining wire shall be cut off and the tie shall present a neat and workmanlike appearance.

Staples shall be set so as to hold the wire securely, but should not be buried in the post in such a manner as to severely nick or bend the wire.

616.03.02 Standard Fence. Standard fencing shall be designated by types as follows: Metal posts—Type A; Wood posts—Type B; Combination metal and wood posts —Type C. The type of fence construction shall be as shown on the plans and indicated in the proposal. Posts shall be firmly set or driven into the ground and spaced as indicated on the plans. Each end, corner, and gate post shall be firmly braced and shall be set in concrete when required. Posts shall be braced as indicated on the plans.

Standard fencing will be designated not only by type, but also by a symbol indicating the fencing required. Thus (Type A–832–3B) will be used to designate a fence composed of metal posts, thirty-two (32) inch woven wire (farm fencing) and three barbed wires; (Type C–726–4B) to designate a fence composed of a combination of metal and wood posts twenty-six (26) inch woven wire and four barbed wires, etc. The figures 832, etc., when they appear in the symbol, correspond to design numbers set forth in the standard plan.

In general, in determining the post spacing, measurements will be made parallel to the slope of the natural ground, and all posts shall be placed in vertical position except in unusual locations where in the opinion of the Engineer it would be more satisfactory to place the posts perpendicular to the slope of the ground. All intervals shall be measured center to center of adjacent posts.

Changes in line where the angle of deflection is thirty (30) degrees or more shall be considered as corners and corner posts shall be installed. Changes in line where the angle deflection is more than fifteen (15) degrees and less than thirty (30) degrees shall be considered as alignment angles and adjacent posts shall be made fast to the angle posts by means of wire, or if such method is impracticable in the opinion of the Engineer, such posts shall be braced as above specified for bracing gate, end and corner posts.

At all grade deflections and alignment angles where stresses tend to pull the posts from the ground, the fencing shall be snubbed or guyed at the critical point by means of a double strand of 9 gage galvanized wire connected to each horizontal line of barbed wire or to the top and bottom of wire mesh fabric, and to a deadman weighing approximately one hundred (100) pounds, buried in the ground not less than two (2) feet. The fencing shall be pulled snug close to the ground before being snubbed or guyed.

Barbed wire and farm fence fabric (woven wire) shall be stretched taut and securely fastened to each post by means of suitable devices approved by the Engineer.

616.03.03 Chain-Link Fence. All posts shall be of a total length of not less than the depth of the concrete footing as shown on the plans, plus the length required above ground.

Changes in line where the angle of deflection is thirty (30) degrees or more shall be considered as corners and corner posts shall be installed.

Between posts, chain-link fences shall be fastened to a bottom tension wire and a top tension cable. The bottom tension wire shall be at least 7 gage galvanized coil spring

wire of good commercial wire. The top tension cable shall be at least three-eighths (⅜) inch diameter galvanized seven (7) strand cable conforming to the requirements of the current ASTM Designation A475 common grade.

Line posts shall be spaced at not more than ten (10) foot intervals, measured from center to center of posts. In general, in determining the post spacing, measurements will be made parallel to the slope of the natural ground, and all posts shall be placed in a vertical position except in unusual locations where in the opinion of the Engineer it would be more satisfactory to place the posts perpendicular to the slope of the ground.

All metal posts shall be set in Class A or AA Portland cement concrete footing crowned at the top to shed water. Depths of footings shall be as shown on the plans.

End, corner, and gate posts shall be braced with galvanized braces used as compression members and galvanized steel truss rods with truss tighteners used as tension members. Line posts, at intervals of five hundred (500) feet, shall be braced and trussed in both directions as shown on the plans.

The fabric shall be stretched taut and securely fastened to the posts, and between posts the top edge of the fabric shall be fastened to the top tension cable and the lower edge fastened to the bottom tension wire. Tension cable and wire shall be stretched tight with truss tightener as shown on the plans. The bottom tension wire shall be installed on a straight grade between posts by excavating the high points of the ground and in no case will filling of depressions be permitted.

The fabric shall be fastened to the end, corner, and gate posts with one-fourth by three-fourths (¼ x ¾) inch steel stretcher bars and not less than one-eighth by three-fourths (⅛ x ¾) inch steel stretcher bar bands placed at one (1) foot intervals, and to line posts tension cable and tension wires with tie wires or metal bands. Tie wires or metal bands shall be spaced on line posts at intervals of approximately fourteen (14) inches and on tension cables and tension wires approximately eighteen (18) inches.

All posts shall be fitted with tops designed so as to fit

securely over the posts, and carry the top tension cable, except that the top of the H-section posts may be open-slotted in such a manner as to securely hold the top tension cable in position without vertical movement. Such slotting shall allow removal and replacement of a post without disturbing the top tension cable. Tubular posts shall be fitted with watertight tops.

616.03.04 Reconstruct Fence. Reconstructed fences shall be carefully erected, using salvaged materials and shall be similar in type to the original construction. Any new materials necessary to rebuild the fence shall be furnished by the Contractor, shall be of the same kind as those in the original fence, and the cost thereof shall be included in the contract price for the work. The resulting reconstructed fence shall be equal to or better than before removed. In reconstructed fences, the Department reserves the right to furnish the Contractor with such new materials as it deems advisable, and these materials shall be used in the reconstruction of the fence in lieu of salvage materials which they replaced.

616.03.05 Gates. The width of drive gates shall be as shown on the plans and as indicated in the proposal and the height shall be suited to the fencing but shall not be more than seventy-two (72) inches nor less than forty-eight (48) inches. The wire mesh filler shall be rectangular or two (2) inch diamond mesh for standard fencing and chain-link fence fabric for chain-link fencing.

Walk gates shall be three and one-half (3½) feet wide and of a height corresponding to the adjacent fence height.

The gates shall be hung by steel or malleable iron hinges so designed as to securely fasten to the gate posts and permit the gate to swing back against the fence.

Gates shall be provided with a combination steel or malleable iron catch and locking-in attachment of approved design. A center rest with catch shall be provided where required.

Missouri gates shall be constructed as shown on the standard plan.

METHOD OF MEASUREMENT

616.04.01 Measurement. The quantity of new fence measured for payment will be the number of linear feet, exclusive of gates and cattle guards, complete and in place.

The quantity of reconstructed fence measured for payment will be the number of linear feet, including used gates, complete and in place.

The quantity of new gates measured for payment will be the number of gates complete and in place. If more than one size or type of gate is involved, separate measurement will be made for each size and type given.

Missouri gates, regardless of width, shall be measured for payment as units.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

616.05.01 Payment. The accepted quantity of new and reconstructed fence measured as provided in subsection 616.04.01, "Measurement," will be paid for at the contract unit price bid per linear foot for the types and sizes specified.

The accepted quantity of new gates measured as provided in subsection 616.04.01, "Measurement," will be paid for at the contract unit price bid per each for types and sizes specified.

The above prices shall be full compensation for furnishing hardware, cement, concrete, framing, erecting, connecting fence, and all incidentals necessary to complete the work.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Type (.....) Fence	Linear Foot
(size) Chain Link Fence	Linear Foot
(size) Metal Drive Gate	Each
(size) Timber Drive Gate	Each
(size) Metal Walk Gate	Each
(size) Timber Walk Gate	Each
Reconstruct Fence	Linear Foot
Missouri Gate	Each

SECTION 617

CATTLE GUARDS

DESCRIPTION

617.01.01 General. This work shall consist of furnishing and constructing standard steel cattle guards and cattle guard wings of the design and at points shown on the plans or ordered by the Engineer.

MATERIALS

617.02.01 General. All materials shall conform to the requirements specified in the following sections:

Portland Cement Concrete	Section 501
Reinforcing Steel	Section 505
Steel Structures	Section 506
Hardware	Section 723
Painting	Section 614
Paint	Section 714

Portland cement concrete shall be Class A or Class AA, unless otherwise provided.

All hardware shall be galvanized steel.

All lumber and timber shall be Douglas Fir, No. 2 joist and plank or No. 1 structural posts and timber. Any commercial grading rules that will provide material of an equal or greater stress value may be used.

CONSTRUCTION

617.03.01 Earthwork. Structure excavation and backfill shall conform to the applicable requirements of Sections 206, "Structure Excavation," and 207, "Backfill."

617.03.02 General. Cattle guards shall be constructed in accordance with the details and dimensions shown on the plans.

Concrete and metal reinforcement construction shall

conform to the applicable requirements of Sections 502, "Concrete Structures," and 505, "Reinforcing Steel," respectively.

Steel member connections shall be welded and the construction thereof shall conform to Section 506, "Steel Structures."

The wing posts and wheel guards shall be given a preservative treatment conforming to the requirements of Section 719, "Timber Preservatives." Treated timber and lumber is not to be painted.

Timber and lumber shall be assembled and placed in conformance to the applicable requirements of Section 507, "Timber Structures."

Painting shall be in accordance with recognized high standards of workmanship and in conformance with the applicable requirements of Section 614, "Painting."

METHOD OF MEASUREMENT

617.04.01 Measurement. The quantity to be measured for payment will be the number of steel cattle guards or cattle guard wings complete and in place. If more than one size of cattle guard is involved, separate measurement will be made of each size given.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

617.05.01 Payment. The accepted quantity of cattle guards measured as provided in subsection 617.04.01, "Measurement," will be paid for at the contract unit price bid per each for the sizes specified. The cost of cattle guard wings shall be included in the contract unit price for cattle guards, however, where wings alone are required, they will be paid for at the contract unit price each for cattle guard wings. The above prices shall be full compensation for furnishing hardware, cement concrete, steel, timber and lumber, structure excavation and backfill, fur-

nishing and applying paint, framing, erecting, adjusting fence, and all incidentals necessary to complete the work.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
(size) Steel Cattle Guard	Each
Cattle Guard Wings	Each

SECTION 618

GUARDRAIL

DESCRIPTION

618.01.01 General. This work shall consist of furnishing and erecting new guardrail, end anchor assemblies, guardrail expansion joints, breakaway cable terminals and additional guardrail beam elements required for constructing double beam rail, or reconstructing guardrail previously removed, in conformity with these specifications and of the types and at the points shown on the plans or ordered by the Engineer. This item shall also consist of furnishing and installing reflector plates as shown on the plans.

MATERIALS

618.02.01 General. All material shall conform to the requirements specified in the following sections:

Timber	Section 718
Timber Preservatives	Section 719
Guardrail Materials	Section 720
Galvanizing	Section 715

Guardrail posts and blocks shall be rough construction grade and shall comply with the grading requirements of subsection 718.03.02.

Cable end anchor assemblies for metal beam guard railing shall be constructed as shown on the plans and shall conform to the requirements set forth in subsection 720.-03.04.

Each post, after fabrication, shall be given a preservative treatment by pressure processes with one of the following in accordance with the provisions of Section 615, "Preservative Treatments for Timber."

The minimum retention of preservative in pounds per cubic foot of wood shall be as follows:

(a) Creosote—8 pounds.

(b) Creosote-Petroleum—8 pounds.

(c) Pentachlorophenol—8 pounds.

Guardrail quantities shown on the plans are approximate. As construction progresses the Engineer will review the need for guardrail and will, at the completion of this review, provide the Contractor with the revised amount of guardrail required. Should the Contractor elect to order guardrail materials prior to receiving this revised list from the Engineer he shall be completely responsible for furnishing the amount of guardrail and appurtenances required by said list. Should additional quantities be required to meet the requirements of the list there shall be no additional compensation allowed above the unit price bid and no compensation shall be allowed for surplus materials in excess of the requirments of the list.

618.02.02 Reflectors. Reflector plates shall be constructed and erected on guardrail in accordance with the details shown on the plans and in the Standard Specifications and shall be spaced as follows:

(a) Fifty (50) feet on tangents and curves of seven hundred (700) feet radius or greater.

(b) On curves with less than seven hundred (700) feet radius, markers shall be placed on the post nearest the spacing shown for guide posts in Table 1, as shown in the plans.

(c) At interchanges, guardrail markers with amber reflectors shall be installed at a maximum spacing of fifty (50) feet along acceleration and deceleration lanes, and in accordance with paragraph (b) on turning ramps and roadways.

Reflectors shall be white except as noted in (c) above.

CONSTRUCTION

618.03.01 General. Unless otherwise specified, guardrail shall be constructed with either treated Douglas Fir, West Coast Hemlock, or Western Larch posts, beam-type plates and fittings, as shown on the plans. Post spacing shall be as shown and guardrails shall be constructed in accordance with the design shown on the plans. The use of more than one type of guardrail on a single project will

not be approved unless so provided in the special provisions or appearing as a contract item in the proposal.

Posts shall be set plumb, except on superelevated curves where they shall be set perpendicular to the roadbed. Front faces of posts shall form a straight line, except on curves where they shall be a uniform distance from the centerline of the roadway. Post holes shall be backfilled in layers with approved material thoroughly rammed with an iron tamping tool in such manner as not to displace the bottom of posts from correct alignment.

Guardrail beam elements may be furnished in twelve and one-half (12½) foot or twenty-five (25) foot lengths at the option of the Contractor.

Cable end anchor assemblies for metal beam guard railing shall be constructed as shown on the plans and as specified herein.

Cable clips and a cable thimble shall be used to attach cable to the anchor rod.

After installation and before backfilling, the portion of the anchor rod to be buried in earth shall be coated with a minimum 20-mil thickness of coal tar enamel conforming to AWWA Standard: C203.

Metal components of the anchor assembly shall be fabricated in conformance with good shop practice and shall be hot-dip galvanized in accordance with the provisions in Section 715.

Anchor blocks shall be constructed of Class A or AA concrete conforming to the provisions in Sections 501 and 502.

Concrete shall be placed against undisturbed material of the excavated holes for anchor blocks. The top twelve (12) inches of holes shall be formed, if required by the Engineer.

Surplus excavated material remaining after the guard railing has been constructed shall be disposed of in a manner satisfactory to the Engineer.

The overall length of each anchor cable assembly shall be a minimum of ten (10) feet.

Workmanship shall be first class in all respects and framing shall be done and fittings attached in such manner

that the rail, after erection, shall be true to line and grade and shall have the proper tension in the rail plates. Care shall be taken to prevent the disturbance of posts during the erection of the rail, and, when necessary, temporary braces shall be installed to insure against post displacement.

618.03.02 Painted Guardrail. (a) Field Painted. After erection, all metal parts and fittings, free from coatings of any kind, including dirt, rust, and oil and grease, shall be given three coats of paint as specified in Section 714, "Paint." Parts shop prime coated by the manufacturer shall conform to subsection 614.03.04, "Painting Structural Steel," and Section 714, "Paint."

Posts shall not be painted.

All beams shall be cleaned prior to priming by wiping down the surface with solvents such as naptha, white (lead-free) gasoline, or detergent. Detergents may be of the type commonly used in washing machines; however, if detergent is used, it shall be thoroughly rinsed from the rail with clear water.

All loose white deposit shall be removed with a stiff brush (not steel), steel wool, or sandpaper. Care shall be exercised so as not to remove zinc coating.

Intermediate and finish coats shall be as specified in Section 614, "Painting." Surfaces to be painted shall be dry and the temperature during priming, painting, and for six (6) hours thereafter shall not be below fifty (50) degrees Fahrenheit.

After the posts are set, the exposed portions shall be wrapped or otherwise protected to the satisfaction of the Engineer so that they shall remain free from paint, road oil, and other objectionable material. After all other work is completed and prior to the semifinal inspection, the wrapping or protection shall be removed. All posts that have paint, road oil, or other objectionable materials on the exposed surface or that do not otherwise meet the required specifications shall be cleaned or removed, as the case may require, at the Contractor's expense.

All exposed surface of the metal guardrail that has become soiled or marred shall be cleaned or repainted at the expense of the Contractor as required by the Engineer.

After the rail has been painted as specified, nuts fastening rail plate to springs shall be backed off slightly so that the connection is firm but not tight and will permit the slight movement necessary to absorb expansion and contraction of the rail.

New guardrail beam elements shall be galvanized both sides, cleaned, primed and painted on the side facing traffic.

Priming.

The cleaned galvanized surface shall be given a prime coat of zinc dust-zinc oxide primer conforming to Federal Specifications No. TT–P–641–b, Type 1 (dated January, 1953).

Prime coat may be applied in the field.

Painting.

Intermediate and finish coats shall be as specified in Section 614 of the Standard Specifications.

(b) Prepainted. Guardail beam elements shall be galvanized, cleaned, primed, and prepainted on the side facing public traffic by the manufacturer prior to delivery to the jobsite as hereinafter specified:

1. Galvanizing. Guardrail beam elements shall be post-galvanized both sides in accordance with the requirements of AASHTO Designation: M180, Type 2.

2. Cleaning. All beam elements shall be alkaline cleaned, mechanically brushed, rinsed, given a zinc phosphate coating with a nominal coating weight of two hundred (200) mg. per square foot, rinsed and neutralized. Metal preparation to comply with Military Specification MIL–T–12879, Type I, Class 1.

3. Priming and Painting. Alternate 1: Prime coat shall be vinyl type, containing corrosion inhibiting pigment, applied at a nominal dry film thickness of 0.50 mil.

Finish coat shall be a high gloss white thermosetting acrylic, baked enamel, applied at 1.0 mil nominal. The white pigment used to be a nonchalking type.

Alternate 2: Prime coat shall be epoxy type, containing corrosion inhibiting pigment, applied at a nominal dry film thickness of 0.50 mil.

Finish coat shall be a high gloss white thermosetting polyester, baked enamel, applied at 1.01 mil nominal. The white pigment used to be a nonchalking type.

All exposed surface of the metal guardrail that has become soiled or marred shall be cleaned or repainted, at the expense of the Contractor, as required by the Engineer.

618.03.03 Galvanized Guardrail. The guardrail beam elements and end sections shall be galvanized. Galvanizing shall be performed after fabrication. Fabrication shall include all operations such as shearing, cutting, punching, forming, drilling, milling, and bending.

Galvanized surfaces that are abraded or damaged at any time after the application of the zinc coating shall be repaired by thoroughly wire brushing the damaged areas and removing all loose and cracked coating, after which the cleaned areas shall be painted with two coats of paint, high zinc dust content, conforming to the requirements of Federal Specification MIL–P–21035.

All exposed surface of the metal guardrail that has become soiled shall be cleaned, at the expense of the Contractor, as required by the Engineer.

618.03.04 Reconstructed Guardrail. Reconstructed guardrail shall be carefully erected using salvaged materials and shall be similar in type to the original construction. Any new materials necessary to rebuild the guardrail shall be furnished by the Contractor, shall be of the same kind as those in the original, if available, and the cost thereof shall be included in the contract price for the work. The Department reserves the right to furnish the Contractor with such materials as it deems advisable, and these materials shall be used in the reconstruction of the guardrail in lieu of salvage materials which they replaced.

Reconstructed guardrail shall be painted with one coat of paint after first touching up all spots on which the original paint has been removed or destroyed.

METHOD OF MEASUREMENT

618.04.01 Measurement. The quantity of new or reconstructed guardrail measured for payment will be the number of linear feet measured along the front face of the rail between centers of end posts or between center of end post and bridge connection as the case may be, complete and in place. In the case of new guardrail an allowance of two (2) feet at each end post shall be added to the length measured between the centers of end posts when terminal sections are specified. The length of expansion joints will be included in the measurement.

The quantity of cable end anchors constructed will be measured for payment as units.

The quantity of guardrail expansion joints constructed will be measured for payment as units.

The additional guardrail beam elements required to construct the double beam rail at locations shown on the plans shall be measured for payment by the linear foot measured along the face of the additional rail between centers of end posts.

Breakaway cable terminals will be measured for payment as units.

Where breakaway cables terminals are installed, guardrail measurements will not include the terminal ends.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

618.05.01 Payment. The accepted quantity of new and reconstructed guardrail measured as provided in subsection 618.04.01, "Measurement," will be paid for at the contract unit price bid per linear foot.

The above prices shall be full compensation for furnishing hardware, reflectors, erecting, painting, galvanizing, and all incidentals necessary to complete the work.

The accepted quantity of "Cable End Anchors" measured as provided above will be paid for at the contract unit price bid per each, which price shall be full compensation for furnishing all labor, materials, tools, equipment and

incidentals, and for doing all work involved in constructing cable and anchors, complete in place, including drilling anchor plate bolt holes in rail elements, excavating anchor block holes, backfilling and disposing of surplus material, as shown on the plans, as specified in these specifications and as directed by the Engineer.

The accepted quantity of "Guardrail Expansion Joints" measured as provided above will be paid for at the contract unit price bid per each, which price shall be full compensation for furnishing all labor, materials, tools, equipment and incidentals, and for doing all work involved in constructing the expansion joints complete in place.

The accepted quantity of "(Type) Guardrail Beam Elements" measured as provided above will be paid for at the contract unit price bid per linear foot of double beam rail, which price shall be full compensation for furnishing all labor, materials, tools, equipment and incidentals, and for doing all work involved in constructing the double beam rail complete in place.

Breakaway cable terminal will be paid for at the contract unit price bid per each, which payment shall be considered full compensation for the terminal element and diaphragms, terminal connector, cable, fittings, straps, anchor plate, bolts, nuts, washers, structure excavation, concrete, reinforcement, redwood, and for doing all the work involved to install the breakaway cable terminal complete in place in the accepted work.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Painted Guardrail	Linear Foot
Galvanized Guardrail	Linear Foot
Reconstruct Guardrail	Linear Foot
Cable End Anchors	Each
Guardrail Expansion Joints	Each
(Type) Guardrail Beam Elements	Linear Foot
Breakaway Cable Terminal	Each

SECTION 619

OBJECT MARKERS AND GUIDE POSTS

DESCRIPTION

619.01.01 General. This work shall consist of furnishing and installing object markers and guide posts of the design and at locations shown on the plans or established by the Engineer.

MATERIALS

619.02.01 General. Materials shall conform to the requirements specified in Section 721, "Object Markers and Guide Posts."

CONSTRUCTION

619.03.01 General. Target members and reflectors appropriate to the color involved shall be assembled, fastened, set, and aligned in accordance with the details and dimensions shown on the plans. All fastenings shall be tight.

Object markers shall be assembled, fastened, set, and aligned in accordance with the details and dimensions shown on the plans. Reflectors shall be installed when required as indicated. The exact locations will be determined by the Engineer.

619.03.02 Reset. Reset object markers and guide posts shall be carefully erected, using salvaged materials, and shall be similar in type to the original construction. Any new materials necessary to rebuild the markers shall be furnished by the Contractor, shall be the same kind as those in the original, if available, and the cost thereof shall be included in the contract price for the work. The Department reserves the right to furnish the Contractor with such new materials as it deems advisable, and these materials shall be used in the resetting of the markers in lieu of salvage materials which they replaced.

METHOD OF MEASUREMENT

619.04.01 Measurement. The quantity of new or reset object markers or guide posts measured for payment will be the number of markers or guide posts ordered by the Engineer and placed by the Contractor.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

619.05.01 Payment. The accepted quantity of new and reset object markers and guide posts measured as provided in subsection 619.04.01, "Measurement," will be paid for at the contract unit price bid per each, which price shall be full compensation for furnishing hardware, erecting, and incidentals necessary to complete the work.

When the Engineer orders guide posts placed for the protection of the public traffic, and such order is prior to the time the Contractor would normally install them, and some posts subsequently are damaged by public traffic, the Contractor shall replace the damaged posts with new ones and receive compensation at the contract unit bid price for both the damaged posts and the ones replaced.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Guide Posts	Each
Reset Guide Posts	Each
Object Markers, Type 1	Each
Object Markers, Type 2	Each
Object Markers, Type 3	Each
Reset Object Markers	Each

SECTION 620

RIGHT OF WAY MARKERS

DESCRIPTION

620.01.01 General. This work shall consist of furnishing and erecting timber posts for right of way markers conforming to these specifications and of the design shown on the plans or ordered by the Engineer.

MATERIALS

620.02.01 General. All materials shall conform to the requirements specified in the following sections:

Timber	Section 718
Timber Preservatives	Section 719
Paint	Section 714

The posts shall be either Douglas Fir, Western Larch, or West Coast Hemlock treated with a preservative by pressure processes conforming to the requirements of Section 615, "Preservative Treatments for Timber."

CONSTRUCTION

620.03.01 General. Right of way markers shall be constructed in accordance with the details and dimensions shown on the plans. The markers shall be set plumb and the post hole shall be backfilled in layers with approved material thoroughly rammed with an iron tamping tool.

The exact location of posts will be staked by the Engineer.

METHOD OF MEASUREMENT

620.04.01 Measurement. The quantity of right of way markers measured for payment will be the number of markers complete and in place.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

620.05.01 Payment. The accepted quantity of right of way markers measured as provided in subsection 620.-04.01, "Measurement," will be paid for at the contract unit price bid per each.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Right of Way Markers	Each

SECTION 621

MONUMENTS

DESCRIPTION

621.01.01 General. This work shall consist of furnishing and installing Portland cement concrete monuments and metal marker posts of the design and at locations shown on the plans or ordered by the Engineer.

Bronze disks furnished by the Department shall be installed in the monuments.

MATERIALS

621.02.01 General. Materials shall conform to the requirements specified in the following sections:

Portland Cement Concrete	Section 501
Fence Materials	Section 724

CONSTRUCTION

621.03.01 Installation. Monuments shall be constructed of Class A or AA Portland cement concrete, in accordance with the applicable provisions of Section 502, "Concrete Structures."

These monuments shall be set to assist in re-establishment of the centerline for future use and shall be set at the beginning and end of each project, at the beginning and end of each curve, and approximately one-half (½) mile apart on long tangents.

These monuments, located as outlined above, shall be established outside construction limits, and the exact location will be that determined by the Engineer.

A hole just large enough for the monument shall be excavated for the required depth. If solid rock is reached before the required depth is reached, the monument may be built on this instead of being built to its full depth. This hole shall be filled with the concrete. When the concrete has set sufficiently, the bronze disk or a plug shall be installed in the exact position required by the Engineer.

Metal marker posts shall be "T" rail steel drive fence posts complete with an anchor and not less than five (5) feet in length, weighing not less than one and three-tenths (1.3) pounds per foot. The posts shall be galvanized or painted with anti-corrosive paint. The posts shall be driven to the depths indicated or ordered and shall be located adjacent to the monument.

METHOD OF MEASUREMENT

621.04.01 Measurement. The quantity of reference monuments or survey monuments measured for payment will be the number of units complete and in place.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

621.05.01 Payment. The accepted quantity of monuments measured as provided in subsection 621.04.01, "Measurement," will be paid for at the contract unit price bid per each, which price shall include metal marker posts, excavation, backfill, and disposing of any surplus material.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Reference Monuments	Each
Survey Monuments	Each

SECTION 622

RAISED TRAFFIC BARS

DESCRIPTION

622.01.01 General. This work shall consist of furnishing and installing traffic separator bars, either precast or extruded in place, of the design and at locations shown on the plans or ordered by the Engineer.

MATERIALS

622.02.01 General. The traffic bars shall be constructed of material that will conform to the physical requirements listed below.

When required by the Engineer, traffic bars shall be sampled and tested and shall conform to the following requirements:

Flexure breaking load (air-cured conditions)	300 pounds min.
Compressive strength (air-cured conditions—7 days)	1,000 pounds min.
Abrasion loss (air-cured conditions)	10 percent max.
Abrasion loss (after soaking in water at room temperature for 24 hours)	10 percent max.
Absorption (24 hours in cold water)	10 percent max.

Extruded traffic bars shall be manufactured and placed by an automatic machine where Portland cement concrete is extruded under pressure through metering gates and a bar forming chamber. The aggregates shall be so graded and proportioned and thoroughly mixed in an approved mixer with such proportions of cement and water as will produce a homogeneous concrete mixture that the extruded traffic bars will conform to the test and design requirements of these specifications. In no case, however, shall the proportion of Portland cement in the mixture be less than six (6) U.S. Standard (94 lb.) bags per cubic yard of concrete. There shall be no slump. The concrete shall contain an approved air-entraining admixture within the range of four to seven (4–7) percent whenever an air-entraining admixture is required in structural concrete on the project.

CONSTRUCTION

622.03.01 Installation. The area where the bars are to be placed shall be thoroughly cleaned of all dust, dirt and debris, and loose material.

The bars shall be set firmly or extruded in place on the finished surfacing with an adhesive in accordance with the directions of the manufacturer. Each precast bar shall fit the surface with reasonably uniform bearing and all excess adhesive material shall be squeezed out from under the bar.

Extruded-in-place bars shall be carefully trimmed and finished to the required shape and dimensions and thoroughly finished to present a neat and workmanlike job.

Precast bars shall be painted with masonry paint as specified in Section 714, "Paint."

Extruded bars shall be painted within thirty (30) minutes after placing with a mixture composed of white Portland cement and water mixed to a thick-cream consistency. After the white Portland cement application has set, the bars shall receive a uniform application of white pigmented liquid curing compound.

METHOD OF MEASUREMENT

622.04.01 Measurement. The quantity of raised traffic bars measured for payment will be the number of linear feet along the axis of each bar complete and in place.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

622.05.01 Payment. The accepted quantity of raised traffic bars measured as provided in subsection 622.04.01, "Measurement," will be paid for at the contract unit price bid per linear foot.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Raised Traffic Bars	Linear Feet

SECTION 623

SIGNALS AND LIGHTING

DESCRIPTION

623.01.01 General. Electrical work shall consist of furnishing and installing, modifying or removing one or more traffic signals, flashing beacon systems, highway lighting systems, sign illumination systems, traffic count stations, electrical equipment in structures, falsework lighting, partial installations for future systems, or combinations thereof, all as shown on the plans, and as specified in these specifications and the special provisions.

The locations of signals, beacons, standards, lighting fixtures, signs, controls, services, and appurtenances shown on the plans are approximate and the exact locations will be established by the Engineer in the field.

All materials furnished and used shall conform to the provisions in Section 106, "Control of Material." The materials shall be manufactured, handled, and used in a workmanlike manner to insure completed work in accordance with the plans, specifications and special provisions.

All systems shall be complete and in satisfactory operating condition at the time of acceptance of the contract.

Where an existing system is to be modified, the existing material shall be reused in the revised system, removed, salvaged and stockpiled or abandoned as shown on the plans, as specified in the special provisions or as directed by the Engineer.

623.01.02 Regulations and Code. All electrical equipment shall conform to the standards of the National Electrical Manufacturers Association (NEMA), the Underwriters' Laboratories Inc. (UL), or the Electronic Industries Association (EIA), wherever applicable. In addition to the requirements of the plans, these specifications, and the special provisions, all materials and workmanship shall conform to the requirements of the National Electrical Code,

hereinafter referred to as the Code; Rules for Overhead Electrical Line Construction, the Public Service Commission; Standards of the American Society for Testing and Materials (ASTM); American National Standards Institute (ANSI); and any local ordinances which may apply.

Wire sizes shall be based on American Wire Gage (AWG).

623.01.03 Equipment List and Drawings. Unless otherwise permitted in writing by the Engineer, the Contractor shall, within fifteen (15) days following approval of the contract, submit to the Engineer for approval, a list of equipment and materials which he proposes to install. The list shall be complete as to name of manufacturer, size and identifying number of each item. The list shall be supplemented by such other data as may be required, including scale drawings of cabinets showing location and spacing of shelves, terminal blocks and equipment, including dimensioning. All of the above data shall be submitted in triplicate for review. Where electrical equipment is constructed as detailed on the plans, the submission of detailed drawings and diagrams will not be required.

Where a basic controller cabinet wiring diagram is provided, circuit diagrams for dectector plug connections, peripheral equipment, and external solid-state logic shall be provided.

The Contractor shall furnish five (5) sets of cabinet schematic wiring diagrams. The diagrams shall show the location of the installation and shall list all equipment installed in each cabinet. In addition, for each signal installation, the Contractor shall furnish an intersection sketch showing poles, detectors, field wire connection terminals and phasing as shown on the plans. One copy of the controller cabinet diagram and the intersection and phase diagram as reviewed by the Engineer shall be placed in a heavy duty plastic envelope with side opening, and attached to the inside of the door of each controller cabinet.

All schematic wiring diagrams of the controllers and auxiliary equipment, all cabinet diagrams, and all operation

manuals shall be submitted at the time the controllers are delivered for testing or, if ordered by the Engineer, previous to purchase. This diagram shall show in detail all circuits and parts. Such parts shown thereon shall be identified by name or number and in such manner as to be readily interpreted.

623.01.04 Warranties, Guarantees and Instruction Sheets. Manufacturers' warranties and guarantees furnished for materials used in the work and instruction sheets and parts lists supplied with materials shall be delivered to the Engineer prior to acceptance of the project.

623.01.05 Maintaining Existing and Temporary Electrical Systems. Existing electrical systems (traffic signal, ramp metering, highway and street lighting, flashing beacon and sign illumination), or approved temporary replacements thereof, shall be kept in effective operation for the benefit of the traveling public during the progress of the work, except when shutdown is permitted to allow for alterations or final removal of the systems. The traffic signal shutdowns shall be limited to periods during normal working hours, or shall be as specified in the special provisions. Lighting system shutdowns shall not interfere with the regular lighting schedule, unless otherwise premitted by the Engineer. The Contractor shall notify the Engineer prior to performing any work on existing systems.

The local traffic enforcement agency shall be notified prior to any operational shutdown of a traffic signal system.

State or local forces will continue operation and maintenance of existing electrical facilities. The State or local authorities will furnish electrical energy for operation and will repair or replace damaged facilities.

Where damage is caused by the Contractor's operations, the Contractor shall, at his expense, repair or replace damaged facilities promptly in accordance with these specifications. Should the Contractor fail to perform the required repairs or replacements, the cost of performing such repairs or replacements will be deducted from any moneys due or to become due the Contractor.

The exact location of existing conduit runs and pull boxes shall be ascertained by the Contractor before using equipment that may damage such facilities or interfere with any system.

Where roadways are to remain open to traffic and existing lighting systems are to be modified, the lighting systems 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.

Temporary electrical installations shall be kept in effective operation until the temporary installations are no longer required for the traveling public. Removal of temporary installations shall conform to the provisions in subsections 623.03.15, 623.03.16, and 623.03.17, "Salvaging and Reinstalling or Stockpiling Electrical Equipment."

These provisions will not relieve the Contractor in any manner of his responsibilities as provided in subsection 107.11, "Responsibility for Damage," and subsection 107.16, "Contractor's Responsibility for the Work and Materials."

A temporary overhead cable system may be used for the existing signal system circuitry in lieu of maintaining the underground installations during construction.

Where an existing system is being modified, work not shown on the plans or specified in the special provisions and which is considered by the Engineer as necessary to keep all or any part of the existing system in effective operation shall be considered as included in the prices paid for the systems, or units, therefore no additional compensation will be allowed.

623.01.06 Scheduling of Work. Work shall be so scheduled that each traffic signal, highway lighting and sign illumination system shall be completed and ready for operation prior to opening the corresponding section of the roadway to traffic.

Traffic signals shall not be placed in operation for use by public traffic without the energizing of street lighting at the intersection to be controlled if street lighting exists or is being installed in conjunction with the traffic signals.

Traffic signals shall not be placed in operation until the roadways to be controlled are open to public traffic, unless otherwise directed by the Engineer.

Highway lighting and traffic signals shall not be placed in operation, including flashing operation, prior to commencement of the functional test period specified in subsection 623.02.14, "Field Tests," unless ordered otherwise by the Engineer.

Conductors shall not be pulled into conduit until pull boxes are set to grade, crushed rock sumps installed, mortar placed around conduit, concrete bottom of pull boxes placed, and metallic conduit bonded.

In vehicular undercrossings, soffit 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.

If the Engineer orders soffit lights or lighting for pedestrian structures placed in operation before permanent power service is available, the cost of installing and removing temporary power service will be paid for as extra work as provided in subsection 104.03, "Extra Work."

623.01.07 Safety Precautions. Before starting work on existing series street lighting circuits, the Contractor shall obtain daily a safety circuit clearance from the serving utility. By-pass switch plugs shall be pulled and "Men at Work" signs posted at switch boxes before any work is done.

623.01.08 Definitions. The following definitions pertain only to Section 623, "Signals and Lighting:"

Actuation. The operation of any type of detector.

Clearance Interval. The length of time of display of the signal indication following the right of way interval.

Controller. The complete electrical mechanism for controlling the operation of a traffic signal. A controller consists of a controller unit, and all auxiliary equipment housed in a weatherproof cabinet.

Controller Unit. The basic timing unit of a traffic signal controller with its manually variable sequence and timing controls.

Detector for Traffic Actuation. A device by which vehicles or pedestrians are enabled to register their presence with a traffic actuated signal controller.

Magnetic Vehicle Detectors. A detector installed in or near the roadway, capable of being actuated by the induced voltage caused by the passage of a vehicle through the earth's magnetic field.

Magnetometer Vehicle Detector. A detector installed in or near the roadway, capable of being actuated by the magnetic disturbance caused by the passage or presence of a vehicle.

Inductive Loop Detector. A detector installed in the roadway capable of being actuated by the change of inductance caused by a vehicle passing over or standing over the loop.

Pedestrian Detector. A detector, usually of the push button type, installed near the roadway and capable of being operated by hand.

Pressure-Sensitive Vehicle Detector. A detector installed in the roadway capable of being actuated by the pressure of a vehicle passing over its surface.

Electrolier. The complete assembly of pole, mast arm, luminaire, ballast, and lamp.

Extendable Portion. That part of the green interval following the initial portion.

Extension Limit. The maximum time for which actuations on any traffic phase may retain the right of way after actuation on another traffic phase, after the initial portion has been timed out.

Flashing Feature. A device which, when operated, discontinues normal signal operation and causes the flashing of any pre-determined combination of signal lights.

Initial Portion. The first part of the green interval which is timed-out or separately controlled by a traffic-actuated controller before the extendable portion of the interval takes effect.

Interval. Any one of the several divisions of the time cycle during which signal indications do not change.

Interval Sequence. The order of appearance of signal indications during successive intervals of a time cycle.

Luminaire. The assembly which houses the light source and controls the light emitted from the light source. Luminaires consist of hood (including socket), reflector, and glass globe or refractor.

Lighting Standard. The pole and mast arm which support the luminaire.

Major Street. The roadway approach or approaches at an intersection normally carrying the major volume of vehicular traffic.

Manual Operation. The operation of a signal controller by means of a hand-operated switch.

Minimum Period. In semi-traffic-actuated controllers, the shortest time for which the right of way shall be given to the approaches not having detectors.

Minor Street. The roadway approach or approaches at an intersection normally carrying the minor volume of vehicular traffic.

Non-Parent Phase. A controller phase which is not modified by an auxiliary control unit.

Parent Phase. A controller phase which is modified by an auxiliary control unit.

Passage Period. The time allowed for a vehicle to travel at a selected speed from the detector to the nearest point of conflicting traffic.

Pre-timed Controller Unit. An automatic control device for supervising the operation of traffic control signals in accordance with a pre-timed cycle and divisions thereof.

Recall Switch. A manual switch in a traffic-actuated controller which will cause the automatic return of the right of way to a street regardless of the absence of actuation on that street.

Right of Way. The privilege of the immediate use of the highway.

Signal Face. That part of a signal head provided for controlling traffic in a single direction and consisting of

one or more lenses. Turning indications may be included in a signal face.

Signal Head. An assembly containing one or more signal faces.

Signal Indication. The illumination of a traffic signal lens or equivalent device, or of a combination of several lenses or equivalent devices at the same time.

Time Cycle. The number of seconds required for one complete revolution of the timing dial or complete sequence of signal indications.

Traffic-Actuated Controller Unit. An electronic or electromechanical control device for supervising the operation of traffic control signals in accordance with the varying demands of traffic as registered with the controller by detectors.

Traffic Phase (Traffic Movement). A part of the cycle allocated to any traffic movement receiving the right of way or to any combination of traffic movements receiving the right of way simultaneously during one or more intervals.

Unit Extension. The minimum time, during the extendable portion, for which the right of way must remain on any traffic phase following an actuation on that phase, but subject to the extension limit.

Vehicle. Any motor vehicle normally licensed for highway use by the State of Nevada.

MATERIALS AND INSTALLATION

623.02.01 General. Where existing systems are to be modified, the existing materials shall be incorporated in the revised system, salvaged, or abandoned as specified.

623.02.02A Foundations. Foundations for posts, standards, pedestals and controller bases shall be Class A or Class AA Portland cement concrete. Portland cement concrete shall conform to the provisions in Section 501, "Portland Cement Concrete."

Concrete foundations shall rest on firm ground.

Foundations shall be placed "in the solid" and monolithic where practicable. For posts, standards, and pedestals not on structures, the top two (2) inches of the concrete foundation shall be placed after the post, standard, or pedestal is in proper position. The exposed portions of the foundation shall be formed to present a neat appearance.

After each post, standard, or pedestal on structures is in proper position, grout shall be placed under the base plate. The exposed portions shall be formed to present a neat appearance. Grout shall consist of one (1) part by volume of Portland cement and three (3) parts of clean sand, shall contain only sufficient moisture to permit packing, and shall be cured by keeping it damp for three (3) days.

Forms shall be true to line and grade. Tops of foundations for posts and standards, except special foundations, shall be finished to curb or sidewalk grade or as directed by the Engineer. Forms shall be rigid and securely braced in place. Conduit ends and anchor bolts shall be placed in proper position and to proper height, and shall be held in place by means of a template until the concrete sets.

Anchor bolts, anchor bars, or studs and nuts, shall conform to the specifications of ASTM Designation: A307 and shall be provided with two (2) nuts and two (2) washers each. Anchor bolts, nuts, and washers shall be galvanized in accordance with the requirements of ASTM Designation: A153.

Plumbing of standards shall be accomplished by adjusting nuts before grouting or before the foundation is finished to final grade. Shims, or other similar devices for plumbing or raking of posts, standards, or pedestals, will not be permitted.

Both forms and ground which will be in contact with the concrete shall be thoroughly moistened before placing concrete. Forms shall not be removed until the concrete has thoroughly set.

Ordinary surface finish, as specified in subsection 502.-03.18, "Ordinary Surface Finish," shall be applied to exposed surfaces of concrete.

Where obstructions prevent the construction of a planned foundation, the Contractor shall construct an effective foundation satisfactory to the Engineer.

The foundations shown on the plans shall be extended if conditions require additional depth, and such additional work, if ordered by the Engineer, will be paid for as extra work as provided in subsection 104.03, "Extra Work."

Unless otherwise shown on the plans, all standards to be relocated shall be provided with new foundations and anchor bolts of the proper type and size.

Posts, poles, standards, and pedestals, except concrete pedestals cast in place, shall not be erected until the foundation has set at least seventy-two (72) hours, and shall be plumbed or raked, as directed by the Engineer.

In unpaved areas, a raised pad of Portland cement concrete of the size shown on the plans shall be placed in front of each controller cabinet.

When a foundation is to be abandoned in place, the top of foundation, anchor bolts, and conduits shall be removed to a depth of five-tenths (0.5) foot below surface of sidewalk or unimproved ground. The resulting hole shall be backfilled with material equivalent to the surrounding material.

623.02.02B Excavating and Backfilling. The excavations required for the installation of conduit, foundations, and other appurtenances shall be performed in such a manner as to avoid any unnecessary damage to street, sidewalks, landscaping, and other improvements. The trenches shall not be excavated wider than necessary for the proper installation of the electrical appurtenances and foundations. Excavation shall not be performed until immediately before installation of conduit and other appurtenances. The material from the excavation shall be placed in a position that will not cause damage or obstruction to vehicular and pedestrian traffic nor interfere with surface drainage.

Unless otherwise permitted in writing by the Engineer, all surplus excavated material shall be removed and disposed of within forty-eight (48) hours outside the highway

right of way in accordance with the provisions in subsection 107.14, "Disposal of Material Outside the Highway Right of Way."

The excavations shall be backfilled in conformance with the provisions in Section 207, "Backfill."

Excavations after backfilling shall be kept well filled and maintained in a smooth and well-drained condition until permanent repairs are made.

All excavations shall be filled, and sidewalks, pavement, and landscaping restored at each intersection prior to excavating at any other intersection, unless otherwise permitted by the Engineer.

Excavations in the street or highway shall be performed in such a manner that not more than one traffic lane is restricted in either direction at any time.

623.02.03 Removing and Replacing Improvements. Improvements such as sidewalks, curbs, gutters, Portland cement concrete and asphalt concrete pavement, base material, lawns, and plants, and any other improvements removed, broken, or damaged by the Contractor's operations, shall be replaced or reconstructed with the same kind of material as found on the work or with materials of equal quality. The new work shall be left in a serviceable condition satisfactory to the Engineer.

Whenever a part of a square or slab of existing concrete sidewalk or driveway is broken or damaged, the entire square or slab shall be removed and the concrete reconstructed as above specified.

The outline of all areas to be removed in Portland cement concrete sidewalks and driveways and in pavements shall be cut to a minimum depth of one and one-half (1½) inches with an abrasive type saw prior to removing the sidewalk, driveways, and pavement material. The cut for the remainder of the required depth may be made by a method satisfactory to the Engineer. Cuts shall be neat and true with no shatter outside the removal area.

623.02.04 Standards, Steel Pedestals, and Posts. Standards for traffic signals and highway lighting, and

steel pedestals for cabinets and other similar equipment shall be located as shown on the plans. Workmanship and finish shall be equal to the best general practice of metal fabrication shops. All welding shall conform to AWS D2.0, "Specifications for Welded Highway and Railway Bridges," and to the requirements in this section.

Type 1 standards shall be used for post-top mounting of traffic signals with or without bracket mounted signals as shown on the plans.

Type 2, Type 5, Type 10, Type 18, Type 23, Type 40, and Type 43 standards shall be used for mast arm mounting of traffic signals without luminaires and with or without bracket mounted traffic signals.

Type 3, Type 6, Type 16, Type 19, Type 20, Type 24, Type 26, Type 36, Type 42, Type 44, Type 45, and Type 46 standards shall be used for mast arm mounting of both luminaires and traffic signals and with or without bracket mounted traffic signals.

Type 4, Type 7, Type 14, and Type 15 standards shall be used for mast arm mounting of luminaires with or without bracket mounted traffic signals.

Type 1 standards and steel pedestals for controller cabinets shall be constructed of No. 11 or heavier U.S. standard gage steel or four (4) inch standard pipe or conduit, with the top designed for post-top slip-fitter.

Standard pipe shall conform to the specifications of ASTM Designations: A53 or A120.

All ferrous metal parts of standards, fifteen (15) feet and longer, shall conform to the details shown on the plans and the following requirements:

Standards shall be fabricated from (a) sheet steel conforming to the specifications of ASTM Designation: A611, Grade C, ASTM Designation: A570, Grade C, or from (b) sheet steel of weldable grade. If alternative (b) is used, the steel, after fabrication, shall have a minimum yield of forty thousand (40,000) pounds per square inch.

Standards with one mast shall be fabricated of not less than No. 10 U.S. standard gage steel, except that when material conforming to alternative (b) above is used, the

gage shall not be less than No. 11 U.S. standard gage steel.

Standards may be fabricated of full length sheets or shorter sections. Each section shall be fabricated from not more than two pieces of sheet steel. Where two pieces are used, the longitudinal welded seams shall be directly opposite one another. When the sections are butt-welded together, the welded seams on adjacent sections shall be placed to form continuous straight seams from base to top of standard.

Standards shall be straight, with a permissive variation not to exceed one (1) inch measured at the midpoint of a twenty-eight and five-tenths (28.5), thirty (30), or thirty-five (35) foot standard and not to exceed three-fourths (¾) inch measured at the midpoint of an eighteen (18), twenty (20), or twenty-five (25) foot standard.

Mast arms for Types 2, 3, and 4 standards shall be fabricated from standard pipe, reamed, free from burrs and without intermediate splices or couplings, curved to the dimensions shown on the plans and shall be provided with raintight connections to shafts. Standard pipe shall conform to the specifications of ASTM Designations: A53 or A120.

Mast arms for all standards, other than Types 2, 3, and 4 standards, shall be fabricated from material as specified for standards and shall conform to the dimensions shown on the plans.

Tie rods for mast arms for Types 2, 3, and 4 standards shall be manufactured of structural steel and pipe as shown on the plans. Structural steel shall conform to the specifications of ASTM Designation: A36. Tie rods shall be provided with two (2) nuts and two (2) lock washers at each end. Tie rods shall be installed with no kinks or bends.

The butt-welded transverse joints shall be strengthened by inserting a metal sleeve at each joint. The sleeve shall be No. 10 U.S. standard gage steel and made from steel having the same chemical composition as the steel in the standard. The metal sleeve shall have a minimum length

of one (1) inch. The sleeve shall be centered at the joint and have the same taper as the standard with the outside of the sleeve in full contact with the inside of the standard throughout the sleeve length and circumference.

All welds shall be continuous.

The weld metal at the transverse joint shall extend to the sleeve, making the sleeve an integral part of the joint.

All longitudinal welds shall be performed by the submerged arc process.

All exposed welds, except fillet welds, shall be ground flush with the base metal.

All exposed edges of the plates which make up the base assembly shall be finished smooth and all exposed corners of such plates shall be neatly rounded to one-eighth (⅛) inch radius, unless otherwise shown on the plans. Shafts shall be provided with slip-fitter shaft caps.

Handholes in the base of standards shall conform to the details shown on the plans.

Push button posts and guard posts shall be pipe conforming to the specifications of ASTM Designations: A53 or A120.

Holes left in the shafts of existing standards, due to removal of equipment or mast arms, shall be repaired by welding in a suitable disk, grinding smooth and painting as provided for repairing damaged galvanized surfaces in Section 715, "Galvanizing."

When directed by the Engineer, existing standards to be relocated or reused in place shall be repaired prior to repainting or regalvanizing. Large dents shall be removed, shafts shall be straightened, and portions which are in poor condition due to corrosion or damage shall be replaced. Extent of repairs or replacements will be determined by the Engineer and said repairs or replacements ordered by the Engineer will be paid for as extra work as provided in subsection 104.03, "Extra Work."

Anchor bolts and nuts required for relocating existing standards shall be furnished by the Contractor.

New standards, posts, and other ferrous materials shall be galvanized as provided in subsection 623.02.15, "Galvanizing."

623.02.05 Conduit. All conductors shall be run in conduit, except for overhead and temporary installations and where conductors are run inside poles.

Conduit shall be of the sizes shown on the plans, as specified in this subsection or in the special provisions. In addition, the Contractor may, at his option and expense, use conduit of a larger size than that shown or specified provided the larger size is used for the entire length of the run from outlet to outlet. Reducing couplings will not be permitted.

(a) Material. Conduit and fittings shall be the rigid metal type manufactured of mild steel conforming to UL Publication UL 6 for Rigid Metallic Conduit, or at the option of the Contractor, conduit to be installed underground may be rigid nonmetallic type conforming to the requirements of the UL Standard for Rigid Nonmetallic Conduit (Publication UL 651).

A Certificate of Compliance conforming to the provisions in subsection 106.05, "Certificates of Compliance," shall be submitted by the manufacturer with all rigid metallic conduit and all rigid nonmetallic conduit.

(b) Use. Conduit to be installed on the surface of poles or structures or other proposed locations shall be the rigid metal type and shall be unpainted, except that exposed conduit installed on a painted structure shall be painted the same color as the structure.

Where nonmetallic conduit is to be installed, the conduit run between the pole base and the nearest pull box and the conduit in structures may be of the nonmetallic type.

Where existing rigid metal conduit systems are to be modified or extended rigid metal conduit only shall be installed.

Where a pull box is installed adjacent to the base of an electrolier, conduit installed from the pull box to the standard shall not be less than one and one-half (1½) inches in diameter.

Where pull boxes are installed adjacent to the base of a signal standard or controller pedestal, conduit installed between pull boxes and the standard or pedestal shall not

be less than two (2) inches in diameter, unless otherwise shown on the plans.

Conduit for detector runs shall be not less than one (1) inch in diameter. All conduit not otherwise specified shall be one and one-half (1½) inches in diameter.

Conduit running from a pull box to soffit, wall or other lights or fixtures below the grade of the pull box shall be installed in the end of the pull box with the centerline of the conduit terminus a minimum of five (5) inches above the bottom of the pull box.

(c) Installation. Conduit shall be installed in conformance with the codes and regulations listed in subsection 623.01.02, "Regulations and Code."

Conduit runs shown on the plans may be changed to avoid underground obstructions with written approval by the Engineer.

The ends of all conduits, whether shop or field cut, shall be reamed to remove burrs and rough edges. Cuts shall be made square and true so that the ends will butt or come together for the full circumference thereof. Slip joints or running threads will not be permitted for coupling conduit. When a standard coupling cannot be used for coupling metal type conduit, an approved threaded union coupling shall be used. The threads on all ferrous metal conduit shall be painted with rust preventive paint before couplings are made up. All couplings for metal type conduit shall be tightened until the ends of the conduits are brought together, providing a good electrical connection throughout the entire length of the conduit run. Where the coating on metal conduit has been damaged in handling or installing, such damaged places shall be painted with rust preventive paint. Nonmetallic type conduit shall be cut with a hacksaw or other approved tool. Nonmetallic type conduit connections shall be of the solvent weld type. Exposed ungalvanized threads on metal conduit resulting from field cuts shall be painted with rust preventive paint.

All metal type conduit ends shall be threaded and shall be capped with standard pipe caps until wiring is started.

When caps are removed, the threaded ends shall be provided with conduit bushings. Nonmetallic type conduit ends shall be capped until wiring is started.

Nonmetallic conduit fittings for connecting nonmetallic conduit to rigid metal conduit shall be threaded on the metal conduit side.

Conduit bends, except factory bends, shall have a radius of not less than six (6) times the inside diameter of the conduit. Where factory bends are not used, conduit shall be bent, without crimping or flattening, using the longest radius practicable.

A No. 12 AWG TW insulated copper pull wire shall be installed in all conduits which are to receive future conductors. At least two (2) feet of pull wire shall be doubled back into the conduit at each termination.

Existing underground conduit to be incorporated into a new system shall be cleaned with a mandrel or cylindrical wire brush and blown out with compressed air.

Conduit shall be laid to a depth of not less than eighteen (18) inches below the curb grade in sidewalk areas and curbed paved median areas, twenty-four (24) inches below highway pavement grade in road areas and finished grade in all other areas, except that conduit may be laid on top of the existing pavement within new curbed medians being constructed on top of said pavement.

Conduit runs parallel to curbs shall be placed adjacent to back of curb, except where in conflict with existing facilities.

Conduit stubs from electrolier bases shall extend at least six (6) inches from face of foundation and at least eighteen (18) inches below top of foundation.

Rigid metal conduit shall be placed under existing pavement by approved jacking or drilling methods. Pavement shall not be disturbed without permission from the Engineer. In the event obstructions are encountered, upon approval of the Engineer, small test holes may be cut in the pavement to locate obstructions. Jacking or drilling pits shall be kept two (2) feet clear of the edge of any

type of pavement wherever possible. Excessive use of water, such that pavement might be undermined, or subgrade softened, will not be permitted.

Rigid nonmetallic type conduit shall not be used for drilling or jacking. Installation of rigid nonmetallic type conduit under existing pavement will be permitted if a hole larger than the conduit is pre-drilled and the conduit installed by hand. Bottom of trenches for rigid nonmetallic conduit shall be relatively free of sharp irregularities which would cause pinching and excessive bending of the conduit. The trench shall be excavated to four (4) inches below the invert grade of the conduit and backfilled with a granular material with one hundred (100) percent passing the three-eighths (⅜) inch size sieve except where backfilled with concrete. A cradle shall be shaped in the granular material cushion to support the conduit. The first six (6) inches of backfill over the top of the conduit shall be of this granular material.

Conduit to be placed beneath railroad tracks shall comply with the following:

The conduit shall be rigid metal type, one and one-half (1½) inch minimum size and shall be placed to a minimum depth of three (3) feet below bottom of tie. The near side of each conduit jacking pit shall be constructed not less than twelve (12) feet from the centerline of track. When the jacking pit is to be left overnight it shall be covered with substantial planking.

Conduit terminating in standards or pedestals shall extend not more than two (2) inches vertically above the foundation and shall be sloped towards the handhole opening. Conduit entering through the side of nonmetallic pull boxes shall terminate not more than two (2) inches inside the box wall and not less than two (2) inches above the bottom, and shall be sloped toward top of box to facilitate pulling of conductors. Conduit entering through the bottom of a pull box shall terminate one (1) to two (2) inches above the bottom and shall be located near the end walls to leave the major portion of the box clear. At all outlets, conduits shall enter from the direction of the run.

Conduit for future use in structures shall be threaded and capped. Conduit leading to soffit, wall or other lights or fixtures below the grade of the pull box shall be sealed by means of a sealing fitting and sealing compound, except that sealing fitting and sealing compound will not be required where conduit terminates in a structure pull box.

Conduits in bridge superstructures shall be supported as shown on the plans, in conformance with the following:

Steel hangers, steel brackets, and other fittings shall conform to the provisions in Section 712, "Miscellaneous Metal."

Cast-in-place metal inserts for hangers or brackets shall be capable of developing twenty thousand (20,000) pounds per square inch in tension on the net section of the bolt or threaded rod.

Openings for conduits through bridge superstructure concrete shall be formed or may consist of pipe sleeves.

Where conduits pass through the abutment concrete, the conduits shall be wrapped with two (2) layers of ten (10) pound asphalt-felt building paper, securely taped or wired in place.

The space around conduits through bridge abutment walls shall be filled with Portland cement mortar conforming to the provisions in subsection 706.03.04, "Mortar," except that the proportion of cement to sand shall be one (1) to three (3).

When the bridge superstructure is to be prestressed the space around conduits through abutments shall not be filled until the prestressing has been completed.

Conduit run on the surface of structures shall be secured with galvanized malleable iron clamps spaced not more than five (5) feet apart.

Attention is directed to "Bonding and Grounding" in subsection 623.02.10. Where pull boxes are placed in conduit runs, the conduit shall be fitted with threaded bushings and bonded.

The location of ends of all conduits in structures, or terminating at curbs, shall be marked by a "Y" at least three (3) inches high cut into the face of curb, gutter, or wall, directly above the conduit and above grade line.

623.02.06 Pull Boxes. Pull boxes shall be installed at the locations shown on the plans.

(a) Materials. Pull boxes, covers and extensions for installation in the ground or in sidewalk areas shall be of the sizes and details shown on the plans and shall be precast reinforced concrete, except that alternative materials and designs may be used if units of equal strength, without excessive deflection, will be provided. Material shall be self-extinguishing when tested in accordance with ASTM Designation: D635, and shall show no appreciable change in physical properties with exposure to the weather. Where a ballast or transformer is to be placed in a nonmetallic pull box, the box shall be provided with recesses for a hanger as shown on the plans.

Pull boxes and covers for installation in structures shall be of the sizes and details shown on the plans. In lieu of the structure pull box shown on the plans, the Contractor may use a telescoping steel pull box, with interior dimensions, conduit entrances, and cast iron cover conforming to the details shown on the plans. Design of the steel pull box shall be submitted to the Engineer for review prior to fabrication.

Covers shall be secured with three-eighths (⅜) inch bolts, capscrews, or studs, and nuts which shall be of brass, stainless steel or other noncorroding material.

Stainless steel hold-down bolts, capscrews or studs, and nuts and washers shall have a chromium content of not less than eighteen (18) percent and a nickel content of not less than eight (8) percent. Nuts shall be recessed below surface of cover.

All ferrous metal parts shall be galvanized in accordance with the provisions in subsection 623.02.15, "Galvanizing."

(b) Cover Marking. Covers for pull boxes shall be marked as follows:

1. "Traffic Signal." Where pull box contains traffic signal conductors with or without street lighting conductors.

2. "Street Lighting." Where pull box contains street lighting conductors only. "High Voltage" shall be

inscribed below where street lighting voltage is above six hundred (600) volts.

3. "Communication." For pull boxes where communication conduit enters the pull box.

4. "Sprinkler Control." For pull boxes where sprinkler control conduit enters the pull box.

5. "Count Station." For pull boxes where traffic count station conduit enters the pull box.

6. "Ramp Meter." For pull boxes where ramp metering conduit enters the pull box.

Marking shall be clearly defined and uniform in depth and may be placed parallel to either the long or short sides of the cover.

Marking letters shall be between one (1) and three (3) inches high.

Marking shall be applied to each steel or cast iron cover prior to galvanizing by one of the following methods:

a. Cast iron strips, at least one-fourth (¼) inch thick, with the letters raised a minimum of one-sixteenth ($\frac{1}{16}$) inch. Strips shall be fastened to covers with one-fourth (¼) inch flathead stainless steel machine bolts and nuts. Bolts shall be peened after tightening.

b. Sheet steel strips, at least 22-gage with the letters raised a minimum of one-sixteenth ($\frac{1}{16}$) inch above the surrounding surface of the strips. Strips shall be fastened to covers by spot welding, tack welding or brazing, or with one-fourth (¼) inch roundhead stainless steel machine bolts and nuts. Bolts shall be peened after tightening.

c. Bead welding the letters on the covers. The letters shall be raised at least three thirty-seconds ($\frac{3}{32}$) inch.

(c) Installation and Use. Pull boxes shall be installed at the locations shown on the plans or, in long runs, they shall be spaced at not over two hundred (200) foot intervals. The Contractor may, at his expense, install additional pull boxes to facilitate his work.

The tops of pull boxes installed in the ground or in sidewalk areas shall be flush with the surrounding grade or top of adjacent curb. Where practical, pull boxes shown in the vicinity of curbs shall be placed adjacent to the back of curb, and pull boxes adjacent to standards shall

be placed along the side of foundations as shown on the plans.

The bottoms of pull boxes installed in the ground or in sidewalk areas shall be bedded in crushed rock as shown on the plans and shall be grouted prior to the installation of conductors. A layer of roofing paper shall be placed between the grout and the crushed rock sump. A one (1) inch drain hole shall be provided in the center of the pull box through the grout and the roofing paper.

623.02.07 Expansion Fittings. Expansion fittings, as detailed on the plan, shall be installed where the conduit crosses an expansion joint in the structure. Each expansion fitting shall be provided with a copper bonding jumper having the ampacity required by the code.

Expansion-deflection fittings shall consist of a molded neoprene sleeve with a bonding jumper passing through a separate waterproof compartment and two (2) silicone bronze couplings. Fittings shall permit a minimum of three-fourths (¾) inch expansion and contraction and a three-fourths (¾) inch deflection without deformation.

623.02.08 Conductors. Conductors shall consist of solid or stranded copper of the gage shown on the plans unless specified otherwise.

Copper wire shall conform to the specifications of ASTM Designations: B3 and B8.

(a) Traffic Signal and Multiple Lighting Conductors. Conductors for traffic signal, flashing beacon and multiple lighting installations shall be rated for six hundred (600) volt operation. The insulation shall be TW Grade polyvinyl chloride compound conforming to the specifications of ASTM Designation: D2219 for conductors No. 14 AWG and larger and TF Grade for conductors No. 16 AWG. Insulation thickness shall be four sixty-fourths ($\frac{4}{64}$) inch minimum for No. 14 to No. 10 AWG, inclusive, and five sixty-fourths ($\frac{5}{64}$) inch minimum for No. 8 AWG, or larger.

All conductors used in controller cabinet wiring shall be No. 22 AWG, or larger. Conductors smaller than No.

14 AWG shall conform to Military Specification: MIL–W–16878D, Type B, Vinyl-Nylon Jacket, six hundred (600) volt, one hundred fifteen (115) degrees Centigrade. Conductors No. 14 AWG and larger shall be as specified above.

All conductors in controller cabinets subject to flexing during opening and closing of the cabinet door or on removal of equipment from the cabinet shall be stranded. Conductors No. 14 AWG through No. 10 AWG, inclusive, shall be 19-strand and conductors No. 16 AWG shall be 26-strand.

Conductors in traffic actuated controller cabinets between service terminals and the "AC+" terminals on external light relays (including connections to the police panel switches), the signal light neutral and all conductors in the highway lighting circuit within the controller cabinet shall be No. 10 AWG, or larger. All other conductors in the signal light circuits shall be No. 14 AWG.

Conductors in pre-timed controller cabinets between the service terminals and "AC+" common bus to signal light circuits (including switches, radio interference suppressor, flasher relays and harness conductors to the controller) shall have an ampacity of twenty (20) amperes at one hundred sixty (160) degrees Fahrenheit.

Conductors for wiring flush wall luminaires shall be Type SA stranded copper, insulated with silicone rubber and asbestos braid for use at temperatures up to one hundred twenty-five (125) degrees Centigrade.

Overhead lighting conductors shall be No. 8 AWG, or larger, medium hard drawn copper with weatherproof covering.

(b) Series Circuit Lighting Conductors. Conductors for series circuit highway lighting shall be No. 8 AWG, solid or stranded copper, shall be rated for 5,000-volt operation and shall be insulated with ten sixty-fourths ($^{10}/_{64}$) inch minimum thickness polyvinyl chloride compound conforming to the specifications of ASTM Designation: D2219, or polyethylene conforming to the specifications of ASTM Designation: D1351.

A Certificate of Compliance conforming to the provisions in subsection 106.05, "Certificates of Compliance," shall be submitted by the manufacturer with all five thousand (5,000) volt, series, lighting conductors.

(c) Conductor Identification. All single conductors and cables shall have clear, distinctive and permanent markings on the outer surface throughout the entire length showing the manufacturer's name or trademark, insulation type-letter designation, conductor size, voltage rating and the number of conductors if a cable.

Conductor insulation shall be of a solid color or of basic colors with a permanent colored stripe as detailed in the table following this subsection 623.02.08, unless otherwise specified. Identification stripes shall be continuous over the entire length of the conductor.

623.02.09 Wiring. Wiring shall be done in conformance with the regulations and code listed in subsection 623.01.02, "Regulations and Code," and the following additional requirements:

(a) Circuitry. Sufficient signal light conductors shall be provided to perform the functional operation of the signal system and, in addition thereto, three (3) spare conductors of a size equal to the largest signal light conductor in the run, except neutral, shall be provided throughout the signal light system, unless shown otherwise on the plans.

All signal light conductors, except branch neutrals, shall be run continuously without splices from a terminal block located in a cabinet, compartment, or signal head, to a similarly located terminal block. Signal light conductors shall not run to a terminal block on a standard unless they are to be connected to a signal head that is mounted thereon.

Connection to each terminal of a pedestrian push button shall be by a single conductor.

The neutral for pedestrian push button circuits shall be separate from the signal light circuit neutral.

Where ballasts or transformers are used, series lighting conductors shall be run from ballast to ballast, transformer to transformer, and from ballast or transformer to service.

CONDUCTOR TABLE

Circuit	Signal Phase or Function	Identification: Insulation Colors — Base	Identification: Insulation Colors — Stripe (Note 1)	Identification — Band Symbols (Note 6)	Size (AWG)
Vehicle Signals	A	Red, Yellow, Green	Black	Band only special (A_1) and overlap ($A_1 + C_1$) phases. Simple phases such as A, B, C, or D do not require banding	14
	B	Red, Yellow, Green	White		14
	C	Red, Yellow, Green	None		14
	D	Red, Yellow, Green	Orange		14
Pedestrian Signals	Aw	Red, Green	Black	Aw (Note 2)	14
	Bw	Red, Green	White	Bw (Note 2)	14
	Cw	Red, Green	None	Cw (Note 2)	14
	Dw	Red, Green	Orange	Dw (Note 2)	14
Pedestrian Push Buttons	Aw	Blue	Black	P–A (Note 2)	14 or larger
	Bw	Blue	White	P–B (Note 2)	
	Cw	Blue	None	P–C (Note 2)	
	Dw	Blue	Orange	P–D (Note 2)	
Detectors (Note 10)	A	Blue	Black	D-(Location No.)-A (Note 2)	12
	B	Blue	White	D-(Location No.)-B	12
	C	Blue	None	D-(Location No.)-C	12
	D	Blue	Orange	D-(Location No.)-D	12
Traffic Signal Controller	Ungrounded between Service Switch and Controller	Black	None	CON	10 or larger
Series Lighting (Note 9)	Loop or Service	Black	None	No band required	8
Lighting	Pull box to Luminaire	Black	None	No band required	14
Multiple Highway Lighting (Note 9)	Ungrounded—Line 1	Black	None	ML 1	10 or larger
	Ungrounded—Line 2	Red	None	ML 2	

Conductor Table—*Continued*

Circuit	Signal Phase or Function	Identification: Insulation Colors: Base	Identification: Insulation Colors: Stripe (Note 1)	Identification: Band Symbols (Note 6)	Size (AWG)
Lighting Control	Ungrounded to P.E.C. unit	Black	None	C–1	14
	Switching leg from P.E.C. unit or SM transformer	Red	None	C–2	14
Multiple Service	Ungrounded—Line 1 (Signals)	Black	None	No band required except per Note 5	8 or larger
	Ungrounded—Line 2 (Lighting)	Red	None		
Sign Lighting (Note 8)	Ungrounded between transformer or Service Switch and Ballasts	Black	None	SL	12 or larger
Flashing Beacons (Note 7)	Ungrounded between flasher and beacons	Red or Yellow	None	F-Location No. See Note 3	14 or larger
Neutral and Common (Note 4)	Detectors and Pedestrian Push Buttons	White	Black	No band required	12 or 14
	Signals and Multiple Lighting	White	None	No band required	10 or larger
	Flashing Beacons and Sign Lighting	White	None	No band required	12
	Lighting Control	White	None	C–3	14
	Multiple Service	White	None	No band required	8 or larger
	Common	White	None	I	14
	Flash	Orange	None	I–F	14
Interconnect	Dial 2	Orange	None	I–D2	14
	Dial 3	Orange	None	I–D3	14
	Offset	Orange	None	I–O	14
Railroad Preemption		Black	None	R	14
Spares		Black	None	No band required	14

NOTES

1. On overlaps, insulation is striped for first phase in designation, for example, a phase ($A_1 + C_1$) conductor is striped as for phase A.
2. Stamp for overlap and special phases as required.
3. Flashing beacons having separate service do not require banding.
4. A single No. 12 common shall be used for pressure sensitive detectors and pedestrian push buttons. A single No. 14 AWG common shall be used when only pedestrian push buttons are connected.
5. "S" if circuit is switched on line side of service equipment by utility.
6. Band conductors in each pull box and near ends of termination points. On signal light circuits, a single band shall be placed around 2 or 3 ungrounded conductors comprising a phase.
7. Ungrounded conductors between service switch and flasher mechanism shall be black and stamped as indicated in this column.
8. Conductors between ballasts and sign lighting lamps shall be No. 16 and color shall correspond to that of the ballast leads.
9. Both conductors between ballast and lamp shall be black.
10. Applies to pressure sensitive detectors. Conductors for inductive loop, magnetic and magnetometer detectors are specified in Section, "Vehicle Detectors."

(b) Installation. Powdered soapstone, talc, or other inert lubricant shall be used in placing conductors in conduit.

Conductors shall be pulled into conduit by hand and the use of winches or other power actuated pulling equipment will not be permitted.

When new conductors are to be added to existing conductors in a conduit, all conductors shall be removed; the conduit shall be cleaned as provided in subsection 623.-02.05C, "Installation;" and both old and new conductors shall be pulled into the conduit as a unit.

Where signal conductors are run in lighting standards containing high-voltage series street lighting conductors, either the signal conductors or the lighting conductors shall be encased in flexible or rigid metal conduit, to a point where the two types of conductors are no longer in the same raceway. Where telephone circuits are installed adjacent to signal and lighting circuits, the telephone conductors shall be encased in UL approved flexible metal conduit.

Temporary conductors less than ten (10) feet above grade shall be enclosed in flexible or rigid metal conduit.

At least one (1) foot of slack shall be left for each conductor at each signal or lighting standard, or combined standard, and at least three (3) feet of slack at each pull box.

At least three (3) feet of slack shall be left for each conductor at each splice.

Ends of spare conductors shall be taped.

Conductors within fixtures or cabinets shall be cabled together with self-clinching nylon cable ties, waxed lacing or other method permitted by the Engineer.

Wiring within controller cabinets shall be neatly arranged and laced, or enclosed in plastic tubing or raceway.

Small permanent identification bands shall be marked as detailed in the conductor table following subsection 623.02.08, "Conductors." The bands shall be securely attached to each conductor in each pull box and near the end of each conductor where conductors are terminated.

Where circuit and phase are clearly indicated by conductor insulation, bands need not be used. Permanent identification bands shall be embossed aluminum foil tape with pressure-sensitive, oil resistant backing. Tape shall be of a type such that embossed symbols contrast with the background color.

(c) Connectors and Terminals. Conductors shall be joined by the use of connectors or other methods permitted by the Engineer. All splices, with or without connectors, shall be soldered by the pouring or dipping method, except that soldering of pressure connectors and terminals may be omitted provided the connectors and terminals are applied with the proper type tool as recommended by the manufacturer of the connector or terminal being applied. Finished connections and terminals shall comply with the requirements of Military Specification MIL–T–7928.

All stranded conductors smaller than No. 14 AWG shall be terminated in crimp style terminal lugs.

(d) Splicing. Unless specified otherwise or permitted by the Engineer, splices will be permitted only in the following types of circuits at the following locations:

1. Branch signal light neutrals in pull boxes.
2. Pedestrian push button circuits in pull boxes.
3. Multiple lighting conductors in bases of standards or in pull boxes.
4. In pull boxes in series lighting circuits where runs are more than four hundred (400) feet between units.
5. In modified traffic signal systems where shown on the plans.

In lieu of the 600-volt or the 5,000-volt splice and splice insulation shown on the plans, the Contractor may elect to use:

A pin and receptacle, locking type connector, with waterproof housing, capable of being disconnected without damage. The pin shall be of medium hard copper material with the portion to be crimped onto the conductor fully annealed. The receptacle shall be of copper material fully annealed. The pin and receptacle shall be of a size to provide not less than ninety (90) percent ampacity of the conductor being spliced. The pin and receptacle shall be

applied to the conductor using a tool as recommended by the connector manufacturer and soldering will not be required. Both the pin and receptacle shall have centrally located, recessed locking areas, which shall match complementary areas of the housing.

The receptacle shall establish contact pressure with the pin through the use of a copper beryllium sleeve spring and the receptacle and pin shall lock together so that the connection will be maintained when a minimum force of twenty (20) pounds tension pull is applied to the attached conductors.

Separate housings shall be provided for the pin and the receptacle. Each housing shall be made of water resisting, synthetic rubber suitable for direct burial in the ground or installation in direct sunlight. Each housing shall have an interior arrangement, complementary to the pin and receptacle, suitable to receive and securely retain the pin and receptacle, also a section to form a water-seal between the housings at the point of disconnection. A small slot or vent shall be provided along the housings to permit the exclusion of air. Sufficient silicon type insulating compound to fill all the voids in the assembly shall be placed in the housings before installing the pin and receptacle.

In lieu of the 600-volt splice and splice insulation shown on the plans, the Contractor may elect to use an epoxy insulated spring connector applied as follows:

The ends of the wires shall be joined together with an insulated spring type connector without soldering.

A two component, self-curing, epoxy resin shall be furnished in a double compartment, plastic envelope. The splice insulation shall be made by thoroughly mixing the two components in the envelope and, after cutting open one end of the envelope, inserting the wire-connection into the epoxy resin and then taping shut the open end of the envelope.

Other methods may be used to mix and apply epoxy resin.

Sufficient epoxy resin shall be provided to completely cover the connector and exposed bare wires at connector. The container shall be transparent to allow inspection.

Conductors in controller cabinets shall not be spliced.

(e) Splice Insulation. Splice insulation shall conform to the details shown on the plans.

Low-voltage tape shall be UL approved and shall be either of the following types at the option of the Contractor:

1. Self-fusing, oil and flame-resistant, synthetic rubber.

2. Pressure-sensitive, adhesive, polyvinyl chloride, 0.007-inch minimum thickness.

Tape for insulating splices in low-voltage circuits (600 volts, maximum) by "Method A" as shown on the plans shall be either of the low-voltage types. Splices made by "Method B" shown on the plans shall be insulated with both types of low-voltage tape.

Tape for insulating splices in high-voltage (over 600 volts) circuits shall be resistant to ozne, corona and water. High-voltage tape shall be self-fusing, vegetable oil base, natural rubber.

Where polyvinyl chloride tape is used for a final layer, an electrical insulating coating shall be used which shall be fast drying, resistant to oil, acids, alkalies and corrosive atmospheric conditions and compatible with the tape.

Where more than one conductor enters a ballast sleeve, the insulation and taping shall be applied between the conductors in such a manner as to provide a watertight joint. The splice shall be capable of satisfactory operation under continuous submersion in water.

On 600-volt and 5,000-volt conductor splices, the Contractor, at his option, may use a cast insulation of self-curing epoxy resin which is compatible with wire insulation to form a moisture resistant joint. The resin shall be resistant to weather, and aromatic and straight chain solvents and, in addition, shall not sustain combustion. The resin shall be poured into molds of dimensions suitable for the splice.

On 600-volt maximum circuits, the Contractor, at his option, may elect to use either of the following splice insulation methods:

(a) A minimum of two (2) thicknesses of electrical insulating pad, composed of a laminate of 0.085-inch thickness of electrical grade polyvinyl chloride and a 0.125-inch thickness of butyl splicing compound with removable liner. Pads shall be applied to the splice in accordance with the manufacturer's recommendations. The ends of the applied pad shall be wrapped with polyvinyl chloride tape half lapped over the conductor insulation.

(b) Heat shrinkable insulating tubing shall be applied after completing the splicing procedure shown on the plans. Insulation over the connector shall consist of a heat shrinkable, mastic lined, heavy wall polyolefin cable sleeve or cover, to which heat shall be applied at a temperature greater than one hundred twenty (120) degrees Centrigrade until the sleeve, or cover, shrinks and covers the connector and the mastic material has flowed completely around the cable to form a waterproof insulation.

On 5,000-volt conductors, the Contractor, at his option, may elect to waterproof splices as follows:

In lieu of the final application of two (2) layers of polyvinyl chloride tape, waterproofing of 5,000-volt splices after being insulated as shown on the plans shall consist of heat shrinkable, mastic lined, heavy wall polyolefin cable sleeve, or cover, to which heat shall be applied at a temperature greater than one hundred twenty (120) degrees Centigrade until the sleeve, or cover, shrinks and covers the connector and the mastic material has flowed completely around the cable to form a waterproof insulation.

(f) Fused Splice Connectors. In each pull box adjacent to an electrolier a fused disconnect splice connector shall be installed in each ungrounded conductor between the line and the ballast. The connector shall be readily accessible in the pull box regardless of whether the ballast is remote or is integral with the luminaire.

For 240-volt and 480-volt circuits, each connector shall be designed so that both ungrounded conductors are disconnected simultaneously. The connector shall have no exposed metal parts.

The splice connector shall completely enclose the fuse and shall protect the fuse against damage from water and

weather. The contact between the fuse and fuseholder shall be by spring pressure. Springs shall not be a part of the current carrying circuit. The terminals of the splice connector shall be rigidly crimped, using a tool of the type recommended by the manufacturer of the fused splice connector, on to the line conductors and the conductors to the ballasts and shall be insulated and made waterproof in accordance with the splice connector manufacturer's recommendations.

Fused splice connectors shall not be used in series circuits.

Fuses shall be standard midget, ferrule type.

623.02.10 Bonding and Grounding. Metallic cable sheaths, metal pull box covers, metal conduit, nonmetallic conduit grounding wire, ballast and transformer cases, service equipment, sign switches, anchor bolts, and metal poles and pedestals shall be made mechanically and electrically secure to form a continuous system, and shall be effectively grounded. Bonding and grounding jumpers shall be copper wire or copper braid of the same cross sectional area as No. 6 AWG for series lighting systems and No. 8 AWG or larger for all other systems.

Bonding of standards and pedestals shall be by means of a bonding wire or braid attached to the anchor bolts or a three-sixteenths ($^3/_{16}$) inch, or larger, brass or bronze bolt installed in the lower portion of the shaft.

Where slip base standards or slip base inserts are installed, the grounding jumper shall not intrude into the slip plane. Bonding shall be accomplished by a bonding strap to the anchor bolts or a three-sixteenths ($^3/_{16}$) inch or larger brass bolt installed in the bottom slip base plate.

One side of the secondary circuit of series-multiple and step down transformers shall be grounded.

Grounding of metal conduit, service equipment, and neutral conductor at service point shall be accomplished as required by the code and the serving utility, except that grounding conductors shall be No. 6 AWG, or equal.

For bonding purposes in all nonmetallic type conduit, a bare No. 6 AWG copper wire shall be run continuously in

circuits used for series lighting, and a bare No. 8 AWG copper wire shall be run continuously in all other circuits. In lieu of the continuous copper ground wire, a ground rod, when approved by the Engineer, may be installed at each pole or standard.

Where nonmetallic conduit is to be installed for future conductors, the above mentioned copper wire may be omitted.

At each multiple service point, unless otherwise shown on the plans, a ground electrode shall be furnished and installed. Ground electrodes of steel or iron shall be one-piece lengths of galvanized rod or pipe at least three-fourths (¾) inch in diameter. Electrodes of nonferrous materials, or their approved equivalent, shall be not less than one-half (½) inch in diameter. Ground electrodes shall be installed in accordance with the provisions of the code. The service equipment shall be bonded to the ground electrode by use of a ground clamp and No. 6 AWG copper wire, enclosed in a one-half (½) inch diameter conduit.

When a ground connection is required in a series lighting system, a plug cutout, as shown on the plans, shall be connected into the circuit and installed in a pull box. The plug shall be grounded to a water pipe or ground electrode.

Where a metal conduit system parallels, or crosses, a permanent water system in accessible areas, grounding jumpers shall be installed at intervals not exceeding five hundred (500) feet.

Ground clamps for service grounding and for grounding of equipment on wood poles shall be a one-half (½) inch galvanized, malleable iron conduit hub with swivel feature.

On wood poles, all equipment mounted less than eight (8) feet above ground surface shall be grounded.

Bonding of metallic conduit in concrete pull boxes shall be by means of galvanized grounding bushings and bonding jumpers.

Bonding of metallic conduit in steel pull boxes shall be by means of locknuts, one inside and one outside of the box.

623.02.11 Service. Electrical service installation and materials shall conform to the requirements of the serving utility.

Service equipment shall be installed as soon as possible to enable the utility to schedule work well in advance of the completion of the project.

Where the service point is a utility-owned pole, the Contractor shall furnish conduit, conductors, and all other necessary material to complete the installation of the service riser. If the Contractor is required by the plans or special provisions to install the service riser and equipment on a utility-owned pole, the position of the riser and equipment will be determined by the utility.

Upon request of the Contractor, the Engineer will arrange with the serving utility to complete service connections for both temporary and permanent installations and the Contractor shall pay all required costs and fees therefor.

Upon request of the Contractor, the Engineer will arrange for furnishing electrical energy. Energy used prior to completion of the contract will be charged to the Contractor, except that the cost of energy used for public benefit, when such operation is ordered by the Engineer, will be at the expense of the State or local authorities.

Full compensation for furnishing and installing service poles, service equipment, conduit and conductors (including equipment, conduit, and conductors, placed on utility owned poles, and the additional conductor where the serving utility requires 3-wire, 120/240-volt service into the meter socket for a 120-volt load), and for any service connection fees, shall be considered as included in the contract item of electrical work involved and no additional compensation will be allowed therefor.

(a) Service Conduit and Riser. Service conduit for multiple lighting or traffic signals shall be not less than two (2) inches in size. Service conduit for series lighting shall be not less than one and one-half (1½) inches in size.

Service riser conduit shall terminate with a service head or shall be sealed to prevent the entrance of water, as approved by the serving utility.

(b) Service Equipment. Service equipment for multiple lighting systems or traffic signals, or both, shall be a 3-wire, solid-neutral, fused switch. The switch shall be enclosed in a NEMA Type 3R raintight enclosure which shall be provided with a top hinged cover, hasp for sealing cover, and provisions for locking the handle in the "On" and "Off" positions. The padlock will be furnished by others. Service switch cabinet cover shall not be interlocked with operating handle.

When specified in the special provisions or shown on the plans a circuit breaker may be used in lieu of the service switch specified above. Ratings shall be as shown on the plans. Circuit breakers shall be approved and listed by the UL. The operating mechanism shall be enclosed and shall be trip-free from operating handle on overload, shall be trip-indicating and shall have trip and frame size plainly marked. Multiple-pole circuit breakers shall have a common trip. 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 zero (0) degrees Fahrenheit to plus one hundred sixty (160) degrees Fahrenheit. Enclosure for circuit breakers shall be provided with a top hinged cover, dead front panel and a hasp for a padlock.

Where a kilowatt-hour meter is required, a meter socket, as approved by the serving utility, complete with sealing rings, shall be furnished and installed. Service equipment for traffic signals or flashing beacons shall, in addition, be provided with a manual circuit closing device or space for a test block as required by the serving utility.

Each service for a series lighting circuit shall be provided with a series circuit switch of 5,000-volt rating. The switch shall be enclosed in a NEMA Type 3R, eighteen inches by twenty-four inches by six inches (18″ x 24″ x 6″), cutout box. The cutout box shall be fitted with a cover permanently inscribed "Danger—High Voltage." The cover shall be attached to the box to form a raintight plate and shall require tools for removal. The cutout box shall be installed not less than eight (8) feet above the ground.

Service equipment enclosures, except cast aluminum meter sockets, shall be hot-dip galvanized or, at the option of the Contractor, said enclosures may be provided with a factory applied rust resistant prime coat and baked enamel finish coat, in lieu of galvanizing.

(c) Series Circuit Switches. Switches for high voltage switching shall be of the oil-filled type. The switch assembly shall consist of twin blades, contacts, terminal blocks, twin plastic shafts, container and mounting plate.

The switch shall operate with the contacts submerged in oil. The oil for the switches shall be insulating oil and shall conform to the specifications of ASTM Designations: D117, D877, and D1040. Level of oil shall be a minimum of two (2) inches above the contacts.

The basic design feature of the switch shall consist of both stationary contacts and movable blades. The stationary contacts shall consist of load and line. The twin blades shall be isolated from each other by a high dielectric strength plastic material secured with plastic screws. When the blades are separated from the stationary contacts, the contacts shall have sufficient spring action to insure positive electrical continuity and shall shunt both line leads and load leads simultaneously, as well as isolate the line from the load. In circuit energized position, the stationary contacts shall hold or lock the blades with approximately five (5) pounds pressure. The action of the stationary contacts shall be coordinated with the movement of the blades, so there is always positive make-before-break contact on both opening and closing of the switch.

The conducting blade shall have a minimum cross-sectional area of 0.027 square inch and the stationary contact shall have a minimum surface area of 0.25 square inch. Both the blades and the contacts shall be fabricated of either copper or bronze.

The insulating plastic material, which separates the two blades, shall be attached to the plastic shafts by means of plastic screws. The twin plastic shafts with handle attached on top shall be operated in upward and downward movements through the top of the container. The

shafts, for operation of the switch extending downward, shall have a positive stop to prevent the blades from over-traveling down the stationary contacts (load and line).

The shaft openings in the top of container shall be equipped with gland and O-ring devices to preclude oil contamination.

An oil-filler hole shall be provided in the top of the unit and shall be fitted with a leak-proof polyvinyl plug.

The container for the switch shall be of oil-resistant clear acrylic plastic with a maximum outside diameter of five (5) inches and shall have a maximum depth of five and three-fourths (5¾) inches when a mounting bracket is attached. The overall height shall not exceed eleven (11) inches when the operating shafts are fully extended.

The bottom cover for the terminal compartment shall be of molded plastic material with one (1) inch round holes for wiring connectors. The shape of the cover shall be cylindrical and shall attach to the barrier with two (2) plastic screws.

The feed-through conductors for connecting terminals and contacts shall be five-sixteenths ($^5/_{16}$) inch minimum, bronze or copper machine screws and shall be completely sealed to the main body of the unit to prevent oil leakage. In addition, bare copper terminals, capable of accommodating up to and including No. 6 AWG conductors shall be externally attached, and the entire assembly shall be sufficiently rigid to allow adequate torquing when wiring connections to terminals are made.

A physical barrier of plastic material shall be rigidly attached to the bottom of the case and shall extend diametrically between the terminals used for connection to the constant current transformer. The barrier shall be of sufficient length and finished to coincide with the circumference of the bottom of the plastic body. The barrier shall be seven-sixteenths ($^7/_{16}$) inch minimum thickness and one and three-fourths (1¾) inches minimum height. Holes to accommodate two (2) machine screws shall be drilled and tapped into the barrier for attachment to the bottom cover for the terminal compartment.

A five and one-half (5½) inch by six and one-half (6½)

inch mounting plate of high impact strength laminated thermoplastic material shall be attached to the container by means of copper or bronze machine screws and shall be positioned so that easy switch operation will be attained. Three one-fourth (¼) inch holes shall be drilled on each side of the plate for mounting in an eighteen inch by twenty-four inch by six inch (18″ x 24″ x 6″) enclosure.

A five (5) inch long plastic lever with an attached movable self-locking detent shall be placed between the shafts and shall be fastened to the container mounting plate with a pivoting device. This plastic level shall be restricted to operate in an imaginary plane perpendicular to the mounting plate and shall be capable of withstanding a load of five (5) pounds minimum when applied to the operating handle in an upward direction, locking it in position with the detent.

The entire oil-filled switch assembly shall be capable of withstanding the following voltage tests:

1. Terminals to ground—20 K.V.
2. Contacts to operating handle—20 K.V.
3. Across open-circuited terminals—20 K.V.

623.02.12 Wood Poles. Wood poles for service or temporary installation shall be ASA Class 5, or larger, Douglas Fir or Southern Yellow Pine.

Poles shall not have more than one hundred eighty (180) degrees twist in grain over the full length. Sweep shall be no more than four (4) inches. Top of poles shall be beveled. Poles shall be placed in the ground to a depth of at least six (6) feet. The lengths of poles shall be twenty-five (25) feet for service poles and thirty-five (35) feet for other poles, unless otherwise specified.

After each wood pole is set in the ground, the space around the pole shall be backfilled with selected earth or sand, free of rocks and other deleterious material, placed in layers approximately 0.33 foot thick. Each layer shall be moistened and thoroughly compacted.

Mast arms and tie rods for wood pole installations shall conform to the provisions in subsection 623.02.04, "Standards, Steel Pedestals, and Posts," and to the details shown

on the plans. Each mast arm shall be provided with an insulated wire inlet and wood pile mounting brackets for mast arm and tie rod crossarm.

Mast arms for luminaires shall be mounted to provide a mounting height of thirty (30) feet. Mast arms for traffic signals, flashing beacons, and overhead detectors shall provide a minimum vertical clearance of seventeen (17) feet from bottom of equipment to the pavement.

Wood poles, not to be painted, shall be pressure treated after fabrication as provided in Section 615, "Preservative Treatment for Timber."

623.02.13 Sign Switches. Each sign illumination installation shall be provided with a disconnect switch mounted on the sign standard or structure, as shown on the plans. Where the sign lighting is served from a series lighting system through a series-multiple transformer or from a multiple service, each sign structure shall have a 120-volt, 240-volt, or 480-volt fused AC switch, approved by UL as service equipment as shown on the plans.

Enclosure for the sign switch shall be NEMA Type 3R, shall be galvanized or, at the option of the Contractor, shall be provided with a factory applied rust resistant prime coat and baked enamel finish coat, in lieu of galvanizing, and shall be provided with top hinged cover, hasp for sealing cover and provisions for locking the handle in the "On" and "Off" positions. Padlocks will be furnished by others.

When specified in the special provisions, a circuit breaker shall be provided in lieu of the above fused switch. Circuit breakers shall conform to the requirements under subsection 623.02.11, "Service," and the ampacity of the circuit breaker shall conform to the requirements of the code.

In the event the sign structure is to be painted, the sign switch or circuit breaker enclosure shall be painted the same color as the sign structure on which it is installed.

623.02.14 Field Tests. Prior to completion of the work, the Contractor shall cause the following tests to be

made on all traffic signal, sign illumination, and lighting circuits, in the presence of the Engineer:

(a) Continuity. Each circuit shall be tested for continuity.

(b) Ground. Each circuit shall be tested for grounds.

(c) Megger. A megger test at 500 volts DC shall be made on each circuit between the circuit and a ground. The insulation resistance shall not be less than 10 megohms on all circuits, except for inductive loop detector circuits which shall have an insulation resistance value of not less than 100 megohms.

(d) Functional. A functional test shall be made in which it is demonstrated that each and every part of the system functions as specified.

The functional test for each new or modified traffic signal, flashing beacon and ramp metering system shall consist of not less than five (5) 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 five (5) days of continuous satisfactory operation is obtained.

The initial turn-on shall be made between 9:00 a.m. and 2:00 p.m. unless specified otherwise in the special provisions. Prior to turn-on, all equipment as shown on the plans shall be installed and operable. This includes "WALK—DON'T WALK" pedestrian signals, pedestrian push buttons, vehicle detectors and highway lighting. All louvers, hoods and signal heads shall be directed to provide maximum visibility.

Turn-on of new or modified traffic signal systems shall be made only after all traffic signal circuits have been thoroughly tested as specified above.

The functional test for each lighting system and sign illumination system shall consist of an operational test for two (2) consecutive days according to the regular lighting schedule.

During the test period, state or local forces will maintain the system or systems. The cost of any maintenance necessary, except electrical energy and maintenance due to damage by public traffic, shall be at the Contractor's

expense and will be deducted from any moneys due or to become due the Contractor.

Functional tests shall start on any working day except Friday, or the day preceding a legal holiday.

Shutdown caused by damage by public traffic or a power interruption shall not constitute discontinuity of the functional test.

(e) High Voltage. The Contractor shall perform, on high-voltage series lighting circuits, a high-voltage test consisting of an 8,400-volt, 60-Hz. alternating current between the conductors and a ground for five (5) consecutive minutes with the two ends of the circuit connected together. The initially applied voltage shall be applied to the entire completed circuit and shall not be greater than the rated voltage of the cable and the rate of increase shall be approximately uniform and not over one hundred (100) percent in ten (10) seconds nor less than one hundred (100) percent in sixty (60) seconds. The voltage shall be increased to the value of 8,400 volts root mean square and held at this value for five (5) minutes.

When permitted by the Engineer, the Contractor may, in lieu of the above 8,400-volt test, perform a high-voltage series lighting test consisting of the open circuit voltage of the connected constant current transformer between conductors and ground.

The high-voltage test shall not be performed on existing circuits or equipment. This shall in no way relieve the Contractor from his responsibility for malfunctioning of existing lighting circuits due to his making splices in or connecting to the circuits, and such malfunctions shall be corrected.

Any fault in any material or in any part of the installation revealed by these tests shall be replaced or repaired by the Contractor at his expense in a manner permitted by the Engineer, and the same test shall be repeated until no fault appears.

623.02.15 Galvanizing. Galvanizing shall be in accordance with the provisions in Section 715, "Galvanizing," except that cabinets may be constructed of material

galvanized prior to fabrication in conformance with the specifications of ASTM Designation: A525, Coating Designation G90.

Iron or steel pipe standards and pipe mast arms shall be hot-dip galvanized after fabrication in conformance with the specifications of ASTM Designation: A120.

Tie-rods, nuts, washers, clamps and other miscellaneous ferrous parts shall be hot-dip galvanized after fabrication in accordance with the provisions in Section 715, "Galvanizing."

Not less than ten (10) inches of the upper end of the anchor bolts, anchor bars, or studs, and all nuts and washers shall be galvanized in accordance with the provisions in Section 715, "Galvanizing."

After galvanizing, the bolt threads shall accept galvanized standard nuts without requiring tools or causing removal of protective coatings.

Galvanizing of existing materials in an electrical installation will not be required.

623.02.16 Painting. Painting of electrical equipment and materials shall conform to the provisions in Section 614, "Painting," with the following additions and modifications:

Paint materials for electrical installation, unless otherwise specified, shall conform to the provisions in Section 714, "Paints."

Factory or shop cleaning methods for metals will be acceptable if equal to the methods specified herein.

In lieu of the temperature and seasonal restrictions for painting as provided in Section 614, "Painting," paint may be applied to equipment and material for electrical installations at any time approved by the Engineer.

All ferrous surfaces to be painted shall be cleaned as provided in said Section 614, "Painting," prior to applying the vinyl wash primer or prime coat. Blast cleaning of galvanized metal surfaces in good condition, as determined by the Engineer, will not be permitted.

Existing equipment to be painted in the field, including State-furnished equipment, shall be washed with a stiff

bristle brush using a solution of water containing two (2) tablespoonsful of heavy duty detergent powder per gallon. After rinsing, all surfaces shall be wire brushed with a coarse, cup shaped, power driven brush to remove all poorly bonded paint, rust, scale, corrosion, grease, or dirt. Any dust or residue remaining after wire brushing shall also be removed prior to priming.

Galvanized metal poles and metal guard posts will not require painting.

Two finishing coats of Aluminum Paint, Finish Coat, Section 714, "Paints," shall be applied to the following nongalvanized equipment: Controller cabinets, reused lighting and signal standards, and reused luminaires; and to exterior surfaces and ungalvanized steel edges of raintight enclosures (switches, service, control equipment, transformers, etc.).

Interior of signal hoods, louvers, and front faces of back plates shall be finished with two coats of Enamel; Traffic Signal, Lusterless, Black, as provided in Section 714, "Paints," except that factory enamel finish in good condition will be acceptable.

Painting of outside of signal heads and other signal equipment which have been factory enameled in dark olive green and are in good condition, may be omitted.

Factory finish on new equipment will be acceptable if of proper color and if equal in quality to the specified finish.

Conduit and conduit fittings above ground shall be prepared and finished in the same manner as the adjacent standard or post.

Signal heads, signal head mounting, brackets and fittings, outside of hoods, pedestrian push button housings, pedestrian signal head housings and hoods, and back faces of back plates shall be finished with two coats of Enamel; Traffic Signal, Dark Olive Green, as provided in Section 714, "Paints."

Reused equipment previously finished as specified in subsection 623.02.15, "Galvanizing," shall be given a spot finishing coat on newly primed areas, followed by one finishing coat over the entire surface.

Reused galvanized equipment with extensively rusted areas shall be cleaned and painted as provided for nongalvanized equipment.

Small rusted or repaired areas of reused galvanized equipment shall be cleaned and painted as provided in Section 715, "Galvanizing," for repairing damaged galvanized surfaces.

New galvanized equipment shall not be painted.

All paint coats may be applied either by hand brushing or by approved spraying machines in the hands of skilled operators. The work shall be done in a neat and workmanlike manner. The Engineer reserves the right to require the use of brushes for the application of paint, should the work done by the paint spraying machine prove unsatisfactory or objectionable, as determined by the Engineer.

CONTROLLERS

623.02.17 Controllers. A controller shall consist of a complete electrical mechanism for controlling the operations of traffic control signals, including the timing mechanism and all necessary auxiliary equipment, mounted in a cabinet.

All equipment inputs, outputs, and terminals shall be identified by the phase designations shown on the plans.

623.02.18 Interval Sequence. The color sequence of signal indications shall be green, yellow, red. During any interval there shall be no visual flicker of signal indications.

623.02.19 Flashing Operations. All controller cabinets shall be equipped for flashing operation of signal lights. Flashing operations, when required by railroad preemption, flashing control, or other causes, shall be set for flashing yellow lights on the main street or highway and for flashing red on the cross street or streets or left turn lanes, unless otherwise specified in the contract documents or directed by the Engineer.

623.02.20 Railroad Pre-emptor. The railroad pre-emptor shall pre-empt normal controller unit operation, or flashing operation as provided in subsection 623.02.-31(j)5, "Police Panel Switches," when actuated by the normally closed track circuit or by a test switch. The pre-emptor shall cause the signals to display the sequence of indications shown on the plans. Once clearance sequence is begun it shall continue to the end regardless of the condition of the track circuit or test switch. After the track clearance interval the signals shall flash while the pre-emption circuit is actuated. When the track circuit or test switch is returned to its normal condition flashing operation shall terminate through the signal sequence shown on the plans. The controller shall go through the phase sequence shown on the plans as if calls had been received on all phases. Pedestrian "WALK" indications shall appear with the first corresponding green indication.

623.02.21 Pre-emption Equipment. The pre-emptor shall consist of solid-state or electro-mechanical components and circuits. Solid-state circuitry shall conform to the material requirements specified in subsection 623.-02.31, "Solid-State Traffic Actuated Controller Units."

The pre-emptor shall be a module which plugs into the controller unit, or a separate unit built on a shelf mounted chassis which is connected into the controller through an "MS" connector.

The controller shall operate only in the flashing mode when the pre-emptor is removed.

The pre-emptor shall be provided with timing controls for the intervals shown on the plans. Pilot lights shall indicate which interval the pre-emptor is in. Means shall be provided to turn the pilot lights on and off.

A momentary contact, normally closed switch shall be installed in series with the track circuit to provide a means to test the pre-emptor.

Relays and flashers shall be as specified for controllers. During pre-emption of normal signal operation, the signal lights may be switched by the normal load switching devices.

623.02.22 Operating Voltage. All traffic signal equipment, except pedestrian push buttons, shall be designated to operate from a 120-volt, 60-Hz, AC supply. Operation shall be satisfactory at voltages from one hundred five (105) to one hundred thirty (130).

The voltage for pedestrian push buttons shall not exceed eighteen (18) volts.

623.02.23 Radio Interference Suppressors. Each traffic controller unit, flasher, and other current interrupting device shall be equipped with a suitable radio interference suppressor installed at the input power point. Interference suppressors shall be of a design which will minimize interference in both broadcast and aircraft frequencies, and shall provide a minimum attenuation of 50 decibels over a frequency range of 200 kilocycles to 75 magacycles when used in connection with normal installations. The interference suppressor shall be hermetically sealed in a substantial metal case filled with a suitable insulating compound. Terminals shall be nickel-plated, 10–24 brass studs of sufficient external length to provide space for connecting two No. 8 AWG conductors, and shall be so mounted that the terminals cannot be turned in the case. Ungrounded terminals shall be properly insulated from each other, and shall maintain a surface leakage distance of not less than one-fourth (¼) inch between any exposed current conductor and any other metallic part, with an insulation factor of 100–200 megohms dependent on external circuit conditions. Suppressors shall be designed for one hundred twenty-five (125) percent of the total connected load and in no event less than 25 amperes, 120 volts, 60 Hz., single-wire circuits, and shall meet standards of the UL and the EIA.

623.02.24 Traffic Actuated Controller Units. The types of traffic actuated controller units, cabinets and auxiliary equipment will be designated on the plans or specified in the special provisions.

Time spans and actuation limits given for various functions are minimum and may be expanded.

The adjusted vehicle clearance interval for all types of traffic actuated controller units shall remain constant regardless of the reason for phase termination.

623.02.25A Electro-Mechanical Controller Units. Types of electro-mechanical traffic actuated controller units are as follows:

(a) Type I Controller Unit. Type I controller unit shall be a 2-phase, full traffic actuated, traffic control device capable of transferring traffic indication from one phase to the other as the movement of traffic demands.

In the absence of detector actuation, or closed recall switch, the right of way shall remain on the traffic phase upon which the last actuation occurred.

The actuation of a detector in the lane or lanes having the right of way during the extendible portion of that traffic phase shall cause the retention of right of way by that traffic phase for one unit extension from the time of actuation.

The actuation of any detector on a traffic phase not having the right of way shall cause the transfer of the right of way to that traffic phase immediately following the expiration of one unit extension during which there was no actuation on the other traffic phase.

The transfer of the right of way for any traffic movement shall take place only after a proper clearance interval which is adjustable from two (2) to eight (8) seconds. The adjusted interval shall remain constant regardless of the reason for phase termination.

The minimum green interval shall consist of an initial portion and one unit extension. The initial portion shall be adjustable between ten (10) and thirty (30) seconds. The unit extension shall be adjustable from two (2) to twelve (12) seconds.

Successive detector actuations spaced less than one unit extension shall not retain the right of way for more than the extension limit.

The timing of the extension limit shall commence with the first actuation on the traffic phase not having the right of way, provided that the initial portion has expired.

An actuation during the clearance period for a traffic phase shall cause the right of way to return to that phase immediately following the expiration of one unit extension during which there was no actuation on the other traffic phase.

When the traffic demand on any phase is continuous and spaced less than a unit extension, the extension limit shall limit the resetting of the unit extension and terminate the extension of right of way on that phase. The extension limit shall be adjustable between ten (10) and sixty (60) seconds.

When the right of way is transferred by the operation of the extension limit, the traffic phase losing the right of way shall again receive it without further actuation immediately following the expiration of one unit extension during which there is no actuation on the other traffic phase, or the expiration of the extension limit on the other traffic phase.

A recall switch shall be provided for each traffic phase. When closed, the recall switch shall cause the automatic return of the right of way to the desired traffic phase or to both traffic phases, alternately, in the event both recall switches are closed.

(b) Type II Controller Unit. Type II controller unit shall be a 3-phase, full traffic actuated, traffic control device with functions similar to the Type I controller except that three phases shall be provided, and timing of the vehicle extension limit shall commence with the first actuation on either traffic phase not having the right of way. The Type II controller unit shall be equipped with provisions for skipping any phase when there is no call for that particular phase.

The controller unit shall be equipped so that it may be coordinated with other controller units or supervised by a master system.

Phase overlap connections shall be available at the controller unit connector.

(c) Type III Controller Unit. Type III controller unit shall be a 2-phase, full traffic actuated, traffic control device capable of transferring traffic control indication from one

phase to the other as the movement of traffic demands and shall be capable of increasing and decreasing the various time intervals due to variations in volume of moving traffic and of waiting traffic.

The controller operations shall include, but shall not be limited to the following functions:

In the absence of detector actuation, the right of way shall remain on the traffic phase upon which the last actuation occurred.

When the transfer of the right of way occurs on any traffic phase, the minimum green interval shall consist of a minimum initial portion, adjustable between five (5) and sixty (60) seconds.

Continued actuations on the traffic phase not having the right of way beyond a predetermined number of actuations shall cause the initial portion next shown for that traffic phase to be increased. This added initial portion shall be in relation to the number of added actuations, adjustable between five (5) and thirty-five (35) seconds, and the increase in the time per actuation shall be adjustable between zero (0) and two (2) seconds.

In light and intermittent traffic, an actuation on a traffic phase having the right of way shall cause the retention of the right of way by that traffic phase for one passage period from the time of actuation. Passage period shall be adjustable between five (5) and fifteen (15) seconds.

Should the transfer of the right of way from one traffic phase to another take place before the passage period has expired the right of way shall be returned to that traffic phase without further actuation.

The transfer of the right of way from any traffic phase shall take place only after a clearance interval adjustable from two (2) to eight (8) seconds.

Successive actuations on any traffic phase shall not retain the right of way on that traffic phase for more than the extension limit. The extension limit shall be adjustable between ten (10) and ninety (90) seconds.

The timing of the extension limit shall commence with an actuation or other registration of traffic demand for right of way on the traffic phase not having the right of

way, provided the minimum initial portion and the added portion have expired.

An actuation during the clearance period for a traffic phase shall cause the right of way to return to that phase without further actuations.

The length of the unit extension on any traffic phase shall be variable within predetermined limits and shall be established by the features described as follows:

**The frequency of actuations on any traffic phase having the right of way shall determine the unit extension on that traffic phase.

Actuation on any traffic phase not having the right of way shall reduce the unit extension on the traffic phase having the right of way in proportion to the time elapsing after that actuation.

**Successive actuations on any traffic phase not having the right of way shall decrease the unit extension on the traffic phase having the right of way in proportion to the number of actuations.

**Actuations on a traffic phase having the right of way shall by the operation of the carryover when the right of way is transferred to another traffic phase, reduce the unit extension of the latter traffic phase in anticipation of the expected arrival of a platoon of vehicles on the first traffic phase.

A recall switch shall be provided for each traffic phase which, when closed, shall cause the automatic return on the right of way to the desired traffic phase or to both traffic phases, alternately.

Pilot lights shall be provided to indicate the position of the controller at all times with regard to operating intervals on each traffic phase and also to indicate which of the several effects is responsible for termination of right of way. A switch shall be provided to energize the pilot lights only when needed.

(d) Type IV Controller Unit. Type IV controller unit shall be a 3-phase, full traffic actuated, traffic control device with functions similar to the Type III controller unit, except as follows:

1. Three phases shall be provided.

2. The right of way shall not be given to any street in the absence of actuation thereon.

3. Paragraphs marked ** in subparagraph (c), "Type III Controller Unit," do not apply to the Type IV controller unit.

The Type IV controller unit shall be equipped with provision for skipping any phase when there is no call for that particular phase.

Phase overlap connections shall be available at the controller unit connector.

(e) Type V Controller Unit. Type V controller unit shall be a 2-phase, semi-traffic actuated, control device which shall, in response to calls from the minor street, transfer the right of way to the minor street.

In the absence of actuation of any detector, the right of way shall return to and remain on the approaches not provided with detectors.

The transfer of the right of way from any traffic movement shall take place only after a clearance interval which is adjustable from two (2) to eight (8) seconds.

Following the transfer of the right of way to the approaches not provided with detectors, a minimum period which is adjustable from thirteen (13) to eighty (80) seconds shall be timed before transfer of the right of way to the approaches having detectors.

The actuation of any detector shall cause the right of way to be transferred to that approach at the expiration of a minimum period, in accordance with the interval sequence provided.

The minimum green interval on approaches having detectors shall consist of an initial portion and one unit extension. The initial portion shall be adjustable from two (2) to twelve (12) seconds. The unit extension shall be adjustable from two (2) to twelve (12) seconds.

The actuation of any detector during the extendable portion shall cause the right of way to remain on that traffic phase for an additional unit extension to be timed from the moment of detector actuation.

If there is no detector actuation during the extendable

portion, the right of way shall be transferred to the approaches without detectors.

Successive detector actuations spaced less than a unit extension shall not retain the right of way for more than the extension limits. The extension limit shall be adjustable from thirteen (13) to sixty (60) seconds.

When the right of way is transferred by the operation of the extension limit, the right of way shall be returned to the approaches with detectors after the expiration of a minimum period.

The controller shall be so equipped that it may be coordinated with other controllers or supervised by a master system.

(f) Auxiliary Movement Controller Unit. Auxiliary movement controller unit shall be a traffic actuated auxiliary traffic control device capable of modifying all or a portion of an actuated controller unit traffic phase for the purpose of permitting an auxiliary traffic phase.

In the absence of auxiliary movement detector actuation, the controller traffic phase shall not be modified.

The minimum green interval shall consist of an initial portion and one unit extension. The initial portion shall be adjustable from two (2) to fifteen (15) seconds. The unit extension shall be adjustable from two (2) to twelve (12) seconds.

The actuation of an auxiliary movement detector during the extendable portion shall cause retention of the right of way for one unit extension from the time of actuation.

Successive detector actuations spaced less than a unit extension shall not retain the right of way for more than the extension limit. The extension limit shall be adjustable from ten (10) to sixty (60) seconds.

The timing of the extension limit shall commence immediately following expiration of the initial portion, except that the extension limit may be allowed to function during other intervals of the controller for secondary timing purposes.

Upon the expiration of one unit extension during which there was no actuation on the auxiliary movement detector, right of way shall be returned to the parent phase.

The transfer of the right of way shall take place only after a proper clearance interval which is adjustable from two (2) to eight (8) seconds.

An actuation during the clearance period shall cause the right of way to return to the auxiliary traffic phase following the answering of traffic demand on the parent, nonparent and other phases of the intersection controller.

When the right of way is transferred by the operation of the extension limit, the right of way shall return to the auxiliary traffic phase following the answering of traffic demand on the parent, nonparent and other phases of the intersection controller.

Timing of the controller parent phase shall either begin with auxiliary movement timing or shall be stopped until the auxiliary movement timing has terminated, as required to provide system operation in accordance with the phase diagrams shown on the plans and as specified in the special provisions. In those systems where the auxiliary movement timing can extend beyond the parent phase, timing shall be stopped on the green interval of the following phase and shall be released when the auxiliary movement terminates.

Parent and nonparent calls shall be placed in such a manner that modification of the controller traffic phase will take place at the first instant of parent phase green.

A recall switch shall be provided for each auxiliary movement controller.

(g) Phase Skip Unit. Phase skip unit shall be an auxiliary control unit for supervising the functioning of auxiliary movement controllers when used in conjunction with one phase (parent phase) of a 2-phase traffic actuated controller.

With the 2-phase controller resting in the parent phase, and in the absence of actuations on the nonparent phase, an auxiliary actuation shall cause the phase skip unit to provide means for returning the controller to the initial portion of parent phase during which the minor movement phases normally occur without the necessity of the signal system passing through the nonparent phase.

The return to the auxiliary movements will be governed by the normal operating features of the controller and shall be accomplished without change in any signal indications, through the various timing intervals to the beginning of the parent green interval. A normal length parent yellow shall be displayed prior to the beginning of the green indication for left turn traffic.

An actuation on the nonparent phase shall result in normal operation of the controller and sequence of phases.

623.02.25B Mechanism for Electro-Mechanical Traffic Actuated Controller Units. Construction of controller units shall be equal to that of first-class electrical instruments. Each variable shall be individually adjustable over its entire range by indicating type knobs, mounted on the timing panel of the controller unit. Changing the timing of one interval shall not change the timing of any other interval. Timing accuracy shall be within ten (10) percent of the dial setting.

The controller unit shall be so designed that temperature variation between zero (0) degrees Fahrenheit and plus one hundred sixty (160) degrees Fahrenheit shall not change the timing intervals by more than five (5) percent.

All contact points which make, break or carry electrical current shall be of fine silver, silver-alloy or superior alternative material, and shall be capable of making, breaking and carrying a current of one hundred fifty (150) percent of maximum demand load of that particular circuit without causing electrical or mechanical trouble through one million (1,000,000) operations.

All bearings, except approved sealed bearings, or moving parts shall be of such design that lubrication at one (1) year intervals shall be sufficient to assure continuous operation.

The complete controller, and each auxiliary unit as specified, shall be assembled, wired, and housed in separate metal cases. All circuits of each 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 terminals to match the terminal block and shall have identifying bands. Ends of spare conductors shall be taped.

Connectors on all equipment cables shall be provided with strain relief clamps.

In addition to actuation by vehicles, provisions shall be made in the mechanism for each phase for actuation or indirect actuation by means of pedestrian push buttons or railroad preemption, or both, without altering the controller mechanism.

623.02.25C Auxiliary Equipment for Electro-Mechanical Traffic Actuated Controller Units. The following auxiliary equipment shall be furnished and installed in each cabinet for electro-mechanical traffic actuated controller units:

(a) Flasher and Flasher Relay. Flasher shall be a solid-state device with no contact points or moving parts, producing between fifty (50) and sixty (60) flashes per minute with a forty (40) to sixty (60) 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 controller unit to flasher and shall permit flashing yellow lights on the main street or highway and flashing red on the cross street or streets and left turn lanes and shall be similar in construction to external light relays specified for use with traffic actuated controller units.

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.

(b) External Light Relays for Controllers. Relays shall be installed in the controller cabinet, external to the controller unit.

External light relays shall be wired so that all opposing and conflicting traffic movement shall have a red indication prior to the display of green indication on the phase which is to receive the right of way.

The relay assembly shall be one of the following types:

For 2-phase controllers—2 double-pole, double-throw relays.

For 3-phase controllers—6 single-pole, double-contact, double-throw relays.

Relays for special control devices and external light relays for pedestrian signals shall have double-pole, double-throw contacts.

Relays shall be designed for continuous duty. Relays shall operate during ambient temperatures from zero (0) degrees Fahrenheit to plus one hundred sixty (160) degrees Fahrenheit. Each relay shall be mounted on a plug-in base with plug-in mounting as shown on the plans. Banana spring type plugs and jacks shall be used.

Contact points shall be of fine silver, silver-alloy or superior alternative material.

Contact points and contact arms shall be capable of carrying a current of 20 amperes per contact at 120 volts, 60 Hz., AC.

Coils shall have a power consumption of 10 volt-amperes or less and shall be designed for continuous duty on 120 volts, AC.

A leakage resistor, which will permit a small amount of 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 light relay to overcome residual magnetism effects.

External light relays shall conform to the requirements of the following tests:

1. Load Test. Relays shall show no failure while making, carrying and breaking a 20-ampere, 120-volt, AC, traffic signal lamp load through ten thousand (10,000) cycles at the rate of ten (10) cycles per minute. The cycle shall be fifty (50) percent on and fifty (50) percent off.

2. Overload Test. Overload test shall consist of the following:

Relay shall be electrically and mechanically operative after a momentary current of 100 amperes, 120 volts, AC, is applied to each set of closed contacts at least five (5) times with a minimum of two (2) minutes between applications of current.

Relay shall not break down or flashover while carrying a load of 30 amperes, 120 volts for at least fifty (50) cycles at the rate of five (5) cycles per minute. Cycle shall be fifty (50) percent on and fifty (50) percent off.

3. Dielectric Strength Test. Relays shall withstand a potential of 1,500 volts at 60 Hz. between insulated parts and between current carrying parts and grounded or non-current carrying parts.

623.02.25D Special Auxiliary Equipment. Special auxiliary equipment shall be furnished and installed when shown on the plans or when required to perform specified functions, some of which are as follows:

(a) Overlap Relays. Relays shall be installed to provide overlap shown in phase diagrams. Overlap relays shall be the same types as specified for external light relays in subsection 623.02.25C(b), "External Light Relays for Controllers."

(b) Special Timing. Interval timers shall be installed for special timing.

(c) Pedestrian Interval Timers. Interval timers shall be installed for pedestrian actuation, which may be operated in conjunction with the time extension traffic actuated controllers to provide a minimum green interval of suitable length for pedestrian movement and pedestrian clearance.

The pedestrian interval timer assembly shall provide the following sequence of operation:

Steady "WALK" interval.

Flashing "DON'T WALK" clearance interval.

Steady "DON'T WALK" interval.

Flashing "DON'T WALK" indication shall occur during the pedestrian clearance interval and shall be accomplished by a separate flasher. The flasher for the pedestrian interval timer assembly shall conform to the provisions in subsection 623.02.25C(a), "Flasher and Flasher Relay."

Where Type I, Type II, or Type V controller units are used, flashing "DON'T WALK" indication shall occur during the pedestrian clearance interval and shall continue until the beginning of the vehicle yellow interval.

This equipment shall be designed to provide the following functional operations as related to one of the phases of the controller. The equipment shall be so designed that two or more pedestrian interval timers may be used for pedestrian movements associated with other phases of controller unit, if desired.

In the absence of actuation of the pedestrian push buttons, the traffic actuated controller unit shall respond to vehicle actuation in accordance with its dial settings and without regard to the pedestrian interval timer.

Actuation of the pedestrian push buttons with the controller unit showing red to the traffic phase associated with the pedestrian movement, shall place a call for right of way on said phase.

When the right of way is next given to the selected phase, the pedestrian interval timers shall time a pedestrian interval and a pedestrian clearance interval of selected durations. The length of these intervals shall be readily adjustable.

Signal circuits shall be provided for the display of "WALK" indication during the pedestrian interval and for "DON'T WALK" indication during the pedestrian clearance interval. In addition to the display of the "DON'T WALK" indication during the pedestrian clearance interval, the "DON'T WALK" indication shall be maintained at all times except when the pedestrian "WALK" indication is displayed.

Means shall be provided whereby the extension functions or minimum green functions of the traffic actuated controller unit may be operated in such a manner as to guarantee the display of the green vehicular signal to the selected phase for a period equal to the sum of the pedestrian interval plus pedestrian clearance interval.

Actuation of pedestrian push buttons during any part of right of way interval associated with the pedestrian movement or clearance shall not change the length of said intervals.

Actuation of a pedestrian push button during the pedestrian clearance interval or at any other time while the pedestrian "DON'T WALK" indication is being displayed,

shall register the presence of said pedestrian. This actuation shall be remembered so that the pedestrian "WALK" indication will be accorded at the next opportunity in the normal cycle of the traffic controller unit.

In the event of a registered pedestrian actuation on a selected phase with no demand for pedestrian or vehicular right of way on an opposing phase or phases of the vehicle actuated controller unit, the pedestrian interval timer shall be capable of recycling and providing pedestrian and pedestrian clearance intervals with associated pedestrian signal indications.

In the event of a pedestrian requirement for right of way on a phase having the green light but with demand for the right of way on an opposing phase of the vehicle actuated controller unit, the pedestrian interval timer shall remember said pedestrian actuation and call for the necessary pedestrian intervals after the vehicle actuated controller unit has served the opposing demands.

The pedestrian interval timer shall be enclosed in a metal case. It shall be equipped with suitably tagged leads to allow the addition of the equipment to existing traffic actuated controller units. It shall be so designed that all connections from the housing terminals to the pedestrian interval timer can be made by inserting a multi-terminal plug into the plug receptacle incorporated in the unit.

The pedestrian interval timer shall be designed for operation on 120 volts, 60 Hz. and shall have power consumption not to exceed 10 watts.

In lieu of a separate pedestrian interval timer, the pedestrian interval timing as described in this subsection may be included as an integral part of the traffic signal controller unit.

(d) Directional Detector Relays. A directional detector relay unit shall be installed for each phase using directional detectors.

(e) Calling Detector Relays. A calling detector relay shall be installed for each phase using a calling detector to eliminate a call from the calling detector to the controller unit during its associated green interval.

(f) Telephone Relays. Each telephone relay for interconnection shall be single-pole, single-throw, with normally open contacts rated at 1½ amperes, 120 volts, and with coil rated at 10,000 ohms, DC, and current sensitive to energize at a minimum of 2 milliamperes. The relay shall be sealed with a dustproof enclosure having a plug-in base for a standard octal socket.

Two ½ ampere fuses shall be installed in the telephone circuit. A four inch by four and one half inch by three inch (4″ x 4½″ x 3″) sheet metal enclosure with a fiber board barrier separating the AC and DC circuits shall house the components specified in this subsection within the controller cabinet.

(g) Test Switches. Test switches shall be installed in the controller cabinet to place calls on each phase. Test switches shall conform to the provisions in subsection 623.02.38, "Pedestrian Push Buttons," shall be mounted on a single readily accessible bracket, and shall be identified with labels.

(h) Toggle Switches. Toggle switches shall have poles as required and shall be rated at 20 amperes minimum per pole at 120 volts, AC.

(i) Tumbler Switches. Tumbler switches shall have poles as required, shall be specification grade and shall be T rated at 15 amperes minimum per pole at 120 volts, AC.

(j) Cartridge Fuses. Cartridge fuses shall be installed in panel mounted, indicating type fuse holders. Fuse type and rating shall be as recommended by the fuse manufacturer for the type of load being protected.

(k) Circuit Breakers. Circuit breakers shall be as specified for service switches in subsection 623.02.11, "Service."

(l) Interconnect Isolation Relay Unit. An interconnect isolation relay unit, capable of electrically isolating direct interconnected traffic signal systems, shall be furnished and installed on the controller cabinet wall at each local intersection in the interconnected traffic signal system.

Each isolation relay unit shall consist of a housing, terminal block, miniature relays, sockets and fuseholders

with integral function lights. One relay, fuse and light shall be provided for each assigned function.

Housing shall be fabricated of noncorroding sheet metal and shall have a maximum volume of two hundred (200) cubic inches and approximate dimensions of four inches by four inches by twelve inches (4″ x 4″ x 12″).

Terminal block shall be internally mounted at the rear of the housing and shall be easily accessible. Separate interconnect conductors or cable shall enter and leave the unit via the terminal block.

Each miniature relay shall be enclosed, triple-pole, double-throw type, rated 120 volts, 60 Hz. with a minimum contact rating of 10 amperes. Each relay shall be mounted on an 11-pin, standard plug-in type base on the outside top of the housing. Relays shall be permanently marked to indicate the coil voltage.

Fuseholders with integral function lights shall be mounted on the field removable front panel of the housing. The function lights shall be clearly visible and shall be illuminated when the respective relay is energized.

Terminal block, relays and function lights shall be labeled to identify the specific function performed.

(m) Three-Dial, Multi-Phase Coordinating Units. Three dial, multi-phase coordinating units shall conform to the following:

For definition purposes in this section only, traffic phases shall be considered as running in sequence; such as, A–B–C–D, etc. Also, any of these phases may consist of two separate auxiliary movements which must begin simultaneously but may end at different times as long as the following phase is the auxiliary's associated through phase.

1. Coordinating units to be installed shall be equipped and wired to provide the following:

a. Three dials.

b. Three offsets per dial.

c. Two sets of permissive periods. Each set of permissive periods shall consist of a short permissive period for pedestrians and vehicles and a longer variable length permissive period for vehicles only. The second set of permissive periods shall be for Phase C calls only.

d. Three maximum limits.
e. Free operation.
f. Offset interruption.
g. When Phase B is skipped, the controller shall remain in Phase A until the second permissive period occurs.

2. Cycle lengths shall be set up on the coordinating unit by installing gears of the proper size. Three sets of the following gears shall be furnished with each coordinating unit:

One 60-second gear
One 70-second gear
One 80-second gear
One 90-second gear
One 100-second gear
One 110-second gear
One 120-second gear

Units shall be so designed that gears may be easily removed or installed.

Motors for dial units shall be rated at a minimum of five watts and shall be of the self-starting synchronous type.

Closing of a contact or any number of contacts up to four simultaneously shall cause no variation or hesitation in the rotational speed of the motors, gears or dial unit.

Except for those parts internal to a totally enclosed replaceable motor assembly, no shaft in the motor gear train, except armature spindle, shall be less than 0.125-inch in diameter, no gear shall be less than 0.045-inch in thickness, and no bearing plate shall be less than 0.0625-inch in thickness.

Each coordinating unit shall have three motors. There shall be an off-on switch for each motor.

3. Offsets shall be capable of being set without the use of tools and from the front panel of the coordinating unit.

All offsets shall be adjustable in one (1) percent steps to any percentage of the asociated cycle length and the offsets so set shall be clearly indicated.

4. Each coordinating unit shall provide two sets of permissive periods. The first permissive period of each set shall be for pedestrian and vehicle calls. This period shall be long enough to permit placing calls and does not have to be adjustable. The second permissive period of each set shall be adjustable and for vehicle calls only. If the first set of permissive periods is utilized, the second set shall become disabled and shall remain disabled until the coordinating unit has returned to the first set of permissives. Pedestrian calls received during Flashing Phase A "DON'T WALK" or Phase A "YELLOW" shall receive their indication on the following associated vehicle "GREEN" if yield occurred during or before the pedestrian permissive period.

5. The maximum limit circuits shall be an integral part of the coordinating unit. The maximum limit circuits (force-offs) shall be adjustable in one (1) percent steps. The first force-off shall operate on Phase B only. The second force-off shall operate on Phase C only. The third force-off (if specified) shall operate on Phase D only. The regular maximum interval of the local controller (set in seconds) shall still be operable. Whichever maximum, percentage or seconds, is timed out first shall terminate the associated green phase.

6. The coordinating unit shall be able to select free (non-coordinated) operation when called for by the master controller, by local time switch, or when a specific cycle or offset is called for.

By suitable connections at the local controller, free operation may be omitted. In this case, when the master controller calls for free operation, the local coordinating unit shall operate in dial number one and the associated average offset.

Offset change, dial transfer, and transfer from free to coordinated operation shall take place at the first yield point.

7. Each coordinating unit shall have an adjustable (0–40 seconds) offset interrupter provided. The interrupter shall be calibrated in five (5) second designations.

When the local coordinating unit, for any reason, gets

out of synchronization with the master synchronized system, the length of the dwell in any one cycle shall be limited to the time allowed by the offset interrupter. Timing shall start at the beginning of the dwell.

A switch shall be provided which will eliminate the offset interrupter completely.

8. Each coordinating unit shall be plug-connected, and it shall be possible to remove a unit and replace it with a similar unit without shutting off the power to the controller or signals. Removal of the coordinating unit and insertion of the coordinating unit harness receptacle into a shorting plug, which shall be mounted on the cabinet wall, shall cause the local controller to go to free operation.

9. At local intersection ("Slave") locations a switch shall be provided for selection of free operation, coordinated operation, Dial Number 1, Dial Number 2, or Dial Number 3. Synchronization shall only be in effect in the coordinated position.

10. An indicator light shall be provided at the local coordinating units to indicate the synchronization period.

11. Absence of offset or dial information on the interconnect shall place the coordinating unit in Dial Number 1.

12. If there are any skip positions in the cam knockout, the first skip position shall be located between the first force-off and the second force-off. All the remainder of the skip positions shall be located between the last force-off and the beginning of the first set of permissive periods.

13. When the controller is working in coordinated operation, the internal maximum of the controller for Phase A shall be disabled. At all other times, the internal maximum of the controller shall remain operable.

623.02.25E Traffic Actuated Controller Cabinet. Each traffic actuated controller unit and auxiliary equipment shall be housed in a weatherproof aluminum, steel, or other approved metal cabinet or cabinets, as shown on the plans, of sufficient size to contain the controller unit, all auxiliary equipment, terminal blocks, and the following fittings:

Substantial shelves or brackets to support controller unit and auxiliary equipment.

Control panel assembly where shown on the plans consisting of:

(a) Controller switch shall be wired to energize the controller timing circuits while the signal lights are off or are being operated by flasher. Switches shall be labeled and rated for load current.

(b) Three-wire, 15-ampere, NEMA standard plug receptacle with grounding contact.

(c) Fuse receptacle or circuit breaker.

Two or more insulated terminal blocks shall be provided for terminating field conductors. Each block shall be provided with twelve (12) poles with ten to thirty-two (10–32) screw type terminals. The terminal block shall be a barrier type with shorting bars in each of the twelve (12) positions and with integral type marking strips.

All terminal blocks shall be provided with nickel, silver, or cadmium plated brass binder head screw terminals.

Conductors from the controller unit shall terminate in "ring" type terminal lugs or shall be soldered to a through panel solder lug on the rear side of the terminal. All other conductors shall terminate in "spade" type terminal lugs.

Terminal blocks rated 1,000 volts, RMS maximum, 20 amperes, may be provided for connecting cables from the controller unit and conductors from external solid-state logic circuits. Conductors shall be secured to the terminal blocks with six (6) thirty-two by one-fourth (32 x ¼) inch bead screws.

No more than three conductors shall be brought to any one terminal. Two flat metal jumpers, straight or U shaped, may also be placed under a terminal screw. At least two full threads of all terminal screws shall be fully engaged when the screw is tightened. No live parts shall extend beyond the barrier.

Field terminals shall be installed on a channel support running from one side of the door opening to the other. Terminals shall be under the front edge of the shelves and shall be oriented for screwdriver operation straight in from

the door opening. Terminals shall be a minimum of six (6) inches above the foundation.

The cabinet shall have a main door, which shall be equipped with a keyed tumbler lock, and an auxiliary door equipped with lock for police key. Two keys shall be furnished for each lock. Each police key shall have a shaft at least one and three-fourths (1¾) inches in length. Door hinge pins shall be made of stainless steel.

The cabinet shall be installed with the back toward the nearest line of traffic.

A police panel shall be provided behind the auxiliary door and shall contain a switch labeled "Flash-Automatic" and a switch labeled "Main" "On-Off." Switch terminals on rear of main cabinet door shall be insulated so that no live parts are exposed.

Each controller cabinet door which is twenty-two (22) inches or larger in width or six (6) square feet or larger in area shall be provided with a stop to limit door opening to both ninety (90) and one hundred eighty (180) degrees, plus or minus ten (10) degrees. The stop shall be provided with a catch which can be operated when the door reaches the extreme open position and will hold the door open securely until released.

Each controller cabinet shall be provided with eight (8) screened, raintight vent holes, one-half (½) inch in diameter or larger, in the lower back side or bottom of the cabinet, or at the option of the Contractor, louvered vents with a glass fiber air filter, which will permit the fan to pass the volume of air specified in this subsection, may be substituted.

A pliable seal, composed of caulking compound or mastic, shall be placed between each controller cabinet and the concrete slab foundation to prevent dust and dirt from entering the cabinet.

Where the cabinet is mounted on a concrete pedestal foundation, a one (1) inch drain hole or pipe, with screen, shall be placed in the foundation connecting to the cabinet and emptying above the ground line.

Each controller cabinet with inside volume less than

seven (7) cubic feet shall be equipped with an electric fan with ball or roller bearings and a capacity of at least fifty (50) cubic feet per minute.

Each controller cabinet with inside volume seven (7) cubic feet or larger shall be equipped with an electric fan with ball or roller bearings and a capacity of at least one hundred (100) cubic feet per minute.

The fan shall be mounted in a raintight housing attached to the top of the controller cabinet.

The fan shall be thermostatically controlled and shall be manually adjustable to turn on between ninety (90) degrees Fahrenheit and one hundred fifty (150) degrees Fahrenheit with a differential of not more than ten (10) degrees Fahrenheit between automatic turn on and turn off. The cabinet fan circuit shall be fused at one hundred twenty-five (125) percent of the ampacity of the fan motor installed.

The fan and cabinet vent holes shall be located with respect to each other so as to direct the bulk of the air flow over the controller unit or through the ventilating holes of the controller unit where such holes exist.

Conductors and cables in controller cabinet shall be as specified in subsection 623.02.08, "Conductors."

When an electro-mechanical controller unit supplied by the Contractor has terminal plugs different than those on the same type controller now in general use by the Division of Highways, the Contractor shall provide a harness which will permit interchangeability of the controller units. The cabinet shall be provided with sufficient space to permit interchanging of controller units.

623.02.26 (Blank).

623.02.27 (Blank).

623.02.28 (Blank).

623.02.29 (Blank).

623.02.30 Pre-Timed Controller Units. Pre-timed controller units shall be the expansible type designed to

permit the installation of plug-connected dial units without additional wiring or modification of the controller unit. Controller units shall be 1-dial, 2-dial, or 3-dial. The types of pre-timed controller units, number of dials, cabinets and auxiliary equipment shall be as shown on the plans or specified in the special provisions.

(a) Controller Units. Pre-timed controller units shall be of the following types:

1. Type XXV Controller Units. Type XXV controller units shall be the future interconnected type and shall be capable of being operated as future units in an interconnected, master controlled flexible progressive system by the addition of easily installed auxiliary attachments.

2. Type XXVI Controller Units. Type XXVI controller units shall be the interconnected type; shall be capable of being operated as units in an interconnected, master controlled flexible progressive system; and shall have three (3) offsets per dial, unless otherwise specified in the special provisions.

3. Type XXVII Controller Units. Type XXVII controller units shall be the combined master and intersection interconnected type and shall be similar to Type XXVI controller units, except that the Type XXVII shall be equipped with master offset supervision, dial change, offset selection and flashing operation of the intersection controllers.

(b) Operations. All pre-timed controller units shall be capable of being operated by manual control; as a pre-timed controller of the independent, isolated type; and as a synchronous-motor-driven coordinated type, for progressive timing without interconnecting circuits.

(c) Mechanism for Pre-Timed Controller Units. Mechanism for pre-timed controller units shall be constructed as a complete, self-contained, readily interchangeable unit arranged to swing out for inspection while in operation. All parts shall be readily accessible.

All circuits of each unit shall be terminated in a multiple-contact connector. Connection between the connector and the panel or field terminal board shall be by means of a

flexible cable. Panel or field terminal board end of the conductors shall be fitted with proper terminals. Each field terminal shall be identified.

(d) Motor and Dial. Controller unit motor shall be of the self-starting, synchronous type, and shall have ample torque for the requirements of the controller operation.

All intervals in each phase shall be readily adjustable by a suitable dial on the face of the controller unit. Intervals shall be adjusted in steps not to exceed one (1) percent of the total cycle by means of self-retained timing keys.

Each dial unit shall consist of motor, dial with slots for timing keys, contact block, motor switch, and connector for plug-in mounting of the entire dial unit assembly. Design of the dial unit shall allow gear changing without tools or with simple tools. The cycle length of the gear used shall be indicated on the face of the dial unit when the gear mesh is correct. Gears shall be brass.

A suitable dust cover shall be provided for the timing mechanism. Dial key settings shall be visible without the necessity of removing the cover.

Color code of dial keys shall be as follows:

Drum Release	Green
Drum Advance	Unpainted
Offset 1	Red
Offset 2	Yellow
Offset 3	White

(e) Signal Contact Mechanism. All parts of the contact mechanism for signal lights, including contacts and contact supports, shall operate one million (1,000,000) times without mechanical wear that impairs normal operation.

All signal light contact points shall be of fine silver, silver alloy, or superior alternative material not less than five-sixteenths ($\frac{5}{16}$) inch in diameter; shall be of not less than 10-ampere capacity, capable of operating one million (1,000,000) times without excessive burning or pitting; and shall be easily removed and replaced.

Cam or drum assembly shall provide not less than twelve (12) intervals, all necessary contacts, and provisions for

not less than a total of fourteen (14) signal light contacts. Wiring shall be complete from terminal strip to each contact position.

(f) Auxiliary Equipment. Each pre-timed controller unit shall be equipped with a complete set of brass gears for each dial fifty (50) to one hundred twenty (120) seconds, inclusive, in ten (10) second steps.

1. Controls. Switches shall provide local control of the following functions:

a. Transfer from automatic to manual operation and vice versa.

b. Transfer from normal operation to flashing and vice versa.

c. Transfer from one dial to another.

d. Turn-off signal lights only without shutting down controller unit mechanism.

e. Shutdown timer mechanism.

Combined master and intersection controller units shall have additional switches properly marked for Functions (B) and (C) above and for offset selection for the interconnected system. Switch for local control of Function (C) is not required at the master.

Combined master and intersection controller units shall also have provisions for time switch or program device control of Functions (B) and (C) above and for offset selection for the interconnected system.

Interconnected controller units shall have relays and wiring for remote control of Functions (B) and (C) above and for offset selection.

Future interconnected controller units shall have provisions for local time switch control of Functions (B) and (C) above and for offset selection.

2. Offset Interrupter. Each Type XXVI controller unit shall be provided with an offset interrupter which, during reset of time cycle to the master synchronization pulse, shall limit the length of the dwell in any one cycle. Interrupter shall have five (5) second, minimum, increments, and shall have a range of forty (40) seconds, minimum.

Timing adjustments shall be made without the use of tools and shall have an accuracy of plus or minus ten (10)

percent of the setting over the full range. Timer shall be plug-in mounted.

A switch shall be provided to bypass the interruption feature.

Removal of the interrupter shall not affect the operation of the Type XXVI controller unit.

3. Flashers. Each pre-timed controller unit shall be wired and furnished with a plug-in-mounted flasher and provisions for jack-mounted relays conforming to the provisions in subsection 623.02.25, "Flasher and Flasher Relay."

Plug-in-mounted flasher and jack-mounted relays for flasher shall be independent of the controller unit and shall remain in operation upon the shut down of the controller or removal of the controller unit from the cabinet.

4. Manual Control. Each pre-timed controller unit shall be provided with labeled terminals for a hand switch.

5. Mounting Panel. A readily accessible mounting panel shall be furnished in each pre-timed controller cabinet, with adequate provisions for terminating all field circuits and for mounting fuses and relays. Each power and direct wire interconnect circuit, except neutrals, shall be fused.

(g) Special Auxiliary Equipment. The following special equipment shall be furnished and installed when required to perform specified functions when specified in the special provisions or when shown on the plans:

1. Time Switches. Time switches to control system or local flash, dial change, or other specified functions shall be synchronous motor driven; shall be equipped with ten (10) hour spring wound reserve carryover; shall be equipped with an omitting device; and shall provide for at least three (3) openings and three (3) closings per twenty-four (24) hour period. Mechanical and electrical characteristics shall be equal to those specified in subsection 623.02.30(c), "Mechanism for Pre-timed Controller Units."

2. Railroad Pre-emption. Railroad pre-emption relays, when required, shall perform the operations provided in subsection 623.02.20, "Railroad Pre-emption."

3. Telephone Relays. Telephone relays shall conform to the provisions in subsection 623.02.25D(f), "Telephone Relays."

4. Toggle Switches. Toggle switches shall conform to the provisions in subsection 623.02.25D(h), "Toggle Switches."

5. Cartridge Fuses. Cartridge fuses shall conform to the provisions in subsection 623.02.25D(j), "Cartridge Fuses."

6. Circuit Breakers. Circuit breakers shall be as specified for service switches under subsection 623.02.11, "Service."

7. Interconnect Isolation Relay Units. Interconnect isolation relay units shall conform to the provisions under subsection 623.02.25D(l), "Interconnect Isolation Relay Unit."

(h) Pedestrian Signal Sequence. The controller unit shall provide the following sequence of operations for pedestrian signals:

Steady "WALK" interval.

Flashing "DON'T WALK" clearance interval.

Steady "DON'T WALK" interval.

On pedestrian signal installations where pre-timed controller units are used, flashing "DON'T WALK" indication shall occur during the pedestrian clearance interval and shall continue until the beginning of the vehicle yellow interval.

Flashing "DON'T WALK" indication shall be accomplished by the light cam assembly and a separate flasher. The flasher shall conform to the provisions in subsection 623.02.25C(a), "Flasher and Flasher Relay."

(i) Pre-Timed Controller Cabinet. Each pre-timed controller unit and auxiliary equipment shall be enclosed in a weatherproof metal cabinet.

The cabinet shall be fitted with a master-keyed, police lock and shall be mounted on a pedestal, as shown on the plans. Two keys with shanks at least one and three-fourths (1¾) inches long shall be furnished for each cabinet.

The cabinet shall be fitted with a slip-fitter attachment to permit post-top mounting as shown on the plans.

One screened, raintight vent, one and one-half (1½) inches in diameter, or larger, shall be installed in the top of the controller cabinet and eight screened, raintight vent holes one-half (½) inch in diameter, or larger, shall be provided in the lower backside or bottom of the controller cabinet.

Each controller cabinet door which is twenty-two (22) inches, or larger, in width or six (6) square feet, or larger, in area shall be provided with a stop to limit door opening to ninety (90) and one hundred eighty (180) degrees plus or minus ten (10) degrees. The stop shall be provided with a catch which can be operated when the door reaches the extreme open position and will hold the door open securely until released.

623.02.31 Solid-State Traffic Actuated Controller Units. Solid-state traffic actuated controller units for traffic signal systems shall conform to the following:

(a) General. Each solid-state, traffic actuated controller unit, with auxiliary equipment, shall operate various traffic signal devices as shown on the plans, to provide right of way, clearance and other indications, with duration and sequence as determined by preset programming and traffic demand.

Details of operation for the complete controller shall be in accordance with the traffic phases, preferential phase sequence and concurrence, signal indications, signal indication sequence, detection requirements and other details shown on the plans or as specified in the special provisions.

Each controller unit shall be capable of skipping actuated phases for which there is no traffic demand.

(b) Physical Description of Controller Units. Each type of controller unit shall be a fully integrated, solid-state electronic device. Each unit shall be housed in a compact portable enclosure with front panel or panels having manually variable program controls, indicator lights, fuseholder, and multiple circuit connector or connectors, for input and output circuits.

The following equipment shall be provided external to the controller unit:

1. All devices required for connecting, switching, protecting, and monitoring 120-volt AC for signal devices.
2. Radio interference suppressors.
3. Cabinet accessories.
4. Test pushbuttons for vehicle detector and pedestrian timing circuits, unless provided on the front panel of the controller unit.
5. Other auxiliary equipment as required or as specified in the special provisions or shown on the plans.

(c) Controller Unit Phase Sections. The term "phase section" applies to that electrical portion or program of the controller unit with its manually variable program controls, which provides control of right of way and clearance interval timing and other functions for a particular traffic phase.

Phase sections may be modular as specified in subsection 623.02.31(i), "Controller Unit Types," and as defined in subsection 623.02.31(g), "Mechanical Design and Component Quality."

(d) Phase Section Timing Intervals and Periods. The operational features and timing ranges of the various timing intervals and periods shall be as listed in this subsection. Timing ranges shown are minimal and may be expanded. The timing intervals and periods required for particular types of controllers are covered in subsection 623.02.31(i), "Controller Unit Types."

Timing shall be accomplished by digital methods and shall utilize the power line frequency or a frequency generated by a crystal controlled oscillator as a time base.

1. Green Interval Timing Periods. The following green interval timing periods may be accomplished by timing and programming techniques differing from those specified, provided total green intervals (and ranges of total green intervals) vary less than plus or minus ten (10) percent from those produced by a controller unit using the specified techniques. This variation shall not be exceeded regardless of the pattern of detector input actuations applied simultaneously to the "comparison" and

"test" controller units. All comparison testing of this nature will be done with normal or practical actuation patterns and settings of program controls.

The program control panel shall be clearly labeled to indicate the principle of operation.

a. Non-Actuated Phase Section.

(1) Minimum Green Period. The green interval shall commence with minimum green period. The minimum green period shall be adjustable from ten (10) to sixty (60) seconds.

(2) Rest Condition. The minimum green period shall be followed by a rest condition, which shall exist until there is a demand on an opposing phase or until released by a coordinating system.

(3) Pedestrian Periods. A "WALK" period shall occur automatically and simultaneously with the associated minimum green period and rest condition.

A flashing "DON'T WALK" clearance period, adjustable from five (5) to thirty (30) seconds, shall follow the "WALK" period.

b. Actuated Phase Section.

(1) Initial Period. The green interval shall commence with a preset initial period, which shall be adjustable from two (2) to thirty (30) seconds.

(2) Extensible or Added Initial Period. An extensible initial period shall begin timing simultaneously with the initial period and shall override the initial period if the extensible initial period exceeds the length of the initial period. The length of the extensible initial period shall be approximately proportional to the number of actuations received during the red interval for that phase. The extensible initial period shall be subject to an adjustable limit not to exceed one hundred twenty (120) seconds.

In lieu of the above extensible initial period an added initial period may be provided which shall begin timing at the end of the initial period. The length of the added initial period shall be approximately proportional to the number of actuations received during the red interval for that phase. Each phase shall be capable of providing a

maximum added initial period of not less than twenty-five (25) seconds.

(3) Rest Condition. The extensible period shall be followed by a rest condition.

(4) Pedestrian Periods. A "WALK" period and a flashing "DON'T WALK" clearance period shall occur only in response to pedestrian push button operation. Said periods shall commence timing at the beginning of the green interval and shall time concurrently with and, if necessary, override the initial period, except that when a pedestrian push button actuation is received by a phase section in the rest condition, the proper pedestrian periods shall be repeated without change in vehicle indications. Successive pedestrian push button actuations during the pedestrian period shall not cause extension of that period.

The "WALK" period and the "DON'T WALK" clearance period shall each be adjustable from two (2) to thirty (30) seconds.

(5) Extensible Portion. Gap Periods, and Maximum Green Period. The initial period (including the pedestrian periods in event of pedestrian push button actuation) shall be followed by the extensible portion of the green interval.

(A) Preset Gap Period. The extensible portion shall be held by successive detector actuations until the time spacing between two (2) successive actuations exceeds the preset gap period. Termination of green interval by the preset gap period shall not place a call for return to the terminated phase. The preset gap period shall be adjustable from one (1) to ten (10) seconds.

(B) Reducible Gap Period. The reducible gap period shall begin timing with the extensible portion and shall function like the preset gap period but shall assume control only when its length becomes less than that of the preset gap period. The length of the reducible gap period may vary over a waiting period from an initial value of less than thirty (30) seconds to a preset minimum gap period. The minimum gap period shall be adjustable from one (1) to ten (10) seconds, and the waiting period shall be adjustable from twenty (20) to fifty (50) seconds.

Phase sections with a reducible gap period shall have a "guaranteed passage time feature." This feature shall work as follows:

When the time spacing between two (2) successive actuations exceeds the gap period the green interval shall be extended for a length of time equal to the difference between the reduced gap period in effect at that time and the preset gap period. This feature shall be capable of being omitted without internal circuit modification.

(C) Maximum Green Period. The green interval shall be subject to an adjustable limit called "maximum green period." The timing of this period shall commence (1) at the beginning of the green interval if a call for another phase has been previously registered, or (2) at the beginning of the green interval if a call is registered during the initial period, or (3) at the time the first call for another phase is registered if the rest condition has been reached, or (4) a maximum green extension may commence at the end of the initial period if a call has been registered.

Termination of green by the maximum green period shall place a call for return to that phase. The maximum green period shall be adjustable from ten (10) to ninety-nine (99) seconds.

2. Vehicular Clearance Interval Timing Periods. The green interval shall be followed by a vehicular clearance interval. The clearance interval shall consist of a yellow period and an omissible all-red period. The yellow clearance interval shall be followed by a minimum one (1) second red interval.

The yellow period shall be adjustable from two (2) to seven (7) seconds. The all-red period shall be adjustable from zero (0) to six (6) seconds.

(e) Miscellaneous Controller Unit Features and Functions.

1. Standard Functions. Each standard function shall be brought to an external terminal strip through the regular controller connector and wiring harness. The connector pin for each function shall be the pin used for the same function on all similar model controllers of the

same manufacturer. Each controller shall be provided with the following functions:

a. Memory Features. Vehicle detector actuations received by an actuated phase section when the red or yellow indication for that traffic phase is displayed shall be remembered and shall cause the controller unit to provide right of way indications for that traffic phase at the next opportunity in the normal phase sequence. A switch shall be provided for disabling the memory circuit. Said switch may be located externally.

Pedestrian push button actuations received by a phase section when the steady or flashing "DON'T WALK" indication for that traffic phase is displayed shall be remembered and shall cause the controller unit to provide "WALK" indications for that traffic phase at the next opportunity in the normal phase sequence of the controller unit.

b. Recall. Various switch-controlled recall features shall be provided for each actuated phase section. With the recall switch or switches in the "OFF" position, the phase section shall function normally with the right of way being granted to that traffic phase only upon vehicle or pedestrian actuation or both. With a recall switch in the "VEHICLE RECALL" position, the effect of a remembered vehicle detector actuation shall be attained.

With a recall switch in the "PEDESTRIAN RECALL" position, the effect of a remembered pedestrian push button actuation shall be attained.

With a recall switch in the "MAX" position, the phase section shall be held in the green interval for the maximum green period.

Maximum position will not be required for Type 50 or Type 60 controller units.

c. Manual Circuit. The manual circuit function shall permit manual advancing of the controller unit. The function may operate in either of the following manners:

(1) The controller unit shall advance one timing interval with each pulsing of the manual circuit, except that the controller unit may be wired to permit timing of complete yellow and all-red clearance intervals if programmed.

(2) The controller unit shall be provided with circuitry which will permit immediate advancing to any one of the timing intervals of any phase.

d. Stop-Timing. Energization of the stop-timing function shall cause the controller unit to stop timing that interval or period in effect when the function was initiated. The interrupted interval or period shall be completely timed or the unexpired portion shall be timed following release of stop-timing.

e. Hold. Energization of the hold function of a phase shall hold the phase in the rest condition. Upon release from "HOLD," the phase shall immediately advance into the yellow clearance period, the unexpired portion of the pedestrian protection period or to the unexpired portion of the vehicle interval provided there is an opposing call.

f. Special Termination or "Force-Off." The special termination or "force-off" feature shall permit termination of green by external command provided the phase section is in the extensible portion. Termination shall operate in the same manner as maximum green period termination.

g. Indicator Lights. An indicator light shall be provided to indicate each timing interval or period in effect.

Additional indicator lights shall be provided to denote:

(1) Reason for termination of vehicular green (gap period or maximum green period).

(2) Vehicular and pedestrian actuations.

Vehicular actuation indicator lights shall be illuminated to denote a registered waiting vehicle and may remain illuminated through the following initial portion, after which an indicator light shall be illuminated momentarily to denote individual actuations.

Pedestrian indicator lights shall be illuminated to denote a registered push button actuation and shall remain illuminated until the subsequent "WALK" period.

For each modular phase section, additional indicator lights shall also be provided to denote:

(1) That the particular phase is next in sequence.

(2) That the phase is in its green interval.

h. Check Circuit. Check circuit function shall be provided. The check circuit function may be included as an integral part of the controller unit or may be installed external to the controller unit. The check circuit function shall indicate to an external circuit that a vehicle or pedestrian actuation or a vehicle and pedestrian actuation has been registered on a phase or phases not displaying a green signal.

i. Simultaneous Termination. When separate phases which time concurrently are provided to control traffic in opposite directions on the same roadway, the controller shall seek a simultaneous gap in traffic on both phases except when there is a call in conflict with only one phase. Means shall be provided to disable this feature.

2. Special Features. When specified or when indicated on the plans, the following special features shall be provided. Said features may be operated by solid-state equipment external to the controller unit.

a. Mutual Coordination. Mutual coordination feature shall permit two (2) or three (3) controller units to mutually coordinate when interconnected. With this type of coordination, intersections having demand for other phases shall terminate their Phase A green intervals simultaneously, provided the minimum green intervals have been timed out at each intersection.

b. Dual Maximum Green Period. Dual maximum green period feature for a phase section shall permit the external selection of two (2) individually selectable and presettable maximum green periods. The second period may be controlled by solid-state equipment external to the controller unit.

c. Omit Skip. The omit skip feature shall permit cancellation by external control of the phase skipping ability of the controller unit.

d. Omit All-Red. The omit all-red feature shall permit the omission by external control of the all-red clearance periods either on all or on selected phases.

e. Selectable Semi-Actuated Mode. The selectable semi-actuated mode feature shall permit a phase section

to be changed to nonactuated operation at external command.

In nonmodular controller units, the phase to become nonactuated shall be designated Phase A. In this mode: (a) pedestrian operation for the modified phase or phases shall be as specified herein for a nonactuated phase, (b) the initial interval or the pedestrian "WALK" period shall become the minimum green period, (c) the maximum green period shall be disabled.

In modular controller units, the phase or phases to become nonactuated shall be designated Phase A or such other phase or phases as shown on the plans. Pedestrian operation shall be as specified above for nonmodular controller units. The minimum green period for the modified phase shall be the pedestrian "WALK" period plus the flashing "DON'T WALK" interval or the initial period plus one vehicle extension interval. The controller unit shall rest in the modified phase until released by an external command.

The controller, when operating in the semi-actuated mode with the actuated phase memory circuit disabled, shall indicate either of the following on the nonactuated phase displaying a vehicle green when an actuated phase has a momentary detector actuation:

(1) "DON'T WALK" flashes, a complete clearance interval times out, returns to "WALK" which shall remain for a normal time before yielding to another phase.

(2) "DON'T WALK" flashes momentarily and returns to "WALK."

This feature is not required for Type 50 controller units.

(f) Controller Unit Circuitry. All circuits, including logic or timing circuits external to the controller unit, shall consist entirely of solid-state electronic circuitry. No electro-mechanical devices, such as camshafts, rotary, stepping or line switches shall be used for switching functions.

Timing of the "yellow" and "all red" clearance intervals shall be capable of being set in one-half (½) second

maximum increments and shall be accurate to the power line frequency or crystal controlled time base.

Timing of the "preset gap period" shall be adjustable in one-half (½) second maximum increments.

Timing of the "reducible gap period" shall be adjustable in one-fourth (¼) second maximum increments.

Timing of all other adjustable intervals shall be adjustable in one (1) second maximum increments.

Calibration accuracy of each manually variable timing control, except clearance intervals, shall be accurate to the smallest selectable setting for the period involved if line voltage is at any value from 105 to 130 volts while the ambient temperature is between zero (0) degrees Fahrenheit and one hundred sixty (160) degrees Fahrenheit.

Controller unit operation shall be unaffected by transient voltages when tested in accordance with Test Method No. Nev. T800.

(g) Mechanical Design and Component Quality. Each controller unit shall be completely enclosed in a sheet metal case with a protective paint finish. The case shall be designed to provide convenient access to the entire interior assembly and permit removal of printed circuit boards or modules with minimum use of tools.

Manually variable program controls shall be arranged on a panel on the front of the controller unit, shall be clearly and permanently identified, shall be operable without the use of tools and shall give a clear visual indication of the preset program settings. Timing dials, if used, shall be linearly calibrated.

Modular controller units shall utilize one or more plug-in phase modules for each phase section. Each phase module with manually variable program controls and associated circuitry shall be assembled on a removable plug-in chassis. Modules shall be removable from the front. Modules of unlike function shall be mechanically keyed or electrically interlocked to prevent insertion into the wrong opening.

Each phase module opening shall be identified as to the traffic phase controlled, such traffic phase identification

shall be only that shown on the plans. Identification shall be by means of engraved or embossed labels. Each engraved label shall be either engraved into the front panel of the controller unit or module or shall be made from multilayer, color-contrasting plastic and shall either slide into a special holder or be secured with chrome-plated brass or stainless steel machine screws. Each embossed label shall be made from aluminum foil tape, with self-adhesive oil-resistant backing and raised symbols contrasting with the background color.

An alternate type of modular controller unit consisting of an enclosure having manually variable program controls for 8-phase sections will be acceptable. The number of active phase sections shall then depend upon the number of circuit modules that are plugged in. Other specified features for phase modules shall apply to circuit modules.

All electronic components shall be easily accessible and shall be arranged in functional grouping on printed circuit boards. Printed circuit boards shall be designed to facilitate identification of components. Identification shall be made either by part identification markings or by providing a pictorial diagram in the maintenance manual for the controller unit showing physical location and identification of each component. Each printed circuit board shall have the following minimum quality requirements: NEMA Grade G–10 glass cloth base epoxy resin board, one-sixteenth ($\frac{1}{16}$) inch minimum thickness, organic solder masking and gold plated contacts. Soldering shall be done using the wave soldering technique. Intercomponent wiring shall be copper track, with a minimum weight of two (2) ounces per square foot, with adequate cross section for current to be carried. Printed circuit design shall be such that components may be removed and replaced without permanent damage to board or tracks.

Solid-state logic or timing circuits, external to the controller unit, shall be built on edge connected, plug-in printed circuit boards. Logic circuits shall be built-up by plugging logic circuit boards into wired connectors. When five (5) or less plug-in logic circuit boards are used, the circuit board connectors may be installed in a chassis or

rack, mounted on a cabinet wall. Connectors shall be provided to permit removal of the chassis or rack without unsoldering connections or removing wires or cables from the cabinet. When more than five (5) plug-in logic circuit boards are used, the circuit board connectors shall be installed on a chassis designed for shelf-mounting. The chassis shall be provided with a Type MS connector and shall be shelf-mounted.

Each controller unit shall be designed to provide reliable service under conditions of continuous operation over an ambient temperature range of zero (0) degrees Fahrenheit to plus one hundred sixty (160) degrees Fahrenheit. All components, except indicator lamps, shall be operated well within their electrical and temperature ratings under the above conditions so their rated life will exceed five (5) years. Indicator lamps used in the controller shall have a minimum rated life of five thousand (5,000) hours.

Each connector or connectors for each controller unit shall be provided with either threaded shell or spring-loaded latch locking or, at the option of the Contractor, connectors may be provided with a minimum of two (2) stainless steel thumb screws for securing the connector or connectors in place.

Multiple circuit connector, or connectors for input and output circuits, may be mounted on the left or right side of the controller unit in addition to the front panel.

(h) Supply and Auxiliary Voltages. The nominal supply voltage of each controller unit shall be 120 volts, 60 Hz. During a supply voltage interruption not exceeding 0.5-second duration, the controller unit shall continue in cyclic operation and shall retain all actuations registered prior to the interruption, or auxiliary equipment shall cause the controller to go into the flashing operation specified in subsection 623.02.19, "Flashing Operations," for a period of not less than eight (8) seconds. Following a supply voltage interruption exceeding 0.5-second duration or at the expiration of the flashing operation specified above, signal operation shall resume or begin in the Phase A yellow clearance interval and calls shall be placed on all phases.

(i) Controller Unit Types. Timing periods and special features specified herein for each controller unit type shall be as defined in subsection 623.02.31(c), "Controller Unit Phase Sections," subsection 623.02.31(d), "Phase Section Timing Intervals and Periods," and subsection 623.02.-31(e), "Miscellaneous Controller Unit Features and Functions."

1. Type 50 Controller Unit. Type 50 controller unit shall be a 2-phase section, semi-actuated type, modular or nonmodular unit.

The non-actuated phase section shall be provided with the following timing periods: Minimum green, pedestrian clearance, yellow clearance, and all-red clearance. The actuated phase section shall be provided with the following timing periods: Initial, pedestrian "WALK" and clearance, preset gap, maximum green, yellow clearance, and all-red clearance.

Special termination (Phase B) and mutual coordination features shall be provided.

2. Type 60 Controller Unit. Type 60 controller unit shall be a 2-phase section, full-actuated type, modular or nonmodular unit.

Each phase shall be provided with the following timing periods: Initial, pedestrian "WALK" and clearance, preset gap, maximum green, yellow clearance and all-red clearance.

Special termination (Phase B) and selectable semi-actuated mode shall be provided.

a. Type 70 Controller Unit. Type 70 controller unit. Each phase shall be provided with the following timing periods: Initial, preset gap, maximum green, yellow clearance, and all-red clearance. Pedestrian "WALK" and clearance intervals shall be provided for at least two phases.

Timing of the preset gap period may be adjustable in one (1) second maximum increments.

Special termination (Phase B and Phase C) shall be provided.

Type 70 controller unit phase modules may be physically and functionally interchangeable through other frame sizes of the individual manufacturer's product.

3. Type 90 Controller Units. Type 90 controller units shall be modular types, each phase shall have timing periods and special functions as indicated on the plans as specified by the following type designations:

a. Type S Phase. Each Type S phase shall be provided with the following timing periods: Initial, preset gap, maximum green, yellow clearance, and all-red clearance.

b. Type SP Phase. Each Type SP phase shall be provided with the following timing periods: Initial, pedestrian "WALK" and clearance, preset gap, maximum green, yellow clearance, and all-red clearance.

c. Type D Phase. Each Type D phase shall be provided with the following timing periods: Initial, extensible or added initial, preset gap, reducible gap, maximum green, yellow clearance, and all-red clearance.

d. Type DP Phase. Each Type DP phase shall be provided with the following timing periods: Initial, extensible or added initial, pedestrian "WALK" and clearance, preset gap, reducible gap, maximum green, yellow clearance, and all-red clearance.

The above timing periods and special functions may be performed by using any number of functional modules.

Type 90 controller unit phase module types shall be physically and functionally interchangeable through all frame sizes (from 2 through 8 phases) of the individual manufacturer's product.

Each Type 90 controller unit shall be capable of providing D or DP functions by the addition or exchange of plug-in modules.

(j) Auxiliary Equipment for Solid-State Traffic Actuated Controller Units. The following auxiliary equipment shall be furnished and installed in each cabinet for solid-state traffic actuated controller units:

1. Flasher and Flasher Relay. Flasher and flasher relay shall conform to the provisions in subsection 623.-02.25C(a), "Flasher and Flasher Relay."

Relay bases and subbases for flasher relays shall be of the type normally used by the manufacturer of the control equipment provided. Relays shall conform to the functional requirements specified in subsection 623.02.-25C(b), "External Light Relays for Controllers."

Transfer to flashing operation shall be accomplished by relays between the normal load switching device and the field terminals.

2. Test Switches. Test switches shall conform to the provisions in subsection 623.02.25D(g), "Test Switches," and may, at the option of the Contractor, be included as an integral part of the Type 90 controller unit.

3. Solid-State Switching Devices. Signal light circuits shall be controlled externally to each solid-state controller unit by 3-circuit solid-state switching devices, which shall be plug-in mounted to a base as shown on the plans. Each circuit shall have a minimum rating of 1,000 watts for tungsten lamp or gas tubing transformer load at 120 volts, AC. Solid-state switching devices shall be unaffected by transient voltages when tested in accordance with Test Method No. Nev. T800.

4. Monitoring Device. A solid-state monitoring device shall be installed externally to each solid-state controller unit. The monitoring device shall, in the event of conflicting green signal indications (vehicular or pedestrian or both), cause the signal system to go into flashing operation and remove AC+ power from the signal light circuit within 0.5 second. The flashing operation shall lock-in and shall release only upon operation of a reset switch. Operation of the monitor shall energize the stop-timing circuit of the controller unit.

Conflicting green is defined as occurring when 24 volts, or more, at 60 Hz. appears for 500 milliseconds, or more, on any green circuit that is in conflict with the green circuit called for by a normally functioning controller unit. Conflicting greens lasting less than 200 milliseconds, or a conflicting voltage of less than 10 volts shall not cause the monitoring device to place the signal system in flashing operation.

Controller logic voltage shall be monitored and, if voltage drops to a value where controller or auxiliary equipment does not work properly, the signal system shall go into flashing operation.

Operation of the signal monitoring device shall disable all functions of the "Flash-Automatic" switch in the police panel.

When the controller is equipped with railroad preemption equipment, the system shall be wired to provide a flashing red on all phases upon operation of the monitoring device and power shall be removed from the railroad preemption equipment.

5. Police Panel Switches. The police panel shall conform to the provisions in subsection 623.02.25E, "Traffic Actuated Controller Cabinet."

6. Toggle Switches. Toggle switches shall conform to the provisions in subsection 623.02.25D(h), "Toggle Switches."

7. Tumbler Switches. Tumbler switches shall conform to the provisions in subsection 623.02.25D(i), "Tumbler Switches."

8. Cartridge Fuses. Cartridge fuses shall conform to the provisions in subsection 623.02.25D(j), "Cartridge Fuses."

9. Circuit Breakers. Circuit breakers shall be as specified for service switches under subsection 623.02.11, "Service."

(k) Special Auxiliary Equipment. Special auxiliary equipment shall be furnished and installed when required to perform specified functions, when shown on the plans or when specified in the special provisions. Special auxiliary equipment shall include, but shall not be limited to, the following:

1. Calling Detector Relays. A calling detector relay shall be installed for each phase using a calling detector to eliminate a call from the calling detector to the controller unit during its associated green interval.

2. Telephone Relays. Telephone relays shall conform to the provisions in subsection 623.02.28D(f), "Telephone Relays."

3. Special Timing. Each special timer shall provide the timing range shown on the plans, shall have a timing accuracy to the smallest timing increment and shall be easily adjustable with a calibrated setting device. Each special timer shall be a plug-connected solid-state digital device with an indicator light to show when the timer is operating.

Solid-state devices shall conform to the provisions in subsection 623.02.31(f), "Controller Unit Circuitry," and subsection 623.02.31(g), "Mechanical Design and Component Quality."

4. Detector Sensor Units. Detector sensor units may, at the option of the Contractor, be included as an integral part of the Type 90 controller unit if the performance characteristics specified in subsection 623.02.37, "Vehicle Detectors," are provided. The "Connector Circuitry" table in subsection 623.02.37(b)3, "Sensor Unit Construction," shall not apply to integral detector sensor units.

(l) Solid-State Traffic Actuated Controller Cabinet. Cabinet and fittings for the solid-state traffic actuated controller unit and auxiliary equipment shall conform to the provisions in subsection 623.02.25E, "Traffic Actuated Controller Cabinet."

In addition to the switches specified in subsection 623.-02.31(j)5, "Police Panel Switches," an internal panel mounted "Signal-Flash" switch shall be provided which, when placed in the "Flash" position, shall provide flashing operation as specified in subsection 623.02.19, "Flashing Operations," with the controller unit remaining energized but without energizing the stop-timing function as specified in said subsection 623.02.31(j)5. When said switch is placed in the "Signal" position, the controller unit shall resume control in the interval the controller unit happens to be in at the time the switch is operated.

Receptacles for relays and shelves, below all removable control equipment, contactors, switches, fuses, circuit breakers and all other equipment, shall be identified below each item with a permanent, printed, engraved or embossed label.

Wall mounted auxiliary equipment and wiring shall be installed on removable panels. Plug-in equipment shall be removable from receptacles without removing any other equipment. Each receptacle, or group of receptacles, and connecting cables shall be so arranged that by removing no more than six (6) fasteners it will be possible to perform any required work on the back of the receptacles or on the cables.

Convenience receptacle shall be a duplex, 3-prong, NEMA Type 5–15R grounding type outlet.

Each controller cabinet shall be provided with a fluorescent lighting fixture mounted on the inside top of the cabinet near the front edge. Fixture shall be provided with an F15T8, cool white, lamp operated from a normal power factor. UL listed ballast. An "ON–OFF" switch shall be provided on the inside control panel to operate the lighting fixture.

Machine screws used for mounting equipment on door or walls of the cabinet shall have nuts on the inside.

Conduit shall enter the controller cabinet at the front.

623.02.32 Type 100 Controller. Type 100 controller shall be solid-state, modular, digital circuit, lane occupancy type complete with all components required for controlling vehicular and pedestrian traffic control signals as specified in subsection 623.02.31(a), "General."

The words "Controller Units" as used in the various sections referred to in this subsection shall be construed to mean "Controller."

(a) Timing Periods. The following timing periods shall be provided:

1. Vehicle Green Period. The length of the vehicle green period shall be determined by the continued presence of a vehicle in the detection zone plus the addition of a preset green gap period which commences timing immediately after the detection zone becomes free of vehicles. Said extension interval shall be adjustable from one-fourth (¼) second to three (3) seconds (minimum range) and shall reset when interrupted by additional demand in the detection zone.

During a pedestrian "WALK" period, the minimum length of the vehicle green period shall coincide with the parallel pedestrian "WALK" and "DON'T WALK" clearance periods.

2. Maximum Green Period. The vehicle green period shall be subject to an adjustable limit called "Maximum Green Period."

The timing of this period shall commence at the beginning of the green period, at the time a call for an opposing phase is registered if the green period has commenced, or a maximum green extension may commence at the end of the initial period, where an initial period is provided.

The maximum green period shall be adjustable from ten (10) to sixty (60) seconds minimum.

3. Vehicle Clearance Period. The vehicle green period shall be followed by a yellow clearance period which shall be adjustable from two (2) to seven (7) seconds minimum.

The yellow clearance period shall be followed by a red period which shall be of not less than one (1) second duration.

4. Pedestrian Period. A pedestrian "WALK" period, followed by a flashing "DON'T WALK" clearance period, shall occur only in response to a pedestrian pushbutton actuation.

The "WALK" and flashing "DON'T WALK" pedestrian periods shall appear only during the vehicular green of the parallel vehicle phase.

Successive pedestrian pushbutton actuations shall not extend the pedestrian period.

Pedestrian pushbutton actuations, at times other than during the "WALK" period, shall be remembered and may be answered immediately if there is no demand on an opposing phase or in the following cycle.

In the absence of pedestrian pushbutton actuations a steady "DON'T WALK" pedestrian signal indication shall be displayed.

The "WALK" period and the flashing "DON'T

WALK" clearance period shall each be adjustable from four (4) to thirty (30) seconds minimum.

5. Rest Period. The controller shall be capable of being set to rest in either an all phases red condition or in main street green in the absence of vehicle or pedestrian actuations.

Timing of all periods, except the green gap period, shall be accomplished by digital methods and shall be synchronized to the power line frequency. The green gap period may be timed by analog or digital methods.

(b) Recall. A switch shall be provided for each phase which, when energized, shall cause the controller to return to that phase.

(c) Indicator Lights. An indicator light shall be provided to indicate each timing interval or period in effect.

Vehicular actuation indicator lights shall be illuminated to denote a vehicle sensor placing a call.

Pedestrian indicator lights shall be illuminated to denote a registered pushbutton actuation and shall remain illuminated until the beginning or until the end of the associated "WALK" period.

Additional indicator lights may be provided.

(d) Phase Sequence. The phase sequence shall be as shown on the plans. A green interval on any phase shall not be terminated to allow a green interval on a nonconflicting phase to begin.

(e) Controller Circuitry. Controller circuitry shall conform to the provisions in subsection 623.02.31(f), "Controller Unit Circuitry."

(f) Mechanical Design and Component Quality. Mechanical design and component quality shall conform to the provisions in subsection 623.02.31(g), "Mechanical Design and Component Quality," except that the variable program controls specified in the second paragraph need not be arranged on the front of the controller and adjustments requiring the use of tools will be permitted.

The controller may utilize one more plug-in phase module for each phase section.

Each controller shall be expansible to a minimum of 3 phases by adding phase modules and load switches.

The eighth paragraph in said subsection 623.02.31(g) shall not apply.

(g) Supply Voltage. The nominal supply voltage of each controller shall be 120 volts, 60 Hz. During a supply voltage interruption not exceeding 0.5-second duration, the controller shall continue in cyclic operation and shall retain all actuations registered prior to the interruption, or the controller shall go into flashing operation as specified in subsection 623.02.19, "Flashing Operations."

Following a supply voltage interruption exceeding 0.5-second duration, or at the expiration of the flashing operation specified above, signal operation shall resume or begin in the yellow clearance interval of the phase flashing yellow and calls shall be registered on all phases.

(h) Solid-State Switching and Monitoring Devices. Signal light circuits shall be controlled by solid-state switching devices conforming to the provisions in subsection 623.02.31(j)3, "Solid-State Switching Devices." A monitoring device as specified in subsection 623.02.31(j)4, "Monitoring Device," shall be provided. Such devices may be installed integral or external to the controller.

(i) Police Panel Switches. Police panel switches shall conform to the provisions in subsection 623.02.31(j)5, "Police Panel Switches."

(j) Control Panel. A dead front, easily accessible control panel shall be installed in the controller cabinet. The panel shall contain the internal power control switch, circuit protection devices and a single, 3-prong, grounding type, 15-ampere, convenience outlet.

(k) Toggle Switches. Toggle switches shall conform to the provisions in subsection 623.02.25D(h), "Toggle Switches."

(l) Tumbler Switches. Tumbler switches shall conform to the provisions in subsection 623.02.25D(i), "Tumbler Switches."

(m) Cartridge Fuses. Cartridge fuses shall conform to the provisions in subsection 623.02.25D(j), "Cartridge Fuses."

(n) Circuit Breakers. Circuit breakers shall be as specified for service switches in subsection 623.02.11, "Service."

(o) Flasher and Flasher Relay. The flasher and flasher relay shall conform to the provisions in subsection 623.02.-25C(a), "Flasher and Flasher Relay."

(p) Radio Interference Suppressor. A radio interference suppressor as specified in subsection 623.02.23, "Radio Interference Suppressors," shall be provided for each controller.

(q) Controller Cabinet. Controller housing or cabinet shall be of weather-proof design, shall be constructed of aluminum, steel, or other approved metal and shall be of a size capable of housing all required equipment.

Cabinet foundation dimensions shall be as recommended by the manufacturer of the cabinet.

The top of the controller cabinet shall be between six feet (6′–0″) and six feet ten inches (6′–10″) above the raised pad or sidewalk grade.

The top of the foundation shall extend a minimum of three (3) inches above the raised pad or sidewalk, and shall extend to a minimum depth of thirty-six (36) inches below the raised pad or sidewalk grade.

Each cabinet for Type 100 controller shall be installed in conformance with the provisions in subsection 623.02.-25E, "Traffic Actuated Controller Cabinet," and shall be provided with signal light busses, locks, door stop, vents and fan as specified for traffic actuated controller cabinet.

Terminal blocks for connecting field wiring shall be provided and shall be installed in the bottom of the cabinet.

Controller schematic wiring diagrams, intersection layouts and other service information may be compiled in foldup or booklet form.

Receptacles for relays and shelves below all removable control equipment shall be identified below each unit with either engraved or embossed metal, or engraved plastic labels fastened to the shelf, cabinet wall, or relay subbases. Contractors, switch, fuses, and circuit breakers shall be similarly identified.

Each controller cabinet shall be provided with an internal lighting fixture with a light output comparable to

a 40-watt incandescent lamp. The fixture shall be provided with an on-off switch.

The cabinet shall be provided with a harness and plug connected in such a manner that will permit a pre-timed controller to be substituted for the solid-state unit in the event of a breakdown.

TRAFFIC SIGNALS AND APPURTENANCES

623.02.33 Signal Faces. Each signal face shall be of the adjustable, colored light, vertical type with the number and type of sections as specified herein or as shown on the plans; shall provide an indication in one direction only; shall be adjustable through three hundred sixty (360) degrees about a vertical axis; and shall be mounted at the location and in the manner shown on the plans.

Unless otherwise shown on the plans, all vehicle signal faces shall contain three (3) sections arranged: Red—top, yellow—center, green—bottom.

Pedestrian signals shall be the "WALK–DON'T WALK" type as specified in subsection 623.02.39, "Pedestrian Signals."

All new vehicular signal faces installed at any one intersection shall be of the same make and type.

All new pedestrian signal faces installed at any one intersection shall be of the same make and type.

Vehicle and pedestrian signal mountings shall be oriented so as to provide maximum horizontal clearance to the adjacent roadway.

(a) Optical Units. Each optical unit shall consist of a lens, a reflector, a lampholder, and a clear traffic signal lamp, visible to the traffic to be controlled.

Lenses shall be of the color indicated, circular in shape, with a visible diameter of approximately eight (8) inches or twelve (12) inches. Each lens shall be true to color, of best quality glass, free from imperfections, of high luminous transmission, and shall conform to ANSI Standard: D–10.1.

Candlepower distribution shall conform to ANSI Standard: D–10.1.

All mast arm mounted signal faces shall be provided with twelve (12) inch sections.

A twelve (12) inch section with crosshatched lens shall be provided for all green arrow signal indications. Configuration of the arrows shall conform to the dimensions shown on the plans.

Reflectors shall be made of glass conforming to ANSI Standard: D–10.1.

Lampholders shall conform to the provisions in ANSI Standard: D–10.1.

Each reflector, lens, and hood shall be designed in such a manner as to reduce sun-phantom to a minimum.

Lamps for the eight (8) inch units shall be 650-lumen minimum initial output, 120-volt, 6,000 hour rated life, clear, traffic signal lamps.

Lamps for the twelve (12) inch units shall be 1,900-lumen minimum initial output, 120-volt, 6,000-hour rated life, clear, traffic signal lamps.

(b) Housing. The signal face housing, or case, shall consist of an assembly of separate interchangeable sections, expansible type for vertical mounting without tie rods, substantially secured together in a watertight manner to form a unit. Each section shall house an individual optical unit.

Each section shall be complete with a one-piece, hinged door mounting for the lens and other parts of the optical system, water-tight gaskets, and a simple door-locking device. The optical system shall be so mounted that the various parts may be swung open for ready access or removal. The sections shall be interchangeable and so constructed that sections can be removed or added. There shall be a round opening in the top and bottom of each head to receive one and one-half (1½) inch supporting pipe frame. All parts of the housing, including the doors and end plates, shall be of die cast aluminum conforming to the specifications of ASTM Designation: B85, and all parts shall be clean, smooth and free from flaws, cracks, blow holes, or other imperfections.

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, lens and reflector gaskets, but not including lampholder gaskets, shall be of neoprene. Lampholder gaskets shall be of material not affected by heat. The lampholder gasket will not be required when the lampholder is not in direct contact with the glass reflector.

All lampholders shall be so wired that a white wire will be connected to the shell of the lampholder and a black or colored wire to the bottom or end terminal of the lampholder. These 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 so as to terminate all field wires and lamp wires independently, with separate screws. The terminals to which field wires are attached shall be permanently identified or wiring shall be color coded to facilitate field work.

Lampholder wires shall be No. 18 AWG, or larger, 600-volt, appliance wiring material (AWM) with two sixty-fourths ($\frac{2}{64}$) inch thermoplastic insulation rated one hundred five (105) degrees Centigrade or with insulation that conforms to Military Specification: MIL W–16878 D, Type B, with vinyl nylon jacket rated one hundred fifteen (115) degrees Centigrade.

The manufacturer's name or trademark, wire size, insulation type-letter designation and temperature rating shall be marked on the insulation or a Certificate of Compliance conforming to the provisions in subsection 106.05, "Certificates of Compliance," shall be submitted by the manufacturer with each shipment of traffic signal head units.

Each lens shall be provided with a removable hood, 0.050-inch thick, of sheet aluminum of the full circle type completely closed, except at the ends. Hoods for eight (8) inch section shall be seven (7) inches minimum length and for twelve (12) inch section shall be nine and one-half (9½) inches minimum length unless otherwise shown on the plans. Hoods shall have a minimum downward tilt of three and one-half (3½) degrees.

Each signal section shall be constructed in such a manner that structural failure of the housing will not occur with a wind load pressure of twenty-five (25) pounds per square foot on the projected area of the complete signal face housing, including back plate and hoods.

623.02.34 Directional Louvers. Where shown on the plans, louvers shall be furnished and installed in signal hoods. Directional louvers shall be so constructed as to have a snug fit in the signal hoods. The outside cylinder shall be constructed of No. 22 U.S. gage sheet steel and the vanes shall be constructed of No. 27 U.S. gage sheet steel or the cylinder and vanes shall be constructed of 3003 H14 aluminum alloy of similar construction. Thickness dimensions and arrangements of vanes shall be as shown on the plans.

623.02.35 Back Plates. Back plates shall be constructed of 3003 H14 aluminum alloy sheet 0.051-inch minimum thickness, and of the dimensions shown on the plans.

Where a back plate consists of two (2) or more sections, the sections shall be fastened with rivets or with aluminum bolts, peened after assembly to prevent loosening.

All mast arm mounted signal heads and all programmed visibility signal heads shall be provided with back plates.

623.02.36 Signal Head Mounting. Bracket mounted signal heads, as shown on the plans, shall be supported by mounting brackets consisting of watertight assemblies of one and one-half (1½) inch standard steel pipe and malleable iron, ductile iron or brass pipe fittings. All members shall be either plumb or level, symmetrically arranged, and securely assembled. Construction shall be such that all conductors are concealed within the assembly.

The dimensions of mounting brackets between the axes through the center of the terminal compartment, or slipfitter, shall not exceed 11 inches, except where required to provide proper signal head alignment or directed by the Engineer.

At each signal location, unless otherwise shown on the plans, a terminal compartment shall be constructed into the mounting brackets. Each compartment shall be fitted with a terminal block containing twelve (12) poles, each with two (2) screw type terminals. Each terminal shall accommodate at least five (5) No. 14 AWG conductors. A raintight cover shall be provided, giving ready access to the terminal block. Terminal compartment shall be bronze of sufficient strength to remain intact in event the pole is knocked down. Slip-fitters, where used without integral terminal compartment, shall be of cast-iron or bronze.

For post-top mounting of bracket mounted signals, the terminal compartment shall be cast with an integral slip-fitter. For post-top mounting of a one-way signal head, a slip-fitter without a terminal compartment may be used. Slip-fitter shall fit over a four (4) inch standard pipe or four and one-half (4½) inch outside diameter end of tapered standard. Each slip-fitter shall be provided with two (2) rows of steel set screws, with three (3) screws in each row to secure the assembly in plumb position. Set screws shall be cadmium plated.

Where signal heads are side mounted on poles, the terminal compartment shall be designed to bolt securely to the pole.

Signal heads shall be equipped with positive brass lock rings and fittings designed to prevent heads from turning due to external forces. Lock ring and connecting fittings shall have serrated contacts as shown on the plans.

Signal head assembly for suspension from mast arm shall be equipped with a slip-fitter as shown on the plans.

Signal heads shall not be installed at any intersection until all other signal equipment, including the controller, is in place and ready for operation at that intersection, except that the signal heads may be mounted if the faces are not directed toward traffic or if the faces are covered.

623.02.37 Vehicle Detectors. Vehicle detectors shall be the type or types shown on the plans.

All sensor units, control units, and amplifiers shall meet the requirements of Test Method No. Nev. T801.

The units shall not be affected by transient voltages when tested in accordance with Test Method No. Nev. T800, or voltage variations of plus or minus ten (10) percent.

After a power interruption the units shall return to normal operation within five (5) minutes.

A separate sensor unit, control unit, or amplifier shall be provided for each direction of travel and for each left turn lane.

Each unit shall be provided with a light or meter to indicate when the detector is ready to detect vehicles.

Each detector shall operate over the voltage range specified in subsection 623.02.22, "Operating Voltage."

Circuitry shall be solid-state except for output relays.

Output relays, if used, shall be normally closed.

Units shall be designed to provide ease of maintenance with easily accessible electronic components.

Each detector shall provide positive vehicle detection without readjustment from zero (0) degrees Fahrenheit to one hundred sixty (160) degrees Fahrenheit.

When components are mounted on insulating boards, printed circuit wiring may be used. Printed circuit boards shall be designed to facilitate identification of components. This shall be done by either part identification markings or by providing a pictorial diagram showing physical location and identification of each component. Each printed circuit board shall have the following minimum quality requirements: NEMA Grade G–10 glass cloth base epoxy resin board, one-sixteenth ($\frac{1}{16}$) inch minimum thickness, organic solder masking and gold plated contacts. Inter-component wiring shall be copper track with a minimum of two (2) ounces weight per square foot. Printed circuit design shall be such that components may be removed and replaced without permanent damage to boards or tracks.

(a) Lane Occupancy Type Loop Detectors. Detectors to be used with lane occupancy type controllers shall be compatible with the Type 100 controller provided for the intersection involved and shall conform to the provisions in subsection 623.02.37(b), "Inductive Loop Detectors," and the following:

Detector loops shall contain the number of turns of conductor as recommended by the manufacturer of the controller supplied.

Detector sensor units may be included as an integral part of the controller unit or may be installed separately in the controller housing.

The connector circuitry tabulation in subsection 623.-02.37(b)3, "Sensor Unit Construction," shall not apply to sensor units installed as an integral part of the controller unit.

(b) Inductive Loop Detectors. Inductive loop detectors shall conform to the following:

1. General. The term "inductive loop detector" applies to a complete installation consisting of a conductor loop or group of loops installed in the roadway, as shown on the plans, lead-in cable and a sensor unit with power supply installed in a traffic signal controller or traffic count station cabinet.

The sensor unit shall be an electronic device capable of providing closure of an output circuit when a vehicle stands or passes over a loop or one of several loops connected to the input circuitry of the sensor unit.

2. Performance Characteristics. Sensor units shall provide an output closure for each vehicle passing through the response area of the loop at speeds up to seventy-five (75) miles per hour and shall also provide an output closure of at least three (3) minutes duration when a vehicle is occupying the response area of the loop.

3. Sensor Unit Construction. Each sensor unit shall be housed in a metal case. Sensor units may be furnished with either an integral power supply or a separate power supply common to more than one sensor unit.

Sensor units to be installed in a common cabinet shall have a frequency difference and shall not interfere with the operation of other sensor units installed in the same cabinet.

In multiple loop installations, all loop conductors to be connected to the same sensor unit shall be wound in the same direction. No more than four (4) loops shall be connected to a single sensor unit.

All input and output circuits for each unit with an integral power supply shall enter via a single connector, type and circuitry for which shall be as shown in the following table. Each connector for modular-type units shall be provided with either threaded shell or spring-loaded latch locking.

Connector Circuitry For Inductive Loop Detector Sensor Units

MS Connector Circuit	Inductive Loop Type 18–1 Pin
120-volt (AC Line)	C
120-volt (AC Neutral)	A
Chassis Ground	H
Loop	D
Loop	E
Relay Contact Common	B
Relay Contact	F
Relay Contact	G
Spare	I, J

All pilot lights and meters shall be mounted on the front panel of the sensor unit or the sensor power source assembly. Input power shall be fused.

Capacitors or inductors necessary for loop tuning shall not be mounted external to the loop detector sensor unit.

4. Construction Materials. Conductor for each inductive detector loop shall be continuous, unspliced, Type RHW–USE, No. 12 AWG, neoprene-jacketed, solid copper wire.

Conductors for inductive loop detectors shall be provided with three sixty-fourths ($\frac{3}{64}$) inch minimum thickness insulation.

Loop detector lead-in cable, from the pullbox adjacent to the loop to the field terminals in the cabinet, shall conform to either one of the following:

a. Lead-in cable shall consist of two No. 12 AWG solid copper conductors with each conductor insulated with 0.030-inch minimum, high molecular weight, heat-stabilized, colored polyethylene, conforming to the requirements of ASTM Designation: D1248, Type I, Class B, Grade 4. The conductors shall be twisted together with approximately two (2) turns per foot. Non-hygroscopic fillers shall

be used to form a firm compact cylindrical core. A non-hygroscopic core tape shall be applied spirally over the core. The cable shall be provided with an outer jacket consisting of extruded, black, polyvinyl chloride conforming to ASTM Designation: D1047. The cable shall conform to the International Municipal Signal Association's Specification: 19–1.

b. Two No. 12 AWG copper conductors with each conductor insulated with 0.035-inch minimum, high molecular weight, heat-stablized, colored polyethylene. The conductors shall be twisted and the twisted-pair shall be protected with a shield of tinned copper-brass, or aluminum-polyester. A No. 16 AWG minimum, stranded tinned copper ground drain wire shall be provided. The cable shall be provided with a chrome vinyl outer jacket with a minimum thickness of 0.037-inch.

The loop detector lead-in, from the field terminals in the cabinet to the sensor unit, shall conform to one of the following:

a. A twisted-pair of No. 22 AWG, or larger, conductors conforming to the requirements for cabinet wiring.

b. A cable containing two No. 22 AWG, or larger, copper conductors with each conductor insulated with 0.014-inch minimum polyethylene or polypropylene. The conductors shall be twisted and the twisted-pair shall be protected with a shield of tinned copper-brass, or aluminum-polyester. The shield shall be grounded at one end of the cable. The cable shall be provided with a chrome vinyl outer jacket with a minimum thickness of 0.027-inch.

Splices in the cable may be made in pull boxes only. All splices in the lead-in cable shall be soldered.

5. Installation Details. Installation and tests shall conform to the details and notes shown on the plans.

Unless shown otherwise each loop shall consist of three turns of conductor as specified in subsection 623.02.-37(b)4, "Construction Materials."

Slots cut in the pavement shall be blown out and dried before installing inductive loop detectors. All sharp edges and ninety (90) degree corners should be chipped off. In

addition to the required tests, the Contractor shall check each detector loop prior to filling slot with epoxy, as follows:

a. Each loop shall be tested for continuity.

b. A megger test shall be made between loops, insulation resistance shall not be less than 5 megohms.

The slots shall be filled with epoxy sealant to within one-eighth (⅛) inch of the pavement surface. The sealant shall be at least one-half (½) inch thick above the top conductor in the saw cut. Before setting, surplus sealant shall be removed from the adjacent road surfaces without the use of solvents. The epoxy sealant shall conform to the requirements of subsection 728.03.09, "Epoxy Sealant for Inductive Loops."

Conductors of all loops to be operated by each sensor unit shall be run continuous to the nearest pull box. The loops shall be joined in the pull box in combination of series and parallel so that optimum sensitivity is obtained at the sensor unit. Final splices between loops and lead-in cable shall not be made until the operation of the loops under actual traffic conditions is approved by the Engineer.

All loop conductors for each direction of travel for the same phase of a traffic signal system, in the same pull box, shall be spliced to a cable which shall be run from the pull box adjacent to the loop detector to a sensor unit mounted in the controller cabinet.

All loop conductors for traffic counters shall terminate in a pull box or on a terminal strip in the traffic count station cabinet when such a cabinet is installed.

Conductors for inductive loop traffic signal and traffic counting installations shall be identified and banded, in pairs, by lane, in the pull box adjacent to the loops and near the termination of the conductors in the controller or traffic count station cabinet. Bands shall conform to the provisions in subsection 623.02.09, "Wiring."

The loop detector conductors shall be installed prior to placing the uppermost layer of asphalt concrete. The conductors shall be installed, as shown on the plans, in the compacted layer of asphalt concrete immediately below the uppermost layer.

Sensor units shall not be provided for inductive loop traffic counting installations.

(c) Magnetometer Detectors. Magnetometer detectors shall conform to the following:

1. General. The term "magnetometer detector" applies to a complete installation consisting of sensing element or group of sensing elements installed in the roadway as shown on the plans, lead-in cable and a control unit with power supply installed in a traffic signal controller cabinet or traffic count station cabinet.

The sensing elements shall be no larger than two (2) inches in diameter by four (4) inches high and shall contain no moving parts.

The control unit shall be an electronic device capable of providing closure of an output circuit when a vehicle stands over or passes through the magnetic field of the sensing elements connected to the input circuitry of the control unit.

All magnetometer detectors to be installed at a particular intersection or traffic count station shall be of the same make.

Where an existing system is being modified and existing magnetometer detectors are to remain in use, new detection equipment shall be the same make and type as the existing.

2. Performance Characteristics. Each magnetometer detector shall be capable of being activated by a change in magnetic field caused by the presence or passage of a vehicle within the lane of required detection at any speed from zero (0) to eighty (80) miles per hour.

Control units for magnetometer detectors shall be provided with a time delay feature which shall extend the vehicle call for an adjustable period of approximately one-tenth ($\frac{1}{10}$) second to three (3) seconds. The delay feature shall not operate during pulse mode. The pulse control unit shall provide an output closure of thirty (30) to fifty (50) milliseconds duration for every vehicle entering the area of detection.

3. Control Unit Construction. Each control unit shall be furnished with an integral power supply.

All input and output circuits for each unit shall enter via a single connector. Each connector for modular-type units shall be provided with either threaded shell or spring-loaded latch locking.

Connector circuitry shall conform to the standard product of the manufacturer of the detector control unit provided.

All controls, pilot lights, and meters shall be mounted on the front panel of the control unit. Said controls shall be manually variable, shall be clearly and permanently identified, and shall be operable without the use of tools. Timing dials, if used, shall be linearly calibrated. Input power shall be used.

4. Construction Materials. The cable from the sensing elements to the adjacent pull box shall be as specified by the detector manufacturer.

The lead-in cable, from the pull box adjacent to the sensing elements installed in the roadway to the control unit, shall be suitable for both direct burial and installation in conduit. At least four (4) No. 18 AWG (minimum size) stranded, copper conductors shall be provided. Individual conductors shall be provided with a minimum thickness of 0.010-inch of polypropylene or polyvinyl chloride, color coded, insulation. The outer jacket shall be 0.035-inch minimum thickness, high density, polyethylene. An amorphous interior moisture penetration barrier shall be provided to prevent hosing, siphoning or capillary absorption of water along cable interstices.

Calibration of the control unit shall be accomplished with tuning controls.

5. Installation Details. The sensing elements shall be placed in holes cut in the roadway at locations shown on the plans. Each hole shall be of a diameter large enough to accept the particular type of sensing element being used, with adequate space for the lead-in conductor cable. Holes shall be cut to a depth to provide a mounting depth of the sensing element as recommended by the manufacturer of the unit provided. The holes shall be vertical, regardless of the slope or grade of the pavement surface.

Slots, 0.03-foot maximum width by 0.08-foot minimum depth, shall be cut in the pavement between the sensing element holes and the nearest pull box for the lead-in conductor cables.

Slots and holes cut in the pavement shall be blown out and dried before installing lead-in conductor cables and sensing elements.

The sensing elements shall be placed in the bottom of the holes, in a vertical position, and the holes shall be filled with clean dry sand to approximately three (3) inches below the pavement surface.

A separate cable shall be provided for each magnetometer sensing element placed in the pavement. The cable shall be run continuously (without splices) to the adjacent pull box where splices shall be made to the lead-in cable.

After the lead-in conductor cables are installed in the slots, the slots for lead-in conductor cables and the top three (3) inches, minimum, of sensing element holes shall be filled with epoxy sealant, as described in subsection 623.02.37(b)5, "Installation Details for Inductive Loop Detectors," to within one-eighth (⅛) inch of the pavement surface. The thickness of sealant in the slots shall be at least one-half (½) inch above the top of the lead-in cable. Before setting, surplus sealant shall be removed from adjacent road surfaces without the use of solvents.

(d) Raising or Relocating Existing Pressure-Sensitive Detectors. Raising existing pressure-sensitive detectors to grade shall be accomplished by removing the existing concrete from the detector frame and filling with Class A concrete around the frame at the new grade, unless otherwise specified.

When detectors are to be relocated, either the existing detector contact unit shall be installed in a new frame and foundation, or the existing frame, if in good condition as determined by the Engineer, may be set in a new foundation. The hole left by removing the detector frame and foundation shall be filled with Class C concrete, except the roadway surface shall be reconstructed with material to match existing surfacing.

623.02.38 Pedestrian Push Buttons. Where shown on the plans, pedestrian push buttons of substantial tamper-proof construction shall be furnished and installed.

The assembly shall be weatherproof and so constructed that it will be impossible to receive any electrical shock under any 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:

Switching unit shall have a stainless steel plunger actuator and shall be provided with U-frame to permit recessed mounting in push button housing.

Switch shall have an operating force of nine (9) to thirteen (13) ounces and a minimum release force of four (4) ounces.

Pretravel shall be one sixty-fourth ($\frac{1}{64}$) inch maximum.

Overtravel shall be seven thirty-seconds ($\frac{7}{32}$) inch minimum.

Differential travel shall be 0.0004 to 0.002-inch.

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. Saddles shall be provided to make a neat fit when required.

Where a pedestrian push button is to be mounted on top of a two and one-half (2½) inch diameter post, the housing shall be provided with a slip-fitter fitting and screws for securing rigidly to the post.

Push button and sign shall be installed on the crosswalk side of the pole.

Arrows on push button signs shall point in the same direction as the corresponding crosswalk.

623.02.39 Pedestrian Signals. Pedestrian signals shall conform to the following:

(a) Messages. Messages shall be Lunar White "WALK" and Portland Orange "DON'T WALK" as defined in the Manual on Uniform Traffic Control Devices.

(b) Types. Pedestrian signal ("WALK, DON'T

WALK") shall be a one-piece jack mounted plug-in plastic module in which the formed neon words and grid neon tubing are integrally molded and positively positioned with relation to the internally screened message plate. The molded polycarbonate module shall plug in for operation without requiring tools or additional wiring. The letter height shall be five and one-half (5½) inches. The letters shall have a stroke width of five-eighths (⅝) inch.

Each signal shall be provided with an "egg crate type" visor designed to eliminate sun phantom.

An alternate pedestrian signal head employing the glass fiber optic concept may be furnished. No visors will be required with this type of head. The unit shall be complete, including aluminum housing, displaying the alternating messages in colors and letter heights and widths described above.

(c) Housing. The housing shall be made of cast aluminum or 3003 H14 sheet aluminum alloy with finish on both sides, and shall be one-eighth (⅛) inch thick minimum at the points of support.

The housing for pedestrian signals shall be dustproof, weatherproof, and corrosion resistant and shall provide for easy access to, and replacement of, all components.

The housing shall be suitable for either post-top or bracket mounting.

(d) Hoods. The hood shall be of material similar to the housing. The top of the hood shall extend a minimum length of six (6) inches at the top and five (5) inches at the bottom when measured from the surface of the lens. The front shall be normal to the top.

A full divider strip shall be provided between the "DON'T" and the "WALK" indications.

(e) Transformers. Transformers shall be of the proper size for the length of tubing and shall carry the label of UL or Electrical Testing Laboratories.

A separate transformer shall be provided for each of the "DON'T WALK" and the "WALK" indications.

The orange words "DON'T" and "WALK" shall operate from a single transformer.

Transformers shall have a power-factor of ninety (90) percent and shall provide 27 milliamperes minimum current.

(f) Conductors. High-voltage wiring between the gas tubes and the secondary side of the transformer shall be made with Gas Tube Sign and Oil Burner Ignition Cable, Type GTO–15 labeled by UL.

Other conductors shall be No. 14 AWG, or larger, with two sixty-fourths ($^{2}/_{64}$) inch minimum Type TW insulation.

(g) Switch. A fused switch consisting of two (2) cartridge fuses and a lever for disconnecting the fuses for pedestrian signals shall be mounted within the signal housing and shall be connected to deenergize the transformer primary circuit.

(h) Relays. All relays for operation of the "WALK–DON'T WALK" signals shall be placed in the controller cabinet.

(i) Fasteners. All the machine screws, studs and washers shall be either plated brass, stainless steel or other corrosion resistant material.

(j) Gaskets. Gaskets shall be provided as required to make the unit raintight and dusttight.

(k) Finish. The outside of the housing and hood shall be painted in accordance with the provisions in Section 614, "Painting."

(l) Terminal Block. A terminal block as specified in subsection 623.02.33(b), "Housing," shall be mounted in the unit for field wiring.

623.02.40 Programmed Visibility Traffic Signal Heads. Programmed visibility traffic signal heads and the installation thereof shall conform to the provisions in subsections 623.02.33, "Signal Faces," and 623.02.36, "Signal Head Mounting," except the provisions in subsection 623.02.-33(a), "Optical Units," and the eighth paragraph in subsection 623.02.33(b), "Housing," shall not apply.

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.

External illumination shall not cause a signal indication

nor shall a signal indication in one signal head cause a signal indication in another signal head.

Each section of a signal face shall provide a twelve (12) inch diameter, round indication.

Each section shall be provided with a sun visor.

The indication of each signal head, when unprogrammed, shall be visible from anywhere within fifteen (15) degrees of the optical axis. The signal head shall be capable of being preset at angles between nine (9) degrees above and nine (9) degrees below the horizontal and shall be preset at five (5) degrees below the horizontal, unless otherwise specified.

The signal head with the yellow indication, prior to programming, shall provide a minimum candlepower of two thousand five hundred (2,500) in the direction of the axis and a maximum candlepower of one hundred (100) at fifteen (15) degrees horizontally in each direction from the axis. Said signal head with yellow indication shall be capable of being programmed so that a minimum candlepower of two thousand five hundred (2,500) can be directed along the optical axis and a candlepower of less than one hundred (100) directed at one-half (½) degree horizontal from the axis and no measurable light is directed from one (1) degree to fifteen (15) degrees horizontal from the axis. Under the same conditions, the candlepower of the red indication shall be at least nineteen (19) percent of the yellow indication and the candlepower of the green indication shall be at least thirty-eight (38) percent of the yellow indication.

Lamps for the signal units shall be 150-watt, 120-volt, incandescent lamps with a minimum average rated life of six thousand (6,000) hours.

During daylight, the signal indications shall be visible only in those areas or lanes designated. During dusk and darkness, a faint glow visible to the side will be permissible.

Dimming devices shall be provided to gradually reduce the candlepower of each signal head for nighttime operation to approximately fifteen (15) percent of that for daytime operation.

The Contractor shall program the head as provided by the manufacturer and as directed by the Engineer.

623.02.41 The R–10 sign for mast arm as shown on the plans (left turn on green arrow only) shall be furnished and installed as indicated on the plans and as directed by the Engineer.

LIGHTING

623.03.01 Mercury Vapor Luminaires. Mercury vapor luminaires shall be horizontal burning type. Unless otherwise specified, light distribution shall be ANSI Type III.

Luminaires shall be provided for slip-fitter end mounting on two (2) inch mast arms.

Glassware shall be the refractor type with inner or outer prisms.

The refractor shall be mounted in a door frame assembly which shall be hinged to the luminaire at the house side and fastened at the street side by means of an automatic type latch.

The refractor and door frame assembly shall be forced upward at the street side by spring-pressure, against the gasket seat, when in the closed and latched position.

All gaskets shall be composed of a material capable of withstanding the temperature involved and they shall be securely held in place.

All parts of the luminaire shall be manufactured from corrosion-resistant materials.

Unless otherwise specified in the special provisions or shown on the plans lamps shall be hard glass type, 400-watt, mercury vapor, ANSI Type H33–1CD, on thirty (30) foot mounting height.

Mercury vapor lamps shall have a minimum average rated life of twenty-four thousand (24,000) hours.

When specified, luminaires shall have an integral ballast as provided in subsection 623.03.13, "Ballasts."

Unless otherwise specified in the special provisions or shown on the plans, all mercury vapor luminaires mounted

on standards shall be equipped with glare shields as provided in subsection 623.03.02, "Mercury Vapor Luminaires with Glare Shields."

623.03.02 Mercury Vapor Luminaires with Glare Shields. In addition to the provisions in subsection 623.03.01, "Mercury Vapor Luminaires," mercury vapor luminaires with glare shields shall conform to the following requirements:

The minimum light distribution for luminaires shall correspond to the isolux charts, or IES Type distribution shown on the plans.

Maximum luminaire brightness reading for luminaires with 400-watt lamps shall not exceed 100 foot-lamberts when measured with a photo-electric brightness meter, under the following test conditions:

Using a one and one-half (1½) degree photoelectric brightness meter on the ninety (90) degree and two hundred seventy (270) degree lateral angle line, the maximum luminaire brightness shall not exceed 100 foot-lamberts when the meter is located at a horizontal distance of one hundred twenty (120) feet and a vertical distance of 7.5 feet between the luminaire and the meter, or at an angle of three (3) degrees thirty-five (35) minutes from the horizontal to the line between the luminaire and the meter.

Measurements shall be made from both the ninety (90) degree line and the two hundred seventy (270) degree line and averaged.

The lamp shall be operated at the wattage necessary to produce 20,000 lumens with 400-watt lamps.

All equipment shall be new and clean and the test conducted under conditions of good visibility.

623.03.03 Fluorescent Tunnel Lighting Fixtures. Fluorescent tunnel lighting fixtures shall conform to the following:

(a) Luminaire Housing. Luminaire housing shall be fabricated of Type 316 stainless steel. The luminaire shell and wire brackets shall be 20-gage, the inner angles,

mounting channels, channel latches and cross channel shall be 16-gage and the cross channel tabs shall be 10-gage.

Mounting brackets and plate washers shall be fabricated of 0.25-inch cold finished steel and shall be galvanized after fabrication.

The latch operators and hooks shall be made of 16-gage and the loops of 12-gage, Type 316 stainless steel. Operator lever shall have at least one hundred thirty-five (135) degrees free travel.

Wireway covers shall be made of 0.040-inch, 3003–H14 aluminum alloy sheet.

Machine screws, cap screws, studs, nuts, rivets, washers and lock washers shall be Type 316 stainless steel.

(b) Lamp Fixture Assemblies. Reflectors, and finger tabs shall be made of 0.040-inch aluminum sheet. Lampholder housing shall be 0.064-inch aluminum sheet.

The reflecting surfaces noted on the plans shall have a specular finish with high resistance to corrosion, abrasion, staining, finger printing and discoloration and to the long range deleterious effects of vehicle fumes, light, heat (up to two hundred (200) degrees Fahrenheit), water, oils and aging.

The specular reflectance of the reflector at forty-five (45) degrees shall be not less than sixty-eight (68) percent when measured in accordance with Test Method No. Nev. T541.

The reflecting surface shall be of the specular anodized type (mechanically polished and electrolytically brightened prior to anodizing).

The aluminum sheet for specular anodized finish shall be Type 3003–H14 alloy with Type 1175 alloy cladding on the reflective side. The finish process shall be performed before or after fabrication of the reflectors. The minimum weight of the protective oxide coating shall be 5.0 milligrams per square inch. The coating shall be sealed to provide stain resistance. The surface shall be such that finger prints may be easily rubbed off with a soft cloth.

Reflectors shall be protected during forming and assembly with secure paper coverings which shall only be removed just prior to operational testing of the completed installation.

Machine screws, nuts, and lock washers shall be Type 316 stainless steel. Rivets shall be aluminum.

(c) Metal Workmanship. All parts of luminaire housings and reflector assemblies shall be clean, uniform in appearance and free of defects such as improper fit, cracks, dents, deep scratches and abrasions, burrs, roughness, off-square ends, holes off center or jagged, damaged machine screw heads, blemished anodizing, welds and brazing exhibiting poor workmanship, surface irregularities and other significant defects.

Bows and crooks in longitudinal sections shall not exceed one-half (½) inch from a flat surface.

(d) Plastic Covers. Plastic covers shall be crystal clear, colorless (except for painted portions), uniform in appearance, shall be free from surface ripples, blemishes, haze, voids, cracks, crazing, warps, scratches, abrasions, burrs, roughness, off-square ends, paint and cement smears, discoloration, surface irregularities and other significant defects, shall have uniform thickness over the light transmission area and shall have high resistance to the long range deleterious effects of motor vehicle fumes, washing detergents, weathering, light, heat (up to two hundred (200) degrees Fahrenheit), water, oils and aging.

Cover bodies shall be cast or extruded of acrylic material or formed in one (1) piece from molded acrylic sheet.

The acrylic plastic used shall be formulated from antioxidant, free water white, methyl methacrylate resin using accepted organic catalysts and accelerators.

The cover ends shall be cemented to the cover body by the "soaked joint" method. The finished joint shall be clean and crystal clear, shall be without gaps and shall provide at least sixty (60) percent of full strength of plastic sheet.

After fabrication, covers shall be annealed by heating in a forced circulating air over at one hundred sixty (160) degrees Fahrenheit for a period of twenty-four (24) hours and slowly cooled over a period of eight (8) hours.

Bows, crooks, edge kinks, or "S" warpage in the longitudinal sections of covers shall not exceed one-eighth (⅛) inch from a flat surface except that side bow may be not more than one-fourth (¼) inch.

Physical tests of the finished plastic covers shall comply with the following:

		Nominal Values
1.	Refraction index by ASTM Designation: D542	1.49
2.	Luminous transmittance "as received" by ASTM Designation: D1003	
	Parallel percent	91
	Total percent	92
	Haze percent	1
3.	Deflection temperature by ASTM Designation: D648	
	2° C./Min.-264 p.s.i.	205° F.
	2° C./Min.-66 p.s.i.	225° F.
4.	Rockwell hardness—R&HP–20, ¼" ball, 100KG (Load)	M80

The plastic cover manufacturers shall furnish samples which shall be selected by the Engineer. In the case of formed or extruded covers, the samples may be cropped ends of stock with a minimum width of three (3) inches or shall be removed from a completed cover.

For fast covers, the sample shall be injection molded into polished molds three (3) inches in diameter with faces 0.250-inch apart which are polished flat and parallel or shall be removed from a completed cover.

Samples shall be furnished on each order involving ten (10) or more fixtures with a minimum of one sample per two hundred fifty (250) covers. Samples shall be subjected to all curing and annealing operations experienced by the finished plastic covers.

(e) Gaskets, Mounting Bracket Strips, and Sealing Strips. Gaskets, mounting bracket strips and sealing strips shall be uniform and even textured and shall be highly resistant to stiffening and setting and the long range deleterious effects of vehicle fumes, weathering, light, heat (up to one hundred sixty (160) degrees Fahrenheit continuous), water, oils and aging.

Medium firmness, closed-cell, synthetic, expanded rubber gaskets and mounting bracket strips shall conform to ASTM Designation: D1056–SBE–42.

Extra high softness, open cell, neoprene gaskets shall conform to ASTM Designation: D1056–SCO–11.

Gaskets shall be neatly applied to thoroughly degreased, clean, metal surfaces with a suitable heat resistant adhesive

which will not allow the gaskets to slip at a temperature of one hundred sixty (160) degrees Fahrenheit (continuous).

The sealing strips shall be vinyl extrusions, gray in color, with a hardness rating of eighty (80) durometer. Brittle temperature shall be minus twenty (20) degrees Fahrenheit or below (Test Method ASTM Designation: D746). Strips shall be packaged in nineteen and one-half (19½) inch lengths in such a way as to maintain extruded shape. The sealing strips shall be installed using a cable "pull in" compound to reduce friction.

(f) Resilient Synthetic Rubber Sealing Compound. Resilient rubber sealing compound shall be of the extruded, oil-soluble elastomer base type with a circular cross section of approximately one-fourth (¼) inch diameter. The material shall have high resistance to the long range deleterious effects of weathering, water and aging.

(g) Ballasts and Fuse Blocks. Ballasts shall be for two ninety-six (96) inch, T–12, fluorescent lamps as shown on the plans. The ballast shall be high-power factor sequence-start type. Ballast leads shall be sealed rubber-covered and color-coded. The ballast shall be rated at 240 volts primary, 1.09 amperes and shall conform to the requirements of ANSI Standard: C82.1 and ANSI Standard C82.2.

Each fuse block shall be single-pole, side barrier, porcelain type, with open type fuse clip mounting. Fuses shall be 600-volt for fluorescent lamp circuits.

All wiring connections in the fixture, except at lampholders, shall be terminated on two molded phenolic, barrier type, pressure connector, terminal block assemblies rated at 15 amperes, 600 volts.

All ballasts, fuse blocks and terminal block assemblies shall be mounted on a mounting chassis.

Each mounting chassis shall be fabricated of 0.125-inch Type 3003–H14 aluminum alloy sheet. All units shall be mounted on the chassis with cadmium plated brass or steel hardware, except for lock washers which shall be beryllium copper, externally toothed.

(h) Lampholders and Lamps. Lampholders shall be earmounted, compressible type, with silver-plated contacts.

All lamps shall be of the very high output, rapid-start type with ninety-six (96) inch, T–12 bulb, cool-white color, and silver-plated contacts for operation at 1,500 milliamperes.

(i) Conductors and Wiring. Conductors from ballast components to the terminal block assemblies and from lamp assembly to ballast block assemblies shall be UL approved appliance wiring material (AWM), No. 16 AWG, minimum, stranded, copper wire with two sixty-fourths ($^{2}/_{64}$) inch thermoplastic insulation.

The manufacturer's name or trademark, wire size, insulation type-letter designation, and temperature rating shall be marked on the insulation or a Certificate of Compliance conforming to the provisions in subsection 106.05, "Certificates of Compliance," shall be submitted by the manufacturer with each shipment of fluorescent tunnel lighting fixtures.

All conductors from the components shall be secured with spring cross straps (but not cabled or served) on the underside of the chassis. Color-coding and terminal markings shall be as shown on the plans.

Conductors from lamp assembly to ballast terminal block assemblies shall have adequate slack to allow swinging down of lamp assembly and shall be cabled up to the terminal block and in proper order and location for insertion in terminals.

Lead ends shall be tinned.

(j) Service and Distribution Cabinet. The cabinet enclosure shall be of tamperproof, weatherproof design and constructed of code gage steel with knockouts as shown on the plans. The doors shall be provided with a tamperproof latch and locking device with a standard type key for activating the lock. Doors shall be provided with a stop to limit their opening to one hundred twenty (120) degrees and shall also be provided with an automatic latching device which will operate when the door reaches the extreme open position and will hold the door securely until released. Each section shall be completely enclosed, self-contained, and self-supporting. Side frames shall have suitable openings at top and bottom pull space to permit

convenient wiring between sections. Finish shall be factory applied light grey baked enamel over rust resistant metal primer and shall be highly corrosion resistant.

Cabinet shall be bottom fed, dead front type for connection to 240-volt, 3-phase, 3-wire service with panelboards, circuit breakers and contactors as shown on the plans. Each panelboard shall have space for future installation of a minimum of two 3-pole breakers.

Circuit breakers shall be molded case type, shall be quick-make and quick-break, whether actuated automatically or manually, and shall have inverse time tripping characteristics. On dangerous overload or short circuit, the breaker shall instantly open the circuit without damage. A laminated phenolic nameplate shall be furnished for each panelboard and each circuit breaker.

Contactors shall be open type with contacts rated for 100 amperes at 240 volts. The operating coil shall be suitable for operation at 240 volts.

The Contractor shall furnish five sets of wiring diagrams of the service and distribution cabinet showing location and description of components and all wiring connections. One set shall be sealed in plastic and attached to inside of cabinet door.

623.03.04 Incandescent Luminaires. Type and style of incandescent luminaires, lamp equipment and transformers shall be as specified in the special provisions.

All side and end mounted luminaires shall be equipped with a two (2) inch slipfitter.

All side mounted incandescent luminaires shall be equipped with a porcelain heat barrier bushing, except that for multiple type luminaires, glass sleeving may be used.

623.03.05 Soffit and Wall Luminaires, and Lamps. Soffit and wall luminaires shall be of the type or types specified.

Soffit and wall luminaires shall be weatherproof and corrosion resistant. Installation details and minimum light distribution shall be as shown on the plans.

Each flush-mounted soffit luminaire shall consist of a

cast metal body, a prismatic refractor mounted in a door frame, a prismatic glass reflector and a socket. The body shall have a continuous anchor ring and shall be provided with four two (2) inch conduit hubs. The door frame assembly shall be hinged, gasketed and secured to the body by at least three machine screws. The refractor shall be clearly identified as to "street side" and shall be keyed so as to fit into the frame in only one way.

Unless otherwise specified, each flush mounted soffit luminaire shall be furnished with an integral ballast mounted on a bracket so constructed that the light center of the mercury vapor lamp is within one-half (½) inch of the light center location for which the luminaire is designed.

Where an existing flush mounted incandescent soffit luminaire is to be modified, the mounting bracket for the lamp socket or for the integral ballast shall be so designed that the existing tapped holes and machine screws can be utilized for the attachment of the bracket to the fixture body.

Each pendant soffit luminaire shall be enclosed and gasketed, and shall be furnished with aluminum finish, three-fourths (¾) inch top-tapped head, stepped or fluted reflector, and refractor attached to reflector. The reflector shall have a specular anodized aluminum finish. The refractor shall be made of heat-resistant acrylic plastic or glass. The optical assembly shall be hinged and latched for lamp access and shall be provided with a safety chain.

Each pendant soffit luminaire shall be furnished with an 11-gage minimum thickness, metal box (maximum dimensions of eight inches by nine inches by eleven inches (8″ x 9″ x 11″)), and such box shall house the ballast for the luminaire. The box shall be provided with a gasketed cover with two (2) captive screws and two (2) chains to prevent dropping. Box shall be hot-dip galvanized.

Each wall-mounted luminaire shall consist of a cast metal body of the dimensions shown on the plans. The lens frame shall be gasketed and shall allow servicing without detachment from the body.

Cast metal bodies made of aluminum, which are to be flush mounted in concrete, shall be given a heavy coat of

alkali-resistant bituminous paint on all surfaces to be in contact with concrete. The paint shall conform to Military Specification MIL–P–6883.

Unless otherwise specified, each soffit luminaire and each wall luminaire shall be furnished with a hard glass type, 175-watt, mercury vapor lamp, ANSI Type H39–22KB, with a minimum average rated life of twenty-four thousand (24,000) hours. Each lamp socket shall be either repositioned or provided with an extension to locate the light center of the lamp within one-half (½) inch of that of a seven (7) inch light center lamp installed in the fixture.

623.03.06 Pedestrian Crossing Fixtures. Pedestrian crossing fixtures shall consist of fluorescent lighting fixtures for pedestrian undercrossings and for pedestrian overcrossings.

(a) Pedestrian Undercrossing Fixtures. Pedestrian undercrossing fluorescent lighting fixtures shall conform to the details shown on the plans and as provided in this subsection.

The design of the fixture shall be submitted to the Engineer for approval before fabrication of the fixtures is started. If deemed necessary by the Engineer, one complete prototype fixture shall be delivered to the Engineer for approval at least thirty (30) calendar days before fabrication of the contract fixtures.

The shell of the fixture shall be of cast aluminum alloy, industrial type or Federal Class 18 aluminum, one-fourth (¼) inch minimum thickness.

The door shall be one piece of 6061 T6 aluminum alloy, one-eighth (⅛) inch minimum thickness.

The lens units in the door section shall be formed of one and one-half (1½) inch methyl methacrylate rod, cut and fire glazed to provide a clear finish or, of cast units, providing equivalent tolerances and finish. Units shall conform to the dimensions shown on the plans.

The lenses shall be secured to the door section with an extruded lens retainer of 6063–T5 aluminum alloy conforming to the lens shape. The lens retainers shall fit the full length of the lens on both sides. Lens retainers which

are continuous for the full length of the three (3) lenses will be permitted. "Zee" bars of 3003–H15 or 5005–H14 aluminum alloy, one-sixteenth (1/16) inch minimum thickness, may be substituted for the extruded lens retainer.

The continuous piano hinge shall be of Type 1100 aluminum alloy. The piano hinge shall be riveted to the door section with one-eighth (1/8) inch aluminum rivets. Matching holes shall be drilled in the piano hinge and the lower edge of the fixture. The door assembly shall be attached after the shell is in place by three-eighths (3/8) inch 8–32 stainless steel, self-tapping screws.

A captive, positive keyed, screw-type, latching device requiring a special wrench, shall be provided at the upper edge to secure the door in the closed position as shown on the plans. Two special wrenches shall be delivered to the Engineer.

A neoprene gasket shall be attached to the frame to provide a cushion between the shell and the door.

A chain or other satisfactory device shall be provided to prevent the door from coming in contact with the undercrossing wall when in the fully open position.

The fixture shall be held in place by three three-eighths inch by eight inch (3/8" x 8") anchor bolts with two nuts as shown on the plans.

Surfaces of the fixtures in contact with concrete and with anchor bolts and nuts shall be painted with a heavy coat of alkali-resistant bituminous paint. The paint shall conform to Military Specification: MIL–P–6883.

Each fixture shall contain an F48T12 reflectorized, rapid start, fluorescent lamp with thirty (30) degree aperature and with recessed, double contact base installed on the back side of the door directly behind the lens.

Lampholders shall be listed by UL for outdoor use without an enclosure and with 1,500-milliampere rapid start, fluorescent lamps. One lampholder for each lamp shall be of the spring loaded type.

The distance between the face of the lampholders for each lamp shall be designed to provide a compression of at least 0.10-inch on the spring type lampholder when the lamp is in place. The lamp shall have positive mechanical

and electrical contact when the lamp is in place. The socket on the spring type lampholder shall have sufficient travel to permit installation of the lamp. Springs shall not be a part of the current carrying circuit.

The ballast shall be of the high power factor type with weatherproof leads for operation of one forty-eight (48) inch rapid start lamp. Ballasts shall be listed by UL for outdoor operation on 110–125-volt, 60 Hz. circuit and rated at 1,500 milliamperes.

All wiring connections in the fixtures shall be terminated on a molded, phenolic, barrier type, 2-pole terminal block rated at 15 amperes, 600 volts and shall have integral type white waterproof marking strips. All current carrying parts of the terminal blocks shall be insulated from the fixture with integral plugs or strips to provide an insulating value in excess of the line to ground flashover voltage. If the Contractor elects to use sectionalized terminal blocks, each section shall be provided with an integral barrier on each side and shall be capable of rigid mounting and alignment.

Conductors from ballast leads to lampholders shall be No. 16 AWG minimum size, stranded, UL approved copper appliance wiring material (AWM). Splicing of lampholder conductors to the ballast leads shall be done by use of mechanically secure connectors.

Sufficient slack shall be provided in conductors to allow the fixture door to be fully opened.

Holes for one inch conduit shall be provided in both ends of the fixture. Unused holes shall be plugged with pressed metal closures.

Exposed surfaces of the fixture shall be clean, uniform in appearance and free from defects such as improper fit, dents, deep scratches and abrasions, burrs, roughness, off-square ends, holes off center or jagged, surface irregularities and other significant defects. Screws for attaching all components to fixture door such as "Zee" bars, ballast and terminal block shall be tapped into door from inside only. No screwheads, nuts or other fasteners shall be removable from the outside.

Any defective parts of the fixture, as determined by the

Engineer, before or after the fixture is installed, shall be removed and replaced.

(b) Pedestrian Overcrossing Fixtures. Fluorescent lighting fixtures for installation in the top railing of a pedestrian overcrossing chain link sidewalk railing shall conform to the details shown on the plans and as provided in this subsection.

Any fixture, the design of which deviates in any way from the details shown on the plans, shall be submitted to the Engineer for review before fabrication of the contract fixtures. If deemed necessary by the Engineer, one complete prototype fixture shall be delivered to the Engineer for review at least thirty (30) days before fabrication of the contract fixtures. The prototype fixture will be returned to the Contractor, and if permitted by the Engineer, the fixture may be installed in the work.

The shell of the fixture shall consist of a top section and a door section of extruded 6063–T5 aluminum alloy (each with a nominal one-eighth (⅛) inch wall thickness), two cast-end sections of 319 aluminum alloy, and an internal wireway cover of 3003–H14 aluminum alloy, all as detailed on the plans.

The top section and the door section shall be joined together on one side by a continuous hinge formed as part of the two extrusions and shall overlay to permit locking on the other side. The hinge shall be treated with a suitable silicone grease that will prevent the entrance of water by capillary action.

Fasteners requiring a special socket wrench as detailed on the plans shall be provided on the overlap to secure the door section in the closed position. Two special socket wrenches capable of operating the fasteners shall be furnished.

The top section of the shell shall have a fin with three-sixteenths ($\frac{3}{16}$) inch holes spaced uniformly at twelve (12) inch centers to permit the use of 9-gage tie wires to support the chain link fence fabric.

The end sections shall fit on the ends of the fixture and shall be welded to the top section only. Each end section shall have an open extension with outside diameter equal

to that of one and one-fourth (1¼) inch rigid conduit. A three (3) inch sleeve shall be provided with each end section for securing the fixture to the top rail as shown on the plans.

The wireway cover (with three-sixteenths ($\frac{3}{16}$) inch hemmed ends up) complete with terminal blocks and circuit conductors shall be inserted before welding end sections and shall provide clearance at both ends for conductors. The cover shall be fastened by at least two one-fourth (¼) inch No. 4 self-threading sheet metal screws with binding head and blunt point. Blind rivets of equivalent strength may be substituted.

The lens units in the door section shall be formed of one and one-half (1½) inch methyl methacrylate rod, cut and fire glazed to provide a clear finish or, of cast units providing equivalent tolerances and finish. Units shall conform to the dimensions shown on the plans.

The lenses shall be secured to the door section with an extruded lens retainer of 6063–T5 aluminum alloy conforming to the lens shape. The lens retainers shall fit the full length of the lens on both sides. Lens retainers which are continuous for the full length of the three (3) lenses will be permitted. Zee bars of 3003–H15 or 5005–H14 aluminum alloy, one-sixteenth ($\frac{1}{16}$) inch minimum thickness, may be substituted for the extruded lens retainer, if approved by the Engineer.

One or more bronze sash chains or other satisfactory devices shall be provided to prevent the door from opening to such an extent as to damage the hinge.

Each fixture shall contain an F48T12, reflectorized, rapid start, fluorescent lamp with thirty (30) degree aperature and recessed, double-contact bases installed on the back side of the door directly behind the lenses.

Lampholders shall be listed by UL for outdoor use, shall be provided with heat resistant, circular cross section, neoprene sealing gasket; silver-coated contacts and waterproofed lead entrance for use with a 1,500 milliampere, rapid start, fluorescent lamp. One lampholder for each lamp shall be of the spring loaded type.

The distance between the faces of the lampholders for

each lamp shall be designed to provide a compression of at least 0.10-inch on the spring type lampholder when the lamp is in place. The lamp shall have positive mechanical and electrical contact when the lamp is in place. The socket on the spring type lampholder shall have sufficient travel to permit installation of the lamp. Springs shall not be a part of the current carrying circuit.

The ballast shall be thirteen and one-half (13½) inches long (maximum) and shall be of the high power factor type with weatherproof leads for operation of one forty-eight (48) inch rapid start lamp. Ballasts shall be listed by UL for outdoor operation on 110–125 volt, 60 Hz. circuits and shall be rated at 1,500 milliamperes.

All circuit conductors entering the fixtures shall be terminated on molded, phenolic, barrier-type, 3-pole terminal blocks rated at 15 amperes, 600 volts and shall have integral-type white waterproof marking strips labeled "Line 1, Neutral, Line 2." All current carrying parts of the terminal blocks shall be insulated from the fixture with integral plugs or strips to provide an insulating value in excess of the line to ground flash-over voltage. The terminal blocks shall be attached to the wireway cover in the top section. If the Contractor elects to use sectionalized terminal blocks, each section shall be provided with an integral barrier on each side and shall be capable of rigid mounting and alignment.

The electrical system of the pedestrian overcrossing shall be effectively grounded by a bare No. 8 AWG copper wire installed in the conduit from fixture to fixture, from the end fixture to conduit fitting on the end post and from conduit fitting on the end post to the grounding bushing in the nearest pullbox.

The ground wire shall be secured to the inside of the telescoping sleeve end casting where conductors are carried and to the inside of the Type LB conduit fitting on the end post by means of a connecting lug and a No. 8–32, self-threading, pan head screw.

The lamp, with lampholders, ballast, and fixture wires, shall be attached to the door section. The terminal blocks shall be attached to the top section or wireway cover.

Three No. 10 AWG, solid copper circuit conductors shall be installed between terminal blocks as part of each completed fixture.

Conductors from ballast to lampholders shall be No. 16 AWG minimum size, stranded copper wire.

All conductors in the fixture, except ballast leads and entrance line conductors, shall be UL approved appliance wiring material (AWM).

Splicing of lampholder conductors to secondary ballast leads shall be done by use of mechanically secure connectors.

Sufficient slack shall be provided in conductors between the ballast and the terminal blocks to allow the fixture door to be fully opened.

Exposed surfaces of the fixture shall be clean, uniform in appearance and free from defects such as improper fit, dents, deep scratches and abrasions, burrs, roughness, off-square ends, holes off center or jagged, surface irregularities and other significant defects.

Screws for attaching all components to the fitxure shell such as lens retainers, "Zee" bars, ballast and lampholders shall be tapped into the shell from inside only with the ends of screws ground even with the outside surface of the fixture. No screwheads, nuts or other fasteners shall be removable from the outside.

Any defective parts of the fixture, as determined by the Engineer, before or after the fixture is installed, shall be removed and replaced at the Contractor's expense.

The fixture shall be completely fabricated and assembled in the shop and shall be ready for installation before shipment to the project.

623.03.07 Sign Lighting Fixtures—Fluorescent. Each fluorescent sign lighting fixture shall be designed for mounting at the bottom of the sign on an overhead sign structure as shown on the plans. The fixture shall be a fully enclosed type, raintight, dusttight, corrosion-resistant, with hinged plastic cover.

Painting of fixtures will not be required.

(a) Housing. The shell of the fixture shall be fabricated

of 0.064-inch minimum thickness, 3003 H14 aluminum alloy sheet with Type 7072 alloy cladding or fabricated of other material which will provide equivalent strength and corrosion resistance.

The maximum dimensions of the fixture housing with cover shall be seventy-four (74) inches long (for seventy-two (72) inch nominal lamps), fifteen and one-half (15½) inches wide and five and one-half (5½) inches high.

All external machine screw parts, lock washers, hinge pins, etc., shall be made of Type 316 stainless steel.

(b) Reflector. The reflector shall be fabricated of 0.020-inch minimum thickness, 3003 H14 aluminum alloy sheet with Type 1175 alloy cladding on the reflective side.

The reflector surface shall be mechanically polished prior to anodizing. The finish process shall be performed before or after fabrication of the reflector and shall include the electrochemical brightening procedure using an acid process. The minimum weight of the protective oxide coating shall be five (5.0) milligrams per square inch. The coating shall be sealed.

The reflector shall have a specular reflectance of not less than sixty-eight (68) percent when measured at forty-five (45) degree specular angle in accordance with Test Method No. Nev. T541.

Reflectors shall be protected during forming and assembling with secure coverings which shall be removed after the assembly has been completed.

Reflectors shall have hemmed edges for safe handling.

(c) Cover. Cover shall be of acrylic material.

Each plastic cover shall latch easily and securely in place without the use of tools and shall be completely free from any tendency to loosen under high winds and vibration. The cover shall be fitted with non-stretching safety cords, chain safety devices, or equivalent, which shall also serve as stops when the cover is hinged open.

(d) Gaskets. Gaskets between the cover and the fixture housing shall be uniform and even-textured, and shall be square-section polyvinyl chloride formed tube with a pressure-sensitive adhesive on one side.

Gaskets shall be neatly applied to thoroughly degressed,

clean surfaces with a suitable heat resistant adhesive, which will not allow the gaskets to slip at a temperature of one hundred sixty (160) degrees Fahrenheit (continuous).

(e) Lampholders. Lampholders shall be listed by UL for outdoor use, shall be provided with silver coated contacts and waterproofed lead entrance for use with a 1,500-milliampere, rapid-start, fluorescent lamp. One lampholder for each lamp shall be of the spring loaded type. Each lampholder shall be provided with a heat resistant, circular cross section, partially recessed neoprene ring to seal against the lamp ends and protect electrical contacts from moisture and dirt or other injurious elements.

The distance between the face of the lampholders for each lamp shall be designed to provide a compression of at least 0.10-inch on the spring-type lampholder when the lamp is in place. The lamp shall have positive mechanical and electrical contact when the lamp is in place. The socket on the spring-type lampholder shall have sufficient travel to permit installation of the lamp.

Springs for lampholders shall not be a part of the current carrying circuit.

Lampholders shall match lamp requirements and shall not increase cathode filament circuit resistance by more than 0.01 ohm.

(b) Terminal Blocks. Each field wiring terminal block shall be of the heavy-duty pressure connector type with minimum rating of 35 amperes, 600 volts (RMS, 60 Hz.), and shall have a phenolic base, marking strip and corrosion resistant metal parts. Terminal screws shall be no smaller than size 10–32. Marking strips shall have permanent symbols indicating wire color as shown on the plans.

All wiring connections in the fixtures and in the ballast boxes shall be terminated on molded, phenolic, barrier type, terminal blocks rated at 15 amperes, 600 volts, and shall have integral type, white waterproof, marking strips. All current carrying parts of the terminal blocks shall be insulated from the fixture or ballast box with integral plugs or strips to provide an insulating value in excess of the line-to-ground flashover voltage. If the Contractor elects to use

sectionalized terminal blocks, each section shall be provided with an integral barrier on each side and shall be capable of rigid mounting and alignment.

(g) Conductors. All conductors within the fixture shall be UL approved appliance wiring material (AWM), stranded copper wire with two sixty-fourths ($^2/_{64}$) inch thermoplastic insulation. Conductors for ballasts shall be No. 16 AWG. Ballast conductors shall be secured with easily removable spring cross straps (not clamped, cabled or served) on the underside of the chassis.

Conductors between sign switch and fixture terminal blocks shall be No. 14 AWG minimum.

Stranded copper conductors shall be tinned before insertion into pressure connector type terminals. Conductors connected to screw type terminals shall terminate in crimp type ring connectors.

1. Sign Lighting Fixtures (120-Volt/240-Volt) Integral Ballast Type. In addition to the requirements in subsection 623.03.07, "Sign Lighting Fixtures—Fluorescent," the following requirements shall also apply:

a. Lamps. Each fixture shall be provided with one F72T12, extra high output, cool white fluorescent lamp with recessed double contact base, designed for use at 1,500 milliamperes and which shall meet the requirements of ANSI Standard: C78.

b. Fuses. Fuses shall be of the miniature, slow blowing type, with appropriate current and voltage rating.

Fuseholder shall be a panel mounting type with threaded or bayonet type knob which grips fuse tightly for extraction.

c. Ballasts. Ballasts shall be the high power factor type with weather-proof leads for operation of one seventy-two (72) inch rapid start lamp. Ballasts shall be listed by UL for outdoor operation on 110–125 or 220–250 volts, 60 Hz. circuits (input voltage shown on the plans). Ballasts shall be rated at 1,500 milliamperes for high-beam and 800 milliamperes for low-beam operation. Multiple to multiple transformers shall not be used.

2. Sign Lighting Fixtures (36-Inch Lamp). In addition to the requirements in subsection 623.03.07, "Sign

Lighting Fixtures—Fluorescent," the following requirements shall also apply:

The maximum dimensions of the fixture housing shall be thirty-seven (37) inches long (for thirty-six (36) inch nominal lamps), fourteen (14) inches wide and four (4) inches high.

a. Lamps. Each fixture shall be provided with one F36T12/HO, cool white, rapid-start fluorescent lamp which shall meet the requirements of ANSI Standard: C78.

The lamps shall operate from 2-lamp or 3-lamp ballasts, wherever possible.

b. Fuses. Fuses shall be of the miniature, slow blowing type, with appropriate current and voltage rating.

Fuseholder shall be a panel mounting type with threaded or bayonet type knob which grips fuse tightly for extraction.

c. Ballasts. Ballasts shall be of the high power factor type and shall be capable of starting the lamps at zero (0) degrees Fahrenheit and above.

Ballasts shall be rated at 800 milliamperes for high output type rapid-start lamps. Ballasts shall be located not more than twenty-five (25) feet from connected lamps and in a ballast box. Ballasts shall be listed by UL or Electrical Testing Laboratories for outdoor operation on 110–125 volt, 60 Hz. circuits and shall conform to the requirements of ANSI Standard: C82.1 and ANSI Standard: C82.2.

3. Sign Lighting Fixtures (480-Volt Integral Ballast). In addition to the requirements in subsection 623.03.07, "Sign Lighting Fixtures—Fluorescent," the following requirements shall also apply:

a. Lamps. Each fixture shall be provided with one F72T12, extra high output, cool white fluorescent lamp with recessed double contact base, designed for use at 1,500 milliamperes, and which shall meet the requirements of ANSI Standard: C78.

b. Ballast Equipment. Ballast inductors shall have losses not exceeding fifteen (15) percent of lamp arc watts at rated current. Maximum current crest factor shall be 1.5 at rated current.

Lamp cathode filament transformers shall provide rated secondary voltage (plus or minus ten (10) percent) at full load and at one-half (½) load. Transformer losses shall not exceed ten (10) percent of load power consumption.

Inductors and transformers shall withstand (for a period of thirty (30) minutes) the application of 2,200 volts (RMS, 60 Hz.) from coil to core and transformers shall be capable of withstanding the same voltage from coil to coil.

Capacitors shall be rated 660 volts (RMS, 60 Hz.) for operation down to minus twenty (20) degrees Centigrade and shall be oil filled, hermetically sealed, paper type. Capacitance shall be within plus or minus ten (10) percent of rating at twenty-five (25) degrees Centigrade.

Surge limiting resistors shall be ceramic coated, 20-watt wire-wound units, resistor leads shall have plastic insulation rated 600 volts (RMS, 60 Hz.) for operation at two hundred (200) degrees Centigrade.

Each mounting chassis for inductor, transformer and resistor shall be fabricated of 0.125-inch, Type 3003–H14 aluminum alloy sheet. All units shall be mounted on the chassis with cadmium plated brass or steel hardware, except for lock washers which shall be beryllium copper, externally toothed.

A minimum spacing of one-eighth (⅛) inch shall be provided between the bottom of the ballast inductor and the bottom of the fixture housing.

c. Plug Disconnect. Each plug disconnect shall consist of molded nylon plug and receptacle housings, containing plug pin and individual sockets, designed to be crimped to conductors and snapped into the housing. Housings shall have integral, molded, polarizing and locking devices. Minimum UL electrical rating shall be 10 amperes, 600 volts (RMS, 60 Hz.). Pins and sockets shall be tin-plated, phosphor-bronze secured to conductors using a ratchet type precision crimping tool.

d. Fuseholder. Fuseholder shall be panel mounting type rated at 250 volts, AC, complete with a thirteen thirty-seconds ($^{13}/_{32}$) inch diameter by one and one-half (1½)

inch length, slow blowing, cartridge type fuse. Fuse rating shall be as shown on the plans or as directed by the Engineer.

Fuseholder shall have a threaded or bayonet type knob which grips fuse tightly for extraction.

623.03.08 Sign Lighting Fixtures—Incandescent. Each sign lighting fixture with an incandescent lamp shall be of the type shown on the plans or as specified in the special provisions.

Sign reflector fixtures shall be UL approved for outdoor installation. The fixture shall consist of a hood with side outlet tapped for conduit and a symmetrical eight (8) inch steel reflector. The hood shall be cadmium plated and finished with aluminum paint.

The reflector shall have porcelain enameled finish, green on outside and white on inside.

The fixture shall be furnished complete with 1,900-lumen traffic signal lamp.

623.03.09 Flashing Beacons. Where shown on the plans, flashing beacons shall be installed. Each beacon shall consist of a single section traffic signal head, conforming to the provisions in subsection 623.02.33, "Signal Faces," with yellow or red lens as shown on the plans. Mounting of beacons, including span-wire mounting if required, shall be as shown on the plans.

Each flashing beacon control unit shall consist of a switch, 10-ampere plug fuse, flasher and terminal block housed in a single enclosure.

The enclosure shall be NEMA Type 3R, and shall be provided with top hinged cover, dead front panel, and a hasp for sealing cover. Padlocks will be furnished by others.

The enclosure shall be provided with factory applied, rust resistant prime coat and baked enamel finish coat. Two coats of aluminum paint shall be applied as specified in subsection 623.02.16, "Painting." At the option of the Contractor the enclosure may be hot-dip galvanized in lieu of painting.

Switches shall be 10-ampere, toggle type, single-pole, 2-wire, 120-volt, AC and shall be mounted at the top and center of the dead front panel.

When shown on the plans or specified in the special provisions, a 15-ampere circuit breaker, conforming to the provisions in subsection 623.02.11, "Service," shall be installed in lieu of the control switch and 10-ampere plug fuse specified above.

The flasher shall be a solid-state device of adequate capacity and shall have no contact points or moving parts.

Flashers shall provide fifty to sixty (50–60) flashes per minute with a forty to sixty (40–60) percent duty cycle.

Flashers shall provide for 2-circuit, alternate operation of beacons and shall be furnished with plug-in mounting.

Terminal blocks shall be rated at 15 amperes, 600 volts, shall be molded from phenolic material and shall be the barrier type with plated brass screw type terminals and integral type marking strips.

Workmanship and materials shall be equal to that of first class electrical instruments.

When flashing beacons are installed adjacent to or in conjunction with a traffic signal system, the flasher control shall be installed in the controller cabinet unless otherwise shown on the plans.

The sign panel to be installed on cantilever flashing beacon shall be mounted using galvanized commercial quality five-sixteenths ($\frac{5}{16}$) inch diameter hexagonal head bolts and nuts, galvanized flat washers and lock washers with a fiber washer contacting the face of the sign panel.

623.03.10 Photoelectric Controls. Photoelectric controls, as specified in the special provisions or as shown on the plans, shall be capable of switching multiple lighting systems directly or of switching series lighting systems through a high voltage controller.

(a) Types. The types of photoelectric controls shall be as follows:

Type I photoelectric control shall consist of a photoelectric unit and a contactor in a single weatherproof housing.

Type II photoelectric control shall consist of a photoelectric unit in a weatherproof housing and a separate contactor located in a traffic signal controller cabinet.

Type III photoelectric control shall consist of a photoelectric unit and a separate contactor, each in a separate weatherproof housing.

Type IV photoelectric control shall consist of a photoelectric unit in a weatherproof housing which plugs into an EEI–NEMA twist lock receptacle integral with the luminaire.

A switch to permit manual operation of the lighting circuit shall be provided for each Type I, Type II, and Type III photoelectric control. Switches shall be of the single-hole mounting toggle type, single-pole, single-throw, rated at 12 amperes, 125 volts. Switches shall be furnished with an indicating nameplate reading "Auto-Test" and shall be connected in parallel with the load contacts of the photoelectric unit.

(b) Equipment Details. Equipment details shall conform to the following:

1. Photoelectric Unit. The photoelectric unit shall provide an output in response to changing light levels. The response level shall remain stable throughout the life of the control unit. Components of the unit shall not require periodic replacement.

Units for highway lighting shall have a "turn-on" between one (1) and five (5) foot-candles and a "turn-off" at between one and one-half (1½) and five (5) times "turn-on."

Units for illuminated signs shall have a "turn-on" level of between twenty (20) and thirty (30) foot-candles. (Turn-on level specified above corresponds to a switching level of approximately forty (40) to sixty (60) foot-candles measured in the horizontal plane.) "Turn-off" level shall not exceed three (3) times "turn-on" level.

Measurements shall be by the procedures set forth in EEI–NEMA Standards for Physical and Electrical Interchangeability of Light-Sensitive Control Devices Used in the Control of Roadway Lighting.

Photoelectric controls, except Type IV, shall be furnished with a four (4) inch minimum inside diameter slipfitter containing a terminal block and with cable supports or clamps to support pole wires.

The photoelectric unit receptacle shall be the EEI–NEMA type. Mounting brackets shall be used where pole-top mounting is not possible. Photoelectric controls shall be installed at the locations shown on the plans and oriented as directed by the Engineer.

For switching 480-volt, 60 Hz. circuits, a 100 volt-ampere, minimum, 480/120-volt transformer shall be installed in the contactor enclosure to provide 120 volts for the photoelectric control unit. Where more than one photoelectric unit is to be installed at the same location, a single transformer, with a volt-ampere rating capable of handling the total controlled load, may be used.

Photoelectric units shall be screened to prevent artificial light from causing cycling.

The photoelectric unit shall also conform to the following:

The supply voltage rating shall be 60 Hz. 105–130, 210–240, or 105–240 volts, as required.

The load rating shall be 800 watts minimum, incandescent, mercury vapor or fluorescent.

The operating temperature range shall be from minus twenty (20) degrees Fahrenheit to plus one hundred fifty (150) degrees Fahrenheit.

The power consumption shall be less than 10 watts.

The base of the unit shall be provided with a 3-prong, EEI–NEMA standard, twist-lock plug mounting.

2. Contactor. The contactor shall have contacts rated to switch the specified lighting load and shall be normally open, unless otherwise specified.

The contactor shall be the mechanical armature type consisting of an operating coil, a laminated core, a laminated armature, contacts and terminals. Contacts shall be fine silver, silver alloy, or superior alternative material.

3. Contactor and Test Switch Housing. For Type I control, the enclosure shall house the test switch only.

For Type III control, the contractor and test switch shall be housed in a suitable NEMA Type 3R enclosure. The enclosure shall be provided with a factory applied rust resistant prime coat and baked enamel finish coat. Two coats of aluminum paint shall be applied as specified in Section 614, "Painting." At the Contractor's option the enclosure may be hot-dip galvanized in lieu of painting. A minimum of two and one-half (2½) inches shall be provided between contactor terminals and end of enclosure for wiring connections. The enclosure shall be mounted on the same standard as the photoelectric unit at a height of approximately six (6) feet above the base.

For Type II control, the test switch shall be housed in the traffic signal controller cabinet with the contactor.

4. Wiring. Conductors between the photoelectric unit and an external contactor shall be No. 14 AWG and shall be run inside the lighting standard, or in conduit, unless otherwise shown on the plans.

623.03.11 Series Multiple Relays. Each series multiple relay shall be a single-pole, normally open, single unit relay in a weatherproof enclosure designed for pole mounting. The operating coil shall be designed and insulated for connecting directly into a high-voltage series lighting circuit. The load rating shall be 40 amperes, 125 volts, AC, unless otherwise specified in the special provisions.

623.03.12 Transformers. Multiple to multiple and series to multiple transformers shall be of the single-phase, dry type designed for operation of a 60 Hz. supply.

(a) Electrical Requirements. Transformer ratings shall be 120/480-volt, 240/480-volt, or 480/120-volt for multiple to multiple units and 6.6-ampere/118-volt or 6.6-ampere/480-volt for series to multiple units or other ratings as shown on the plans.

Secondary 480-volt windings shall be center tapped and the center tap shall be grounded.

Special taps for high or low voltages will not be required.

Volt-ampere ratings shall be as shown on the plans.

Transformer efficiency shall exceed ninety-five (95) percent for multiple to multiple units and eighty (80) percent for series to multiple units.

Average temperature rise of windings, at full load, shall conform to NEMA requirements for Class A insulation.

Secondary voltage regulation and tolerance shall be plus or minus three (3) percent from half load to full load for multiple to multiple units and plus ten (10) percent (maximum) at no load to plus or minus three (3) percent at full load for series to multiple units.

External leads for multiple to multiple and series to multiple secondary connections shall be Type RHW–USE, No. 10 AWG, rated 600 volts, AC. Primary conductors for series to multiple transformers shall be rated for use on 5,000-volt, AC circuits.

Transformer insulation shall be NEMA Class F or better.

Potting compound shall conform to the temperature requirements of NEMA Class A insulation.

Series to multiple transformers shall withstand the application of 12,000 volts (RMS, 60 Hz.) from core to primary coil and from coil to coil for a one (1) minute period.

Series to multiple transformer secondaries and multiple to multiple transformers shall withstand the application of 2,200 volts (RMS, 60 Hz.) from core to coils and, for multiple units only, from coil to coil for a one (1) minute period.

The above tests shall be made immediately after operation of the transformer at full load for twenty-four (24) hours.

(b) Physical Requirements. Submersible type transformers shall be securely encased in a rugged, corrosion resistant, watertight case and shall withstand a five (5) day test submerged in two (2) feet of salt water (two (2) percent salt by weight) with twelve (12) hour on and off periods. The operating periods shall be at full load.

Submersible units shall be capable of withstanding a shock test as specified in Military Specification: MIL–STD–202; Test Method 205; Test Condition C. Mounting for shock test may be by any convenient means.

Proof of performance after the above tests shall be as follows:

1. Continuity in all windings.
2. Insulation test at ninety (90) percent of initial test voltage.
3. There shall be no evidence of physical damage such as cracks.

Each transformer to be installed in a pull box shall be the submersible type and shall be provided with a handle and a hanger as shown on the plans for ballast installation in pull box.

Non-submersible transformer units shall be provided with metal half-shell coil protection, shall have moisture resistant, synthetic varnish impregnated windings and shall be suitable for outdoor operation in a raintight enclosure.

Transformer leads shall extend a minimum of twelve (12) inches from the case. Leads of submersible units shall be brought out through one sealed hub and shall be secured in a manner which will withstand a one hundred (100) pound static pull without loosening or leaking.

623.03.13 Ballasts. Ballasts for mercury vapor lamps shall be designed for the primary current and types of lamps specified in the special provisions or shown on the plans.

Ballasts shall be the fully isolated winding type and shall provide reliable lamp starting down to minus twenty (20) degrees Fahrenheit. Ballasts shall not be the auto-transformer type.

Rubber covered ballast leads, except for integral multiple circuit ballasts, shall be non-hydroscopic and the entrance of the leads into the ballasts shall have a water-tight seal.

Ballasts installed in pull boxes shall be protected from moisture by either encasing ballast in a neoprene water-proof jacket or constructing ballast with aluminum, brass or galvanized steel casing and cover. The casing and cover shall be coated with a moisture resistant paint.

Ballasts encased in a glass fiber polyester case potted

with epoxy resin, or encased in other suitable non-corroding material, may be substituted.

Each ballast to be installed in a pull box shall be provided with a handle and hanger as detailed on the plans.

Ballasts for soffit luminaires shall conform to the following:

Ballast shall be furnished with mounting brackets attached and shall be equipped with terminal blocks for primary connections and lamp socket preconnected to the secondary for flush mounted luminaires and with terminal blocks for both primary and secondary connections for use with suspended luminaires.

The maximum size of complete ballast unit to be installed in Type 9 structure pull boxes shall be five and one-half inches by five and one-half inches by ten and one-half inches (5½" x 5½" x 10½"), exclusive of handle.

(a) Multiple Circuit Ballasts. Power factor for multiple ballasts shall be better than ninety (90) percent.

Ballast losses (in lamp watts) for the various sizes of mercury vapor lamp ballasts shall not exceed the following:

Mercury Vapor Lamp Ballast	Loss
100-watt	30 percent
175-watt	25 percent
250-watt	20 percent
400-watt	15 percent
700-watt	12 percent
1,000-watt	10 percent

Unless otherwise specified in the special provisions or shown on the plans, ballasts for multiple circuit luminaires as specified in subsection 623.03.01, "Mercury Vapor Luminaires," shall be installed in the pull box adjacent to each electrolier.

Integral ballasts shall be the component type with resin-impregnated coils and metal cased, hermetically sealed, capacitors.

Ballasts for multiple circuits shall be constant wattage type with nominal primary voltage rating of 120/240 or

240/480 volts and shall regulate the lamp wattage to plus or minus four (4) percent over a plus or minus thirteen (13) percent variation in primary voltage. The lamp current wave shape crest factor shall not exceed two (2.0) at rated line voltage.

Integral ballasts for soffit luminaires shall be of high-reactance lag-type for operation of a single 175-watt mercury vapor lamp on a nominal primary voltage of 120 volts.

(b) Series Circuit Ballasts. Primary and secondary windings shall be completely wrapped with layers of irradiated polyethylene tape to a minimum thickness of one-eighth (⅛) inch. The layers of tape shall be fused together by heating to insure the exclusion of moisture and other contaminants. The complete assembly shall be dipped in insulating material conforming to ANSI Standard: C89.1, Class F or H, capable of withstanding an operating temperature of one hundred five (105) degrees Centigrade to provide a moistureproof coating.

The voltage insulation of primary and secondary windings and associated leads shall meet or exceed the requirements of ANSI Standard: C82.7.

Name plate data shall conform to ANSI Standard: C82.7.

623.03.14 Falsework Lighting. When required by the special provisions, falsework lighting shall be installed where vehicular traffic with or without pedestrian traffic crosses through or under structure falsework.

Illumination of the portal faces of falsework shall be provided during the hours from dusk to dawn. Illumination of the pavement and pedestrian openings through or under falsework shall be provided twenty-four (24) hours per day.

The Contractor shall submit a plan of the proposed lighting installations and shall not commence falsework construction until such plans have been reviewed by the Engineer. A subsequent review shall be made by the Engineer after falsework lights have been placed in operation.

Fixtures for illumination of roadway pavement between entrances and exit portals shall be provided with an RLM Standard Dome reflector. The reflector shall have a white porcelain enamel finish on the inside and shall be provided with a steel wire guard.

Fixtures shall be equipped with high-temperature glazed porcelain medium base sockets and six (6) foot conductors for splicing, approved by UL for outdoor use.

Fixtures shall be fully adjustable with bracket and locking screws on a mounting-plate and shall provide mounting directly to a standard metal junction box.

Fixtures for pedestrian passageways shall be porcelain box receptacles mounted on standard metal junction boxes and equipped with wire lamp guards. Porcelain box receptacles shall be rated at 660 watts, 250 volts. Wire lamp guards shall be made of No. 10 AWG wire and shall be suitable for general construction work.

Lamps shall be of the medium-base incandescent type. For pavement illumination, lamps shall be 150 watts minimum. For pedestrian passageway illumination, lamps shall be 100 watts minimum.

Portal faces of falsework shall be illuminated on the side facing traffic with 150-watt minimum PAR reflector flood lamps mounted on the structure directly over each vertical support adjacent to the traveled way and over the center of each lane. Each lamp shall be supported approximately sixteen (16) feet above the pavement and approximately six (6) feet in front of the portal face, the exact position to be as directed by the Engineer. In addition to the overhead lighting, each side of each vehicular passageway between portals shall be illuminated by a string of yellow, 25-watt lamps spaced at twelve (12) foot intervals and mounted between eight (8) and eight and one-half (8½) feet above the pavement.

Each flood light shall be aimed in such a manner as to preclude glare to oncoming motorists.

The overhead clearance sign mounted on the falsework shall also be illuminated.

For illumination of roadway pavement between entrance and exit portals, a continuous row of fixtures shall be

installed over the center of each lane beneath the falsework structure at intervals of not more than fifteen (15) feet, with the end fixtures not further than seven (7) feet inside the portal faces. Mounting height of fixtures over the pavement shall be as directed by the Engineer.

Pedestrian openings, through or under falsework, shall be illuminated with fixtures centered over the passageway at intervals of not more than fifteen (15) feet, with the end fixtures not more than seven (7) feet inside the portal faces. The fixtures shall be mounted between 9.5 feet and 10.5 feet above the walkway surface.

For roadway pavement and portal face illumination, No. 12 AWG conductors with Type S insulation shall be used. For pedestrian passageways, conductors shall be No. 12 AWG and enclosed in a one-half (½) inch unpainted zinc-coated metallic conduit.

Not less than two branch circuits shall be provided. Pedestrian passageway lights and roadway pavement lights shall be on a minimum of one circuit and portal flood lights shall be on a minimum of one separate circuit. Each branch circuit shall be fused, not to exceed 20 amperes.

The above specified portal lighting shall be installed on the day that horizontal members are erected and before traffic is permitted to pass under the falsework during the hours from dusk to dawn. The other falsework lights shall be installed as soon as the members on which they are to be supported are in place.

Energy costs for falsework lighting shall be paid by the Contractor.

On each side of each portal entrance, and no farther apart than the least horizontal clearance within the portal, clearance guides consisting of a panel of boards or a plywood sheet, four (4) feet wide by eight (8) feet long, shall be fastened vertically facing traffic with the bottom of the panel three (3) feet to four (4) feet above the roadway. The panel shall be painted with not less than two (2) coats of flat white paint, furnished and applied by the Contractor. Testing of paint will not be required. Said clearance guides shall be fastened in place before darkness on

the day that vertical supports are erected and shall be maintained clean and white by the Contractor.

Upon completion of the project or when directed by the Engineer, falsework lighting equipment shall become the property of the Contractor and shall be removed from the site of the work.

SALVAGING AND REINSTALLING OR STOCKPILING ELECTRICAL EQUIPMENT

623.03.15 Salvaging Electrical Equipment. Where shown on the plans or ordered by the Engineer, existing electrical equipment to be removed, including controller units, cabinets, signal heads, luminaires, standards, mast arms, ballasts, transformers, service equipment, pull boxes, and detector contact units shall be salvaged.

Care shall be exercised in removing and salvaging electrical equipment so that it will remain in its original form and existing condition whenever possible. Attention is directed to the provisions in subsection 107.11, "Responsibility for Damage Claims," and 107.12, "Protection and Restoration of Property and Landscape." The Contractor will be required to replace, at his expense, any of the above-mentioned electrical equipment, which, as determined by the Engineer, has been damaged or destroyed by reason of his operations.

Unless otherwise specified, underground conduit, conductors, foundations, and detector frames not reused shall become the property of the Contractor and shall be removed from the highway right of way, except if not interfering with other construction, said materials, except foundations, may, with the written approval of the Engineer, be abandoned in place. Certain other materials, when shown on the plans, shall also become the property of the Contractor.

Attention is directed to the provisions in subsection 623.02.02A, "Foundations," regarding foundations to be abandoned.

Holes formed by removing pull boxes and foundations shall be filled with material equivalent to the surrounding material.

623.03.16 Reinstalling Salvaged Electrical Equipment. When salvaged electrical equipment is to be reinstalled, the Contractor shall furnish and install all necessary materials and equipment, including signal mounting brackets, anchor bolts, nuts, washers and concrete as required to complete the new installation.

All traffic signal, flashing beacon, and lighting fixtures to be reinstalled shall be cleaned and relamped.

Existing materials required to be relocated and found to be unsatisfactory by the Engineer shall be replaced by new material and the cost therefor will be paid for as extra work as provided in subsection 104.03, "Extra Work."

623.03.17 Stockpiling Salvaged Electrical Equipment. Existing equipment removed and not reused shall be salvaged and shall be stockpiled at the site of the work.

METHOD OF MEASUREMENT

623.04.01 Measurement. The unit of measure for "Traffic Signal System," "Highway Lighting System," and "Traffic Signal and Highway Lighting System," will be lump sum.

The quantity of "Conduit for Future Conductors" will be measured for payment by the linear foot of conduit complete and in place.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

623.05.01 Payment. The lump sum price or prices paid for traffic signals, highway lighting systems, sign illumination systems, traffic counting detectors, or combinations thereof, or the unit prices paid for various units of said systems shall include full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in furnishing and installing, modifying, or removing the systems or combinations thereof as shown on the plans, and as specified in

these specifications and the special provisions, and as directed by the Engineer, including any necessary pull boxes; excavation and backfill; concrete foundations; restoring sidewalk, pavement and appurtenances damaged or destroyed during construction; salvaging existing materials; and making all required tests.

Full compensation for all additional materials and labor, not shown on the plans or specified, which are necessary to complete the installations of the various systems, shall be considered as included in the prices paid for the systems, or units thereof, and no additional compensation will be allowed therefor, except as provided in subsection 623.01.05, "Maintaining Existing and Temporary Electrical Systems."

The accepted quantities of "Conduit for Future Conductors," measured as provided in subsection 623.04.01, "Measurement," will be paid for at the contract unit price bid per linear foot for conduit.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Traffic Signal System	Lump Sum
Highway Lighting System (may include sign lighting system)	Lump Sum
Traffic Signal and Highway Lighting System (may include sign lighting system)	Lump Sum
Conduit for Future Conductors	Linear Foot

SECTION 624

ACCOMMODATIONS FOR PUBLIC TRAFFIC

DESCRIPTION

624.01.01 General. This work shall consist of providing for traffic by constructing detours or special detours, permitting traffic to pass through construction, and using flagmen or pilot cars and maintaining the base, or a combination of these methods as indicated in the contract documents or as directed in writing by the Engineer.

MATERIALS

624.02.01 General. The materials used for the construction and maintenance of facilities required for the free flow of public traffic and for protection of the work shall be those prescribed for the several items which constitute the finished work and shall conform to all the requirements for such materials as set forth herein.

CONSTRUCTION

624.03.01 Special Detours. Special detours shall be constructed as shown on the plans or as specified. Detour locations indicated on the plans may be approximate only; the exact location shall be as staked by the Engineer.

Grading for special detours shall consist largely of motor grader work, supplemented where necessary by other mechanical equipment, to provide the specified roadbed width and a grade line free from breaks or rolls of sufficient magnitude to be hazardous to traffic.

When grading of special detours has been completed and approved by the Engineer and, if required on the plans or in the special provisions, the special detours shall receive surfacing materials of the kind and type specified, and they shall be placed and constructed in accordance with the requirements for the particular materials used.

Water shall be applied to detours in amounts necessary to attain the compaction of graded sections and of surfacing materials.

Maintenance on special detours shall consist largely of filling holes as they develop, adding surfacing and applying liquid asphalt, blading, watering, and performing any other work necessary to maintain the detour satisfactorily, as ordered by the Engineer.

Eradication of special detours shall consist largely of blade grader and scraper work supplemented by other equipment when necessary. Eradication will be performed to the extent that the ground will be restored as nearly as feasible to the original, and material disposed of, all as directed by the Engineer.

624.03.02 Flagmen. If, in the opinion of the Engineer, controlled traffic is necessary for protection of the work or for safety of public traffic, flagmen shall be employed by the Contractor at places designated by the Engineer. This does not exclude the use of flagmen by the Contractor, at his expense, whenever he sees fit to do so.

Flagmen shall have completed an approved instructional course in flagman procedures. A prospective flagman shall possess a valid flagman card attesting that he has satisfactorily completed said instructional course conducted by the Highway Department or some other approved course given by another entity of government within the State.

Each flagman shall be supplied for use in daylight, with an orange vest, and an orange hard hat. For nighttime conditions similar outside garments shall be reflectorized. Flags shall not be less than twenty-four (24) inches square, made of a good grade of red material securely fastened to a staff approximately three (3) feet in length. The free edge shall be weighted to insure that the flag will hang vertically, even in heavy winds. Sign paddles may be used in lieu of red flags. Paddles shall be at least twenty-four (24) inches wide, with six (6) inch series "C" letters and have a rigid-fixed handle. This combination sign paddle may be fabricated from sheet metal or other light semi-rigid material. The background of the "STOP" face shall be red with white letters and border. The background of the "SLOW" shall be orange with black letters and border.

The flagman must stand just outside of approach traffic

lane. He should be near enough to the men and work being protected so that there can be no doubt as to his purpose. This distance may vary from two hundred (200) to five hundred (500) feet, depending upon road conditions and upon the visibility and location in regard to curves and hills. The flagman should place himself so that approaching drivers can see him from a distance of at least five hundred (500) feet. He should be positioned so as to have the flag or sign paddle visible in the traffic lane, but he should not jeopardize his own safety and must be ready to stand clear of an approaching vehicle in case it does not stop.

When signalling traffic to stop, slow down, or proceed, the flagman must face the traffic affected by the signals. The flag or sign paddle is not to be waved. Particular attention must be given to the flagging of traffic when operations are being conducted on a curve or hill and are hidden from the view of an approaching driver.

The flagman should always be courteous but firm, giving explanation in a few words as to the delay or hazard, such as "Men Working in Road Ahead," "Fresh Oil," etc. A flagman must not lose his temper or get into an argument with the traveling public.

In stopping traffic, the flag or paddle shall be extended in a horizontal position across the lane of traffic so that the full area of the flag hanging below the staff is visible.

In slowing down traffic, without stopping, flag or paddle shall be extended in a horizontal position across the lane of traffic and as the vehicle approaches, the flag shall be lowered and traffic motioned to proceed.

To request traffic to proceed after stopping, the flag and arm shall be lowered from the horizontal position and traffic motioned to proceed.

624.03.03 Pilot Cars. If, in the opinion of the Engineer, it is necessary to afford additional protection to the work, workmen, or public traffic, a pilot car and driver shall be used as he directs. This provision shall be in effect even though the pilot car and driver are not indicated on the plans or provided for in these specifications.

Pilot cars shall be suitable vehicles in good mechanical

condition and shall carry a sign which shall comply with the design and mountings as shown on the standard drawing appended to the special provisions, or shown on the plans.

624.03.04 Maintain Base. When the proposal contains an item of "Maintain Base," the provisions of subsection 109.03, "Extra and Force Account Work," shall apply.

624.03.05 Equipment Rental. When the proposal contains an item of equipment rental, the use of such equipment shall be as directed by the Engineer or as indicated on the plans.

METHOD OF MEASUREMENT

624.04.01 Measurement. Measurement for the various items involved in accommodating traffic shall be paid for as follows:

(a) When the proposal contains an item "Special Detours," measurement for payment will be made in accordance with the provisions of subsection 109.03, "Extra and Force Account Work."

(b) When the proposal contains an item of "Flagman," the flagging as specified in the contract documents, or ordered by the Engineer or required by other government agency having jurisdiction, will be measured by the number of hours that flagmen are actually used to direct traffic within the right of way limits of the project, and at points where the Contractor's hauling equipment enters or leaves the public traffic stream while hauling borrow and base and surface aggregates from deposits set forth in the Special Provisions and Material Information Packet, as possible sources of such material, will be measured or paid for. The cost of all other required flagmen shall not be measured or paid for directly but the cost thereof shall be considered as included in the payment for other items of work.

(c) When the proposal contains the item of "Pilot Car," the piloting as specified in the contract documents or ordered by the Engineer, will be measured by the number

of hours that the pilot car and driver are actually used to lead traffic through the controlled areas.

(d) When the proposal contains an item "Maintain Base," measurement for payment will be made in accordance with the provisions of subsection 109.03, "Extra and Force Account Work."

(e) When equipment is used for constructing special detours or maintaining the base and such equipment is rented as indicated in the proposal, it shall be measured for payment by the number of hours actually used.

BASIS OF PAYMENT

624.05.01 Payment. Payment for special detours and maintain base, measured as specified in subsection 624.-04.01, "Measurement," will be paid for by "Force Account."

Eradication of special detours shall be paid for as "Force Account" and shall be included in the bid item "Special Detours."

The accepted quantities of flagmen measured as specified in subsection 624.04.01, "Measurement," will be paid for at the contract bid price per hour for flagmen, which price shall be full compensation for all equipment, competent personnel, and all incidentals necessary for the operation.

The accepted quantities of pilot car, measured as specified in subsection 624.04.01, "Measurement," will be paid for at the contract bid price per hour for pilot car, which price shall be full compensation for the vehicle, an experienced driver, all operating costs, and depreciation.

When the items of flagmen or pilot car do not appear in the proposal, and it is necessary to protect the traveling public, in the Engineer's opinion, flagmen or pilot cars will be furnished by the Contractor and payment therefor will be made in accordance with subsection 104.03, "Extra Work," except, however, when the Contractor constructs and maintains a detour at his expense as provided in subsection 104.04(c), "Maintenance of Traffic."

The accepted quantities of equipment rental measured as specified in subsection 624.04.01, "Measurement," will be paid for at the contract unit price bid per hour for the

particular items of equipment indicated in the proposal form. The contract unit price bid per hour shall include skilled operators for each piece of equipment, fuel, lubricants, repairs, depreciation, and all expenses incidental to the operation of the equipment.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Special Detours	Force Account
Flagman	Hour
Pilot Car	Hour
Maintain Base	Force Account
Rent Equipment (type)	Hour

SECTION 625

CONSTRUCTION SIGNS

DESCRIPTION

625.01.01 General. This work shall consist of furnishing and erecting for rental, all necessary barricades, traffic cones, delineators, Type A and Type B barricade warning lights, and standard construction signs at locations set forth in the contract documents, or as directed by the Engineer, for the protection of the work, workmen, and guidance and safety of the traveling public.

All construction signs, barricades, traffic cones, delineators and barricade warning lights shall remain the property of the Contractor upon completion of the contract and shall be removed from the project by him.

All signs, barricades, traffic cones, delineators and barricade warning lights shall conform to the requirements of the MUTCD Manual, the Standard Highway Sign Book (1972) including the Nevada Supplement thereto, unless indicated otherwise on the plans or in the special provisions.

MATERIALS

625.02.01 General. It is expressly intended that a rather broad selection of material be granted the Contractor since construction signs are in temporary use. Sign panels may be constructed of steel, aluminum, wood, or other approved material and be of a sound, durable nature. The materials shall be of such quality to do the job for which they are intended and are subject to approval by the Engineer. Signs which have become dull, have flaking or peeling paint, are dirty or are otherwise marred shall be repaired or replaced with acceptable signs.

All materials shall conform to the requirements specified in the following section:

Sign Materials.....Section 716

625.02.02 Reflectorization. All construction signs, barricades and delineators shall be reflectorized. Traffic cones, when used during the hours of darkness, shall be reflectorized. Minimum reflectorization shall be as follows:

(a) Signs shall be reflectorized using Type I reflective sheeting materials.

(b) Barricades and traffic cones shall be reflectorized so as to be visible under normal atmospheric conditions from a minimum distance of one thousand (1,000) feet when illuminated by the low beams of standard automobile headlights.

(c) Delineators shall be reflectorized by means of a prismatic reflector with a minimum diameter of three (3) inches.

625.02.03 Sign Dimensions. Sign dimensions shown are minimum standard. Increases above this minimum are permissible and desirable where investigation has shown a larger sign is needed for adequate emphasis. In the enlarging of signs, standard shapes and colors shall be used, and standard proportions shall be retained, so far as practicable.

CONSTRUCTION

625.03.01 General. Before any detour or temporary route is opened to traffic, all necessary signs shall be in place. Signs required by road conditions or restrictions shall be removed immediately when those conditions cease to exist or the restrictions are withdrawn. Guide signs directing traffic to and on temporary routes or detours shall be removed when no longer applicable.

625.03.02 Sign Placement. Signs must always be placed in positions where they will convey their messages most effectively without restricting lateral clearance of sight distance. Placement must therefore be accommodated to highway design and alignment. Signs must be so placed that the driver will have sufficient time to absorb the message before having to act.

As a general rule, signs shall be located on the right hand side of the roadway, with the near edge of the sign

from six (6) feet to twelve (12) feet from the edge of the traveled way or at least two (2) feet outside an unmountable curb. Where construction or maintenance operations are underway, however, it is often necessary to place signs on barricades within the roadway, or (usually as supplementary or duplicate signs) on the left of the roadway. All signs should be mounted approximately at right angles to the direction of and facing the traffic they are to serve. Roadside signs should be mounted so that the bottom of the sign is approximately five (5) feet above the pavement level. Where construction equipment or materials or other obstructions may be present, this height should be increased to seven (7) feet. Standards for height and lateral clearance of roadside signs are shown in the standard drawings. Signs mounted on barricades, or temporary signs in the roadway, may be at lower heights as dictated by circumstances, however when signs are to be mounted on barricades, the bottom of the sign must have a one (1) foot minimum clearance above the pavement.

625.03.03 Sign Supports. Signs, posts, and their foundations shall be so constructed as to hold signs rigidly in a proper and permanent position, and prevent them from swaying in the wind, or from being turned or otherwise displaced by children or irresponsible persons.

A portable or removable type of mounting may be used for signs required intermittently or which are frequently moved. Such a mounting shall be heavy enough not to turn over in the wind, and its base shall not be appreciably wider than the sign.

625.03.04 Barricades. Highways closed to traffic shall be protected by Type I, Type II, or Type III barricades, as approved by the Engineer, on which shall be placed appropriate warning signs. The Contractor shall provide and maintain appropriate warning and detour signs at all closures, intersections, and along detour routes, directing the traffic around the closed portions of the highway so that the temporary detour route or routes shall be indicated clearly throughout its or their entire length.

Rocks, asphalt or concrete pieces, construction materials and other debris shall not be used as a weighting device for barricades, however, sand bags will be permitted as long as a low center of gravity is maintained as approved by the Engineer.

METHOD OF MEASUREMENT

625.04.01 Measurement. The quantity of construction signs to be measured for rental will be the number of square feet of sign surface furnished in accordance with the dimensions shown on the plans.

Barricades will be measured for rental and will be identified by the type set forth in the proposal. If more than one type of barricade is involved, separate measurement will be made for each type given. For purposes of measurement and rental, Type I and Type III barricades shall be measured for rental by the linear foot of width of the barricade or barricades erected. Type II barricades shall be measured for rental as units. Traffic cones or delineators shall be measured for rental as units. Type A and Type B barricade warning lights shall be measured for rental as units.

Only the quantity and type of signs and barricades ordered or approved in writing by the Engineer for delivery to the project will be measured for payment. Such order or approval will not be given until after the Contractor has informed the Engineer of his proposed method of operation.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

625.05.01 Payment. The accepted quantity of construction signs measured as provided in subsection 625.-04.01, "Measurement," will be paid for at the contract unit price bid per square foot.

Signs which have been measured for payment as set forth in subsection 625.04.01 but were not erected will be

paid for only at the rate of sixty (60) percent of the contract unit price bid.

Payment will not be made for signs which are inadequate or are not in compliance with the specification requirements, therefore, permanent deductions will be made from the final payment as determined by the schedule of prorating progress set forth in subsection 109.06 of these special provisions.

The accepted quantity of barricades measured as provided above will be paid for at the contract unit price bid per linear foot for Type I and Type III barricades and at the contract unit price bid per each for the Type II barricades and traffic delineators and cones and Type A and Type B barricade warning lights.

Moving signs and barricades from one location to another on the project, as directed by the Engineer, shall be considered necessary and essential and no additional compensation will be allowed therefor.

The above prices shall be full compensation for furnishing, erecting, maintaining, moving, removing, and disposing of signs and barricades and any necessary excavation and backfill and for furnishing warning lights, and hardware necessary to complete the work.

Partial payments may be made as set forth under subsection 109.06, "Partial Payments."

Signs and barricades which have been approved for payment shall not be removed from the project until approved in writing by the Engineer.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Rent Construction Signs	Square Foot
Rent Construction Barricades (Type I)	Linear Foot
Rent Construction Barricades (Type III)	Linear Foot
Rent Construction Barricades (Type II)	Each
Rent Traffic Delineators	Each
Rent Traffic Cones	Each
Rent Barricade Warning Lights (Type A)	Each
Rent Barricade Warning Lights (Type B)	Each

SECTION 626

TEMPORARY SIGNS

DESCRIPTION

626.01.01 General. This work shall consist of furnishing and erecting signs, barricades, traffic cones, delineators, and/or warning lights, or erecting similar traffic control devices previously removed at locations shown in the contract documents or directed by the Engineer, for the safety of the traveling public at temporary connections, crossovers, and/or detours. All signs, barricades, traffic cones, delineators, and warning lights shall be retained by the State as State property.

All signs, barricades, traffic cones, delineators, and/or warning lights shall conform to the requirements of the MUTCD Manual, the Standard Highway Sign Book (1972), including the Nevada Supplement, unless indicated otherwise on the plans or in the special provisions.

MATERIALS

626.02.01 General. All materials shall be new, except materials which have been designated as "Reset."

New material shall conform to the following applicable requirements:

Sign Materials.....Section 716

Sign posts shall be timber of the size shown on the plans. The posts shall be of the same materials and receive the same preservative treatment as required under Section 620, "Right of Way Markers."

626.02.02 Reflectorization. All signs, barricades, traffic cones, and delineators shall be reflectorized. The minimum reflectorization shall be as follows:

(a) Signs shall be reflectorized using Type 1 reflective sheeting.

(b) Barricades and traffic cones shall be reflectorized so as to be visible under normal atmospheric conditions from

a maximum distance of one thousand (1,000) feet when illuminated by the low beams of standard automobile headlights.

(c) Delineators shall be reflectorized by means of a prismatic reflector with a minimum diameter of three (3) inches.

CONSTRUCTION

626.03.01 General. Signs, barricades, traffic cones, and delineators shall conform to the detailed design and methods of erection shown on the Standard Design Sheets.

Before any route is opened to traffic, all necessary signs shall be in place.

626.03.02 Signs. Sign locations indicated on the plans are approximate only. Final determination of sign locations will be made in the field by the Engineer.

Each sign face shall be thoroughly cleaned according to the reflective material manufacturer's recommendations, and all undesirable material that is visible on the face of the sign shall be removed. The use of abrasives or other cleaning material that will scratch or otherwise deface shall not be permitted.

Sign faces of all directional signs facing public traffic and directing such traffic to a portion of the project not yet open to public traffic, shall have the message covered.

Care shall be exercised at all times in handling, storing, transporting, and erecting of the signs. Signs which are damaged shall be repaired or replaced at the Contractor's expense.

626.03.03 Traffic Cones. Temporary traffic cones shall conform to the design and placement shown on the plans. Cones shall be attached to the pavement with an epoxy designed for the purpose of attaching the flexible cone material to the type of pavement at the location shown on the plans. The rate of application of the epoxy, the allowable temperature at time of application and the method of application shall be as recommended by the manufacturer and as approved by the Engineer.

626.03.04 Barricades. Rocks, asphalt or concrete

pieces, construction materials and other debris shall not be used as a weighting device for barricades, however, sand bags will be permitted as long as a low center of gravity is maintained as approved by the Engineer.

626.03.05 Remove and Re-erect Temporary Signs or Barricades. Signs or barricades to be removed and re-erected will be designated on the plans or in the special provisions. Care shall be taken in removing signs or barricades and no equipment or devices shall be used which might cause damage thereto. If damage is done due to the negligence of the Contractor, the sign shall be replaced in kind at the expense of the Contractor.

Any new posts or hardware necessary to re-erect the sign or barricade shall be furnished by the Contractor, shall be of the same kind as those in the original, if available, and the cost thereof shall be included in the contract price for the work. The Department reserves the right to furnish the Contractor with such materials as it deems advisable, and these materials shall be used in the re-erection of the signs or barricades in lieu of materials removed.

Sign and barricade reflectorized faces shall be cleaned in accordance with the provisions of subsection 626.03.02, "Signs."

METHOD OF MEASUREMENT

626.04.01 Measurement. The quantity of new or re-erected temporary signs to be measured for payment will be the number of square feet of sign surface in the completed work measured in accordance with the dimensions shown on the plans.

Barricades will be measured for payment and will be identified by the type set forth in the proposal. If more than one type of barricade is involved, separate measurement will be made for each type given. Type I and Type III barricades shall be measured for payment by the linear foot of width of the barricade or barricades erected complete in place to the satisfaction of the Engineer. Temporary traffic cones shall be measured for payment on an each basis complete in place to the satisfaction of the Engineer.

Temporary signs and barricades shall remain a part of the completed project.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

626.05.01 Payment. The accepted quantity of new and re-erected temporary signs measured as provided in subsection 626.04.01, "Measurement," will be paid for at the contract unit price bid per square foot.

The accepted quantity of barricades measured as provided above will be paid for at the contract unit price bid per linear foot for Type I and Type III barricades. Type II barricades, traffic delineators and Type A and Type B barricade warning lights will be paid for at the contract unit price bid per each.

The accepted quantity of temporary traffic cones measured as provided above will be paid for at the contract unit price bid each which price shall be full compensation for furnishing and installing the cones complete in place in the accepted work.

The above prices shall be full compensation for erecting, removing and re-erecting, excavation and backfill, and for all materials and labor necessary to complete the work.

Partial payments for new signs and barricades may be made as set forth under subsection 109.06, "Partial Payments."

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Temporary Signs	Square Foot
Temporary Barricades (Type I)	Linear Foot
Temporary Barricades (Type III)	Linear Foot
Temporary Barricades (Type II)	Each
Temporary Signs, Remove and Reset	Square Foot
Temporary Signs, Remove	Square Foot
Temporary Signs, Reset	Square Foot
Temporary Traffic Cones	Each
Temporary Delineators	Each
Temporary Barricade Warning Lights (Type A)	Each
Temporary Barricade Warning Lights (Type B)	Each

SECTION 627

PERMANENT SIGNS

DESCRIPTION

627.01.01 General. This work shall consist of furnishing, erecting and installing all signs, sign supports and other materials required for highway signs in accordance with the MUTCD Manual, the Standard Highway Sign Book including the Nevada Supplement, these specifications as shown on the plans and as directed by the Engineer. This item does not include construction signs used for traffic control during construction or temporary signs.

The work shall generally consist of:

(a) Overhead signs, including concrete foundations, steel sign posts and frames, and steel sign panels with porcelain enamel finish.

(b) Ground mounted signs consisting of concrete foundations, steel sign posts, reflectorized aluminum sign panels, and appurtenances.

This item does not include sign illumination systems.

627.01.02 Shop Drawings. When overhead sign structures are to be furnished, the Contractor shall submit to the Engineer five (5) sets of shop drawings for each overhead sign structure for approval. Fabrication of the overhead sign structures shall not commence until the shop drawings have been approved by the Department.

Shop drawings for signs will not be required, however all signs shall conform to the plans and either the Standard Highway Sign Book or the Nevada Supplement thereto. For signs which are shown on the Sign Summary Sheets and are not included in the Standard Highway Sign Book or the Nevada Supplement, special sign design sheets shall be furnished by the Department to the successful bidder after the time of award of the project. The special design sheets shall include such information as letter heights, spacing between letters and words, borders, sign radii, etc.

These signs shall conform to the special design sheets as well as the drawings noted on the plans.

MATERIALS

627.02.01 General. Materials shall conform to the following applicable requirements:

Sign Materials.....Section 716

627.02.02 Reflectorization. All signs, except overhead signs, shall be reflectorized. The types of reflective materials to be used shall be as follows:

(a) Reflectorized green guide signs (excluding overhead guide signs) shall utilize Type I reflective sheeting for sign background, letters, numerals, symbols, borders and accessories. All letters, numerals, symbols, borders and accessories shall be directly applied to the sign background.

(b) All other reflectorized signs shall utilize Type I reflective sheeting.

627.02.03 Overhead Guide Signs. All overhead guide signs shall be porcelain enamel.

627.02.04 Cut-out Letters, Numerals, Symbols and Accessories for Guide Signs. All names of places and highways on guide signs shall be composed of lower case letters with initial capital letters. The initial capital letters shall be one and one-third times the "loop" height of the lower case letters. Other legend on guide signs shall be in capital letters.

It is intended that the initial capital letters (and numerals) used shall be series E, modified by widening the stroke-width to approximately one-fifth ($\frac{1}{5}$) the letter (or numeral) height. Tables of recommended letter spacing can be obtained from the FHWA.

Arrows which are used for large directional guide signs shall be in direct proportion to the arrows shown in the MUTCD.

CONSTRUCTION

627.03.01 Panel Fastenings. The panel sections shall be provided with suitable fastenings, as shown on the plans, to permit easy attachment to the supporting frames. These fastenings shall be so designed as to carry the full design load with a factor of safety of not less than 1.5. Panel sections shall be provided with closure strips at the joints.

Panel fastenings for use on sign panels covered with Type II reflective sheeting shall utilize nylon washers for contact between the reflective sheeting and the metal washer.

627.03.02 Closure Strips. Closure strips shall be anchored by aluminum rivets as shown on the plans. Rivets shall be the same color as the sign face. Closure strips are required only on aluminum sign panels.

627.03.03 Installation. Sign locations indicated on the plans are approximate only. Final determination of sign locations will be made in the field by the Engineer.

Signs and sign islands shall be constructed to the lines and grades given by the Engineer and in accordance with the design and locations shown on the plans.

All signs shall be erected as specified before, during or immediately after the completion of bituminous plantmix surface operations.

The date of installation, consisting of month and year, shall be permanently stamped on the back of each sign with metal dies and shall be visible only on close inspection. The stamp shall be placed on the lower right hand corner when facing the rear of the sign.

Each sign face shall be thoroughly cleaned according to the reflective material manufacturer's recommendations, and all undesirable material that is visible on the face of the sign shall be removed. The use of abrasives or other cleaning material that will scratch or otherwise deface shall not be permitted.

Sign islands shall be constructed as roadway embankment in conformity with Section 203, "Excavation and Embankment." Structure excavation and backfill shall conform to the requirements of Section 206, "Structure Excavation," and Section 207, "Backfill." Anchor bolts shall be set true to line and grade and posts shall be plumb.

Sign faces of all directional signs facing public traffic and directing such traffic to a portion of the project not yet open to public traffic, shall have the message covered.

Care shall be exercised at all times in the handling, storing, transporting, and erecting of the signs. Signs which are damaged shall be repaired or replaced at the Contractor's expense.

Pipe sign posts may be field cut and drilled to adjust for local conditions when approved by the Engineer. Flame cutting will not be permitted. All field cuts and abraded areas on steel pipe posts shall be thoroughly cleaned and given two coats of paint having a high zinc dust content conforming to the requirements of Federal Specification MIL–P–21035.

Extending the lengths of sign posts to adjust for local conditions by splicing or welding will not be permitted.

627.03.04 Tests. It shall be the Contractor's responsibility to ascertain that all required tests have been made by qualified testing laboratories as approved by the Department. The Contractor shall furnish the Department with a written certification that all required tests have been satisfactorily completed and that materials and fabrication thereof comply with all the requirements.

METHOD OF MEASUREMENT

627.04.01 Measurement. Permanent signs, other than signs listed as "Overhead," shall be measured for payment by the number of square feet of sign face surface. The square footage shall be determined from the dimensions of sign panels in the completed and accepted work.

Sign panels on permanent signs listed as "Overhead"

signs shall be measured by the square foot of sign panel in the completed and accepted work.

Sign supports for permanent signs listed as "Permanent Overhead Sign Support Structures" shall be measured and paid for on the lump sum basis.

All measurements will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

627.05.01 Payment. Sign panels shall be paid for at the contract unit price bid per square foot for "Permanent Signs (Ground Mounted)," which shall be full compensation for furnishing all labor, materials, tools, supplies, equipment, and incidentals and for doing all the work involved in furnishing and erecting permanent signs (other than signs listed as overhead) complete in place as shown on the plans and as herein specified, including but not limited to structure excavation and backfill, concrete foundations, supports, sign islands, and making all required tests.

Sign panels shall be paid for at the contract unit price bid per square foot for "Permanent Sign Panels (Overhead)," which payment shall be full compensation for furnishing all labor, materials, tools, supplies, equipment, and incidentals and for doing all the work involved in furnishing and erecting permanent sign panels (for signs listed as overhead signs) complete in place as shown on the plans and herein specified.

Sign supports shall be paid for at the contract lump sum price bid for "Permanent Overhead Sign Support Structures" which payment shall be full compensation for furnishing all labor, materials, tools, supplies, equipment, and incidentals and for doing all the work involved in furnishing and erecting permanent sign supports (for all signs listed as overhead signs) complete in place as shown on the plans and as herein specified, including structure excavation and backfill, concrete foundations, cast-in-place

concrete piles, structural steel posts and frame, sign islands, and making all required tests.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Permanent Signs (Ground Mounted)	Square Foot
Permanent Sign Panels (Overhead)	Square Foot
Permanent Overhead Sign Support Structures	Lump Sum

SECTION 628

MOBILIZATION

DESCRIPTION

628.01.01 General. The item of mobilization shall consist of preparatory work and operations, including, but not limited to, those necessary for the movement of personnel, equipment, supplies, and incidentals to the project site, for the establishment of all offices, buildings and other facilities necessary for work on the project, as well as all other work and operations which must be performed, or costs incurred, not otherwise paid for prior to beginning work on the various items on the project site.

This item shall also consist of furnishing water and electricity to all Department furnished field laboratories used on the project. The amount of water and electricity supplied shall be that necessary to satisfy the requirements of the Department and the Contractor shall make all necessary connections of both water and electricity to the laboratories.

PAYMENT

628.05.01 Payment. Payment for this work will be made at the contract lump sum bid price for "Mobilization."

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Mobilization	Lump Sum

109.06 (8/13)

SECTION 632

HEADLIGHT GLARE SCREEN

DESCRIPTION

632.01.01 General. This work shall consist of furnishing and installing headlight glare screen at the locations and in accordance with the details shown on the plans and as specified herein.

Headlight glare screen may consist of expanded steel or aluminum mesh panels mounted on galvanized steel posts and tied to a top and bottom tension wire or may be of other acceptable material specified in the plans.

MATERIALS

632.02.01 General. The aluminum and steel materials for the headlight glare screen shall conform to the following provisions:

(a) Expanded Mesh. The expanded steel mesh panels shall be fabricated from 22 gage Galvanized Sheet Commercial Quality (dry for continuous strip painting) to ASTM A–525, 1.25 oz. commercial galvanized coating with minimum spangle; or

The expanded aluminum mesh panels shall be fabricated of aluminum alloy 3105–H25. The expanded mesh panels shall have the following nominal dimensions:

Diamond Size	1.33″ short dimension (center to center of bridges) 4.00″ long dimension (center to center of bridges)
Strand Size	Aluminum 0.050″ Steel 0.034″ thick Aluminum or Steel 0.250″ in width
Panel Size for Type A	2′–0″ long dimension of diamonds 6′–8″ or 12′–8″ short dimension of diamonds
Panel Size for Type B	2′–0″ long dimension of diamonds 5′–5″ or 10′–5″ short dimension of diamonds

The weight of expanded aluminum mesh shall be not less than 0.21-pound per square foot.

Steel mesh panels before fabrication shall be treated in power washing equipment with a chemical conversion coating conforming with the requirements of Federal Specification MIL–C–5541 and furnished with two coats of protective paint on both sides, applied before fabrication.

Aluminum mesh panels before fabrication shall be treated in power washing equipment with a chemical conversion coating conforming with the requirements of Federal Specification MIL–C–5541 and finished with one coat of high temperature baking enamel on both sides, applied before fabrication.

The finish for the steel mesh panels shall be one primer coat of zinc chromate containing epoxy followed by a finish coat of commercial quality, high temperature baking enamel, made with a combination of alkyd, vinyl, and amino resins, or equivalent materials formulated for roller coating application. Both coats shall be applied in one continuous pass through the roller coating equipment.

The finish for the aluminum mesh panels shall be commercial quality, high temperature baking enamel, made with a combination of alkyd, vinyl, and amino resins, or equivalent materials, formulated for roller coating application.

The color of the enamel finish shall be Interstate Green unless otherwise specified. The baked enamel finish shall be uniform throughout and shall be smooth and free from flow lines, streaks, blisters, or other surface imperfections.

The composition of the baked dry film shall conform to the following requirements:

1. Thickness. The dry film thickness shall be not less than 0.8 mil as determined by ASTM Designation: D1400.

2. Gloss. The gloss of the enamel shall be standard medium gloss (sixty (60) degrees specular gloss 70 minimum when tested in accordance with Federal Test Method Standard No. 141, Method 6101).

3. Color Uniformity. The color uniformity of the enamel after baking shall be constant within commercial limits when checked visually in the Macbeth Daylight Booth.

4. Coating Adhesion. There shall be no loss of adhesion of the coating to the base metal during or after fabrication of the expanded mesh panels.

After fabrication, expanded mesh when installed on the barrier rail shall give a complete cut-off of all oncoming headlight beams at angles up to twenty (20) degrees from their straight ahead direction.

Shearing shall be accomplished in a uniform and workmanlike manner with a minimum of burrs, edge spalling of enamel, sharp edges and shear marks.

(b) Posts, Caps and Hardware. Posts on metal beam barrier rail shall be fabricated of structural steel conforming to the specifications of ASTM Designation: A36 and shall be hot-dip galvanized after fabrication in accordance with specifications of ASTM Designation: A123. Hardware shall be commercial quality and shall be galvanized.

Posts on concrete barrier rail shall be standard weight black pipe conforming to the requirements of ASTM Designation: A53 or A120 and shall be threaded to receive standard threaded pipe caps. Posts and caps shall be hot-dip galvanized after fabrication. Hardware shall be commercial quality and shall be galvanized.

(c) Tension Wires. The top and bottom tension wires shall be 7-gage and shall be galvanized coil spring steel wire of commercial quality.

(d) Wire Ties. The bottom tension wire shall be tied to each post with 9-gage (0.1483″ min. dia.) steel wire ties or hog rings. The expanded mesh panels shall be tied to the top and bottom tension wires and to each post with 11-gage (0.120″ min. dia.) steel wire ties or hog rings. Wire ties shall be given at least one complete turn.

Steel wire ties and hog rings shall be commercial quality and shall be galvanized.

Aluminum wire ties or hog rings of the same minimum diameters as specified for steel may be substituted for steel wire ties or hog rings.

The aluminum wire ties shall be aluminum alloy 1100–H18 conforming to the specifications of ASTM Designation: B211. Aluminum hog rings shall be fabricated from either aluminum alloy 6061–T94 or 5052–H38.

(e) Removable Expanded Mesh Panel. Removable expanded mesh panels shall be installed as shown on the plans.

The steel "L"-shaped bolts with nuts and washers for supporting the removable panel and the sign fastening hardware shall be commercial quality and shall be galvanized.

The sign shall conform to the provisions for target plates as provided in Section 619 and the plans. The enamel finish coat shall comply with the requirements of Federal Specification TT–E–489 as required in Section 721 of the Standard Specifications. The color of the finished sign shall be white. The letters on the sign shall be black.

Note: Without expense to the Department, two certificates covering each order of material shall be furnished by the manufacturer certifying that the product complies with the specifications. One certificate shall be delivered to the Engineer in charge at the jobsite at the time of, or prior to, delivery of the order. The other certificate shall be delivered to the Department at Carson City prior to acceptance of the material.

CONSTRUCTION

632.03.01 General. Headlight glare screen shall be erected on steel posts and tied to a top and bottom tension wire and shall be mounted on the metal beam or concrete barrier rail at the locations and in accordance with the details shown on the plans. The exact location of the removable expanded mesh Emergency Panel will be determined by the Engineer.

METHOD OF MEASUREMENT

632.04.01 Measurement. The quantity of headlight glare screen to be paid for will be determined by the linear foot from actual measurement along the line of the completed headlight glare screen.

BASIS OF PAYMENT

632.05.01 Payment. The quantity of headlight screen measured as provided above shall be paid for at the contract

unit price bid per linear foot for "Headlight Glare Screen," which payment shall be full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in constructing headlight glare screen, including the Emergency Panels and hardware complete in place as shown on the plans and as specified.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Headlight Glare Screen (Type A)	Linear Foot
Headlight Glare Screen (Type B)	Linear Foot

SECTION 633

PAVEMENT MARKERS

DESCRIPTION

633.01.01 General. This work shall consist of furnishing and placing pavement markers at the locations shown on the plans or where directed by the Engineer.

The markers shall have the shape, dimensions and tolerances shown on the plans.

Pavement markers will be of the type and color shown on the plans or specified herein.

This work shall also consist of furnishing, locating, placing, maintaining, and removing temporary pavement striping tape and temporary pavement striping tape (pilot line).

MATERIALS

633.02.01 Non-Reflective Pavement Markers. Non-reflective pavement markers shall consist of a heat-fired, vitreous, ceramic base and a heat-fired, opaque, glazed surface to produce the properties required in these specifications. The glazed surface shall not be present on the bottom of the marker which will be cemented to the road surface. The markers shall be produced from any suitable combination of intimately mixed clays, shales, tales, flints, feldspars, or other inorganic material which will meet the properties herein required. The markers shall be thoroughly and evenly matured and free from defects which affect appearance or serviceability.

The top surface of the non-reflective marker shall be convex and the radius of curvature shall be between three and one-half (3½) inches and six (6) inches, except that the radius of the one-half (½) inch nearest the edge may be less. Any change in curvature shall be gradual. The top and sides shall be smooth and free of mold marks, pits, indentations, air bubbles, or other objectionable marks or discolorations. The base of the marker shall be flat (the deviation from a flat surface shall not exceed 0.05-inch)

and free from gloss glaze or substances that may reduce its bond to the adhesive.

The non-reflective ceramic type markers shall conform to the following tests:

(a) Adhesive bond strength to bottom surface of the marker using adhesives specified in subsection 633.02.03, "Epoxy Adhesive for Pavement Markers".....700 p.s.i. min.
(b) Glaze Thickness.....0.005″ min.
(c) Moh Hardness.....6 min.
(d) Directional reflectance (white markers only)
1. Glazed surface.....75 min.
2. Body of marker.....70 min.
(e) Yellowness Index (white markers only)
1. Glazed surface.....0.07 max.
2. Body of marker.....0.12 max.
(f) Autoclave.....Glaze shall not spall, crack or peel
(g) Strength.....750 lbs. min.
(h) Water absorption.....2.0 percent max.

633.02.02 Reflective Pavement Markers. Reflective pavement markers shall be of the prismatic reflector type consisting of methyl methacrylate or suitable compounded acrylonitrile butadiene styrene (ABS) shall be filled with a mixture of an inert thermosetting compound and filler material. The exterior surface of the shell shall be smooth and contain one methyl methacrylate prismatic reflector face of the color specified.

The infrared curves of the compounded methyl methacrylate or acrylonitrile butadiene styrene shell shall match approved curves on file in the Materials and Testing Department.

The base of the marker shall be flat (the deviation from a flat surface shall not exceed 0.05-inch), rough textured and free from gloss or substances which may reduce its bond to the adhesive.

The color of the reflector when illuminated by an automobile headlight shall be an approved clear. Off-color reflection shall constitute grounds for rejection.

The reflective type markers shall conform to the following tests:

(a) Adhesive bond strength to bottom surface of the marker using adhesives specified in subsection 633.02.03, "Epoxy Adhesives for Pavement Markers".....500 p.s.i. min.

(b) Reflectance.....Specific Intensity Clear
0 degree Incidence Angle, min.....3.0
20 degrees Incidence Angle, min.....1.2

(c) Strength.....2000 lbs. min.

633.02.03 Epoxy Adhesive for Pavement Markers. Unless otherwise ordered in writing by the Engineer, markers shall be cemented to the pavement with Standard Set Type adhesive as provided in Section 728, "Epoxy." If approved by the Engineer, the Contractor, for his convenience, may substitute Rapid Set Type for the Standard Set Type at no additional cost to the State.

If Rapid Set Type adhesive is ordered by the Engineer, the difference in cost between furnishing and applying Standard Set Type and Rapid Set Type will be paid for as extra work as provided in subsection 109.03, "Extra and Force Account Work."

633.02.04 Temporary Pavement Striping. Temporary striping tape shall be yellow or white or any combination thereof as directed by the Engineer and shall conform to the following requirements:

The striping material shall be a reflectorized adhesive marking tape which will be readily visible when viewed with automobile headlights at night and shall be composed of a conformable backing coated with a pressure sensitive adhesive and shall be designed for marking of asphalt. The tape shall be four (4) inches wide and not less than 20 mils or more than 30 mils thick with a minimum tensile strength of forty (40) pounds per inch of width. The color shall closely match the color normally used by the State in pavement striping. The upper or visible surface shall have

a minimum apparent reflectance of seventy-five (75) percent as determined in accordance with ASTM Designation E–97. Beads shall be strongly adhered to the four (4) inch tape at the rate of at least 1.76 but not more than 1.95 lb. per 100 lin. ft. The striping material backing shall permit complete removal without requiring sandblasting, solvent or grinding methods.

Temporary pavement striping tape (pilot line) shall be four-inch by four-inch (4″ x 4″) squares and shall be placed on traffic lane lines at ....*.... foot intervals. Lane lines and ....*.... foot intervals shall be located by the Contractor as approved by the Engineer.

633.02.05 Tests. Pavement markers and epoxy adhesives for pavement markers shall comply with the requirements of these specifications when tested in accordance with Test Method No. Nev. T500.

The Contractor shall furnish the Engineer with Certificates of Compliance executed by the manufacturers of the markers and epoxy adhesives attesting that they conform to these specifications.

CONSTRUCTION

633.03.01 Installation. The portion of the highway surface to which the markers are to be bonded by the adhesive shall be free of dirt, curing compound, grease, oil, moisture, loose or unsound layers, paint and any other material which would adversely affect the bond of the adhesive. Cleaning shall be done by blast cleaning on Portland cement concrete. The adhesive shall be placed uniformly on the cleaned pavement surface or on the bottom of the marker in a quantity sufficient to result in complete coverage of the area of contact of the marker with no voids present and with a slight excess after the marker has been pressed in place. The marker shall be placed in position and pressure applied until firm contact is made with the pavement. Excess adhesive around the edge of the marker, excess adhesive on the pavement, and adhesive

*As shown on proposal.

on the exposed surfaces of the markers shall be immediately removed. Soft rags moistened with mineral spirits conforming to Federal Specifications TT–T–291 or kerosene may be used if necessary, to remove adhesive from exposed faces of pavement markers. No other solvent shall be used. The markers shall be protected against impact until the adhesive has hardened to the degree designated by the Engineer.

The adhesive requires that the mixing operation and placing of the markers be done rapidly. When hand mixing or machine mixing the Standard Set Type adhesive, all markers shall be aligned and pressed into place within five (5) minutes after mixing is started. When hand mixing adhesive, not more than one (1) quart shall be mixed at one time. Any mixed batch which becomes so viscous that the adhesive cannot be readily extruded from under the marker on application of slight pressure shall not be used.

Automatic mixing equipment for the epoxy adhesive shall use positive displacement pumps and shall properly meter the two components in the specified ratio, plus or minus five (5) percent by volume of either component. At the beginning of each day and at any other time ordered by the Engineer, the ratio shall be checked by the Contractor in the presence of the Engineer. This check shall be made by disconnecting the mixing heads, or using suitable bypass valves, and filling two suitable containers with the unmixed components. The mixing head shall properly mix the two components so that there is no trace of black or white streaks in the mixed materials.

The Standard Set Type adhesive shall not be used when either the pavement or the air temperature is less than fifty (50) degrees Fahrenheit. No markers shall be installed if the relative humidity of the air is greater than eighty (80) percent or if the pavement is not surface dry. The Engineer shall be the judge as to when the adhesive has set sufficiently to bear traffic.

All markers shall be installed to the line established by the Engineer. Reflective markers shall be installed in such

a manner that the reflective face of the marker is at right angles to a line parallel to the roadway centerline.

No pavement markers shall be installed over longitudinal or transverse joints of the pavement surface.

The Contractor shall furnish, apply, maintain, and remove all temporary pavement striping tape. Temporary pavement striping tape shall be used on construction crossovers, detours and temporary connections. Temporary pavement striping tape (pilot line) shall be placed on all lane lines of permanent unmarked bituminous surfaces prior to allowing public traffic thereon, or, when approved by the Engineer, at the conclusion of paving operations on the day public traffic is first allowed on the unmarked bituminous surface.

The surface to which the tape is applied shall be dry, free of oils, grease, dust and dirt. The tape shall be tamped down immediately after application in order to obtain a proper bond, and shall be removed from final pavement surface and where necessary to reroute public traffic as directed by the Engineer.

It should be considered normal and expected that portions of the temporary striping tape shall have to be replaced during the life of the contract. The locations and extent of these replacements shall be determined by the Engineer.

633.04.01 Measurement. The quantity of each type of pavement marker to be measured for payment as units will be the number of each type determined by actual count complete in place.

Temporary pavement striping tape shall be measured for payment on a linear foot of tape basis. Temporary pavement striping tape (pilot line) shall be measured for payment on a station basis and each one hundred (100) feet shall constitute the unit of one station. Measurement shall be made on the initial application at the locations approved by the Engineer.

633.05.01 Payment. The accepted quantity of pavement markers measured as provided in subsection 633.-04.01, "Measurement," will be paid for at the contract

unit prices bid per each for "Non-Reflective Pavement Markers" and "Reflective Pavement Markers," which shall be full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in furnishing and placing pavement markers, complete in place, including adhesives, as shown on the plans, as specified herein and as directed by the Engineer.

The contract unit price bid per linear foot of tape for "Temporary Pavement Striping Tape" and the contract unit price bid per station for "Temporary Pavement Striping Tape (pilot line)" shall be considered full compensation for furnishing the tape as well as all labor, materials, tools, equipment, and incidentals necessary to locate, install and maintain the temporary pavement striping tape. Replacement of tape, as set forth above, shall not be measured or paid for directly but shall be considered included in the contract unit price bid per linear foot for "Temporary Pavement Striping Tape" and the contract unit price bid per station for "Temporary Pavement Striping Tape (pilot line ----*----ft."

Payment will be made under:

Non-Reflective Pavement Markers	Each
Reflective Pavement Markers	Each
Temporary Pavement Striping Tape	Linear Foot
Temporary Pavement Striping Tape (pilot line ----*----ft.)	Station

*As shown on proposal.

SECTION 634

ASBESTOS–CEMENT PIPE

DESCRIPTION

634.01.01 General. This work shall consist of furnishing and installing asbestos-cement pipe for culverts, sewers, storm drains, and conduits as shown on the plans or directed by the Engineer in accordance with the provisions specified in these specifications and the special provisions.

Asbestos-cement pipe shall be of the class shown on the plans, as specified in these specifications, and as designated in the contract item.

MATERIALS

634.02.01 General. Asbestos-cement pipe culvert shall conform to the specifications of ASTM Designation: C428, Type II, and these specifications.

The classes of pipe specified in Section 2a and the minimum crushing strength prescribed in Table II of Section 7 in said C428 are superseded by the following:

(a) Asbestos-cement pipe shall be designated as Class II or Class III based on the crushing strength per foot of pipe as listed in the following table:

Pipe Class	Crushing Strength Per Foot, in Pounds
II	1500D
III	2000D

(Where D is the diameter of pipe, in feet)

(b) Crushing strength tests shall be performed in accordance with the requirements of AASHTO Designation: T33.

The tests for soundness and flexural strength specified in Sections 5 and 6 of ASTM Designation: C428, will not be required.

Each pipe length shall be provided with a sleeve coupling designed to maintain alignment and insure tight flexible joints. At the option of the Contractor the material for the couplings shall be either of the same composition as

the pipe or of a plastic material not susceptible to attack by normal atmospheric or soil conditions. Couplings shall be sampled for compliance testing at the same rate of frequency as required for the pipe.

Couplings of the same composition as the pipe shall meet the same crushing strength requirements as required for the pipe. These couplings shall contain rubber gaskets or sealing rings. These rubber rings shall conform to the requirements of ASTM Designation: D1869.

If plastic couplings are used, the crushing strength test shall be performed on an end one (1) foot length of pipe, tapered to receive the coupling. This end one (1) foot section shall meet the minimum crushing strength requirement for the class of pipe specified. The crushing strength test shall be performed in accordance with the requirements of AASHTO Designation: T33 except that plaster of paris bedding fillets may be used.

The material for the plastic coupling shall be a polyethylene material complying with the requirements of ASTM Designation: D1248, Type I, Class C, Grade 5, except that samples taken from the finished coupling shall have a minimum tensile strength of one thousand five hundred (1,500) p.s.i. and a minimum elongation of four hundred (400) percent. The Contractor shall furnish to the Engineer a certification by the manufacturer that the material in the plastic couplings to be furnished conforms to the requirements of the aforesaid specification. The certification shall be supported by a certified copy of the results of tests, performed by the manufacturer upon samples of the material to be used in the couplings. The finished plastic couplings shall conform to the following table of minimum dimensions:

Inside Pipe Diameter	Thickness	Length
12″ through 16″	0.15″	6¾″
18″ through 21″	0.18″	8½″
24″ through 27″	0.21″	10¼″
30″ through 36″	0.25″	12¼″

(Length is measured along the longitudinal axis)

CONSTRUCTION

634.03.01 General. Construction methods shall conform to the applicable requirements of Section 601, "Pipe Culverts—General," and in addition thereto shall meet the following requirements.

634.03.02 Structures. Where shown on the plans, inlet and outlet structures shall be constructed or installed in connection with asbestos-cement pipes. Where such structures are constructed or installed the ends of pipes shall be placed flush or cut off flush with the structure face, unless otherwise directed by the Engineer.

634.03.03 Laying Culvert Pipe. Asbestos-cement pipe used for drainage purposes and dry conduits shall be laid and jointed in accordance with generally accepted practice and the following provisions in order to obtain results for the purpose intended.

Necessary facilities shall be provided for lowering and properly placing the sections of pipe in the trench.

The pipe shall be laid to the lines and grades with the sections closely jointed. All pipe shall be laid upgrade, unless otherwise permitted by the Engineer.

Every precaution shall be taken to prevent flooding the pipe trench before backfilling operations. Free water shall not be allowed to come in contact with the pipe line until Portland cement sealing materials have set at least twenty-four (24) hours.

METHOD OF MEASUREMENT

634.04.01 Measurement. Method of measurement shall conform to the requirements of subsection 601.04.01, "Measurement."

Asbestos-cement pipe will be measured by the linear foot of pipe for the different sizes and classes listed in the contract items.

All measurement will be made in accordance with subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

634.05.01 Payment. Payment shall conform to the requirements of subsection 601.05.01, "Payment," and in addition thereto, the following requirements shall apply:

The accepted quantities of asbestos-cement pipe measured as specified in subsection 634.04.01, "Measurement," will be paid for at the contract unit price bid per linear foot for asbestos-cement pipe of the size and class specified. These payments shall be full compensation for furnishing all labor, materials, tools, equipment and incidentals, and for doing all the work involved in installing different sizes and classes of pipe, as shown on the plans, as specified in these specifications and as directed by the Engineer.

Structure excavation and structure backfill will be paid for as set forth in Sections 206 and 207.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
(Size) Asbestos-Cement Pressure Pipe (Class)	Linear Foot
(Size) Asbestos-Cement Pipe Conduit (Class)	Linear Foot

SECTION 637

POLLUTION CONTROL

DESCRIPTION

637.01.01 General. This work shall consist of temporary pollution control measures which may be shown on the plans, specified in the special provisions, or ordered by the Engineer during the life of the contract. Said work is intended to provide prevention, control, and abatement of water and air pollution within the limits of the project and to minimize damage to the work and to adjacent property and streams or other bodies of water.

The Contractor shall, seven (7) days prior to the preconstruction conference, submit for acceptance his proposed plans and schedules, in duplicate, for accomplishing the prevention of erosion and pollution that may occur due to his operations. No work shall be started until these schedules and methods of operations have been accepted by the Engineer.

This work shall include furnishing and applying a dust palliative to all completed excavation and embankment grading planes and other disturbed areas within the right of way except those areas which are to be paved under the terms of this contract and as directed by the Engineer. The dust palliative item does not include dust control measures required due to construction operations or carrying public traffic through construction or on detours.

MATERIALS

637.02.01 General. The binder for dust palliative shall be a resin emulsion that is miscible in water in the proportions hereinafter provided, is noncorrosive and is effective as a dust palliative.

Resin emulsion shall be composed of from fifty-seven (57) percent to sixty-three (63) percent of semi-liquid petroleum resin and the remainder water to which a suitable emulsifying agent has been added. The binder shall be mixed with additional water at the jobsite and at the

approximate rate of four (4) parts of water to one (1) part of binder. The exact rate of mixture to be determined by the Engineer. The resin emulsion shall be readily miscible with water and when diluted with any hard water in proportions of one (1) part emulsion to ten (10) parts water shall show no signs of breakdown or separation of the petroleum resin base. Resin emulsion which has been stored in closed containers at temperatures above freezing for a period up to three (3) months shall show no signs of separation. Any resin emulsion which has been stored for more than three (3) months shall not be used until tested and approved.

CONSTRUCTION

637.03.01 General. The temporary pollution control measures shall be as directed from time to time by the Engineer for the duration of the contract. The Engineer may revise and bring up to date any temporary control measures or instigate any new temporary pollution control measures found necessary as the work progresses.

The temporary control measures to prevent pollution of streams or other bodies of water or of the air and to minimize damage to the work and to adjacent property and streams or other bodies of water, as directed by the Engineer and paid for on a force account basis, are in addition to any other measures provided for within the contract that are to be paid for as separate bid items.

It is expected that compliance with these requirements will necessitate performance of certain items of work at a different time or in a different manner than has been considered normal construction practice in the past and that such revisions in scheduling of work will interfere with said normal construction practices.

Unless otherwise approved by the Engineer, the total area of erosible earth material exposed by the Contractor's operations shall not exceed seven hundred fifty thousand (750,000) square feet before either temporary pollution control or temporary or permanent erosion control measures are accomplished.

Where erosion damage is probably due to the nature of

the material or to the season of the year, the Contractor's operations shall be so scheduled that pollution control features will be installed concurrently with or immediately following grading operations.

Compliance with the requirements of this section shall in no way relieve the Contractor from his responsibility to comply with the other provisions of the contract except that he will not be required to replace, at his expense, any of the temporary pollution control work that is damaged by action of the elements.

All erosion control work required elsewhere in the specifications or on the plans will be paid for under the provisions for the applicable contract items of work therefor.

The Contractor shall coordinate this temporary pollution control work, as required by the Engineer, with such erosion control work as may be specified elsewhere in the contract to the extent practicable to assure that effective and continuous pollution control is maintained during the construction of the project.

The Contractor shall, insofar as practicable, conduct his operations in such a manner as to minimize the effects of erosion and air pollution due to his operations upon areas within the limits of the project, haul roads, material sites, disposal sites and upon adjacent properties, streams and other bodies of water.

Mixing of the dust palliative material shall be accomplished by simultaneously lacing the binder and water in the spreading equipment or by other mixing methods that will produce equivalent results. The resulting mixture shall be applied with pressure type water distributor trucks equipped with a spray system, or pressure type asphalt distributors conforming to the requirements of subsection 404.03.02. The mixture shall be applied at a total rate of approximately one-half (½) gallon per square yard in two applications. The exact rate of application to be determined by the Engineer.

METHOD OF MEASUREMENT

637.04.01 Measurement. The required quantity of temporary pollution control work, except as set forth

below, shall be measured for payment on a force account basis in accordance with subsection 109.03.

The required quantity of dust palliative will be measured by the ton prior to addition of water at the jobsite. In the event that volumetric measurement is permitted by the Engineer, the dust palliative shall be measured as set forth in subsection 109.01 for asphaltic emulsion.

The cost of furnishing materials and equipment and conditioning crushing, mixing and processing plants and other equipment to comply with the requirements of NRS Chapter 445, especially the "Air Quality Regulations," adopted by the State Commission of Environmental Protection, January 18, 1972, including watering for dust control, shall be considered as included in the contract price bid for other items of work and no further compensation will be allowed therefor.

BASIS OF PAYMENT

637.05.01 Payment. Payment for "Temporary Pollution Control," measured as provided above, will be paid for by force account.

Dust palliative, measured as provided above, shall be paid for at the contract unit price bid per ton for "Dust Palliative" which price shall be full compensation for furnishing the material, adding and mixing additional water at the jobsite, applying the mixture, and for furnishing all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work, complete and in place as indicated on the plans and as directed by the Engineer.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Temporary Pollution Control	Force Account
Dust Palliative	Ton

SECTION 646

WATERPROOFING AND DAMPPROOFING

DESCRIPTION

646.01.01 General. This work shall consist of furnishing and applying membrane waterproofing or dampproofing to the surface of the concrete as shown on the plans and as specified in these specifications. Membrane waterproofing consists of a coating of primer and a firmly bonded membrane composed of two (2) layers of saturated glass fabric and three (3) moppings of waterproofing asphalt. Dampproofing consists of a coating of primer and two (2) moppings of waterproofing asphalt.

MATERIALS

646.02.01 General. Waterproofing asphalt shall conform to the specifications of ASTM Designation: D499, Type A for below ground and Type B for above ground, except that the ductility for Type B shall be five (5) minimum. The provisions in said D449 relating to felt, asbestos felt, and cotton fabrics shall not apply.

Primer for use with asphalt in waterproofing below and above ground level shall conform to the specifications of ASTM Designation: D41.

Fabric shall conform to the specifications of ASTM Designation: D1668 for bituminous glass fabric treated with asphalt.

CONSTRUCTION

646.03.01 General. All concrete surfaces which are to be waterproofed shall be reasonably smooth and free from holes and projections which might puncture the membrane. The surface to be waterproofed or dampproofed shall be dry and shall be thoroughly cleaned of dust and loose materials.

No primer or asphalt shall be applied in wet weather, nor when the temperature is below sixty-five (65) degrees

Fahrenheit, without authorization in writing from the Engineer.

The primer shall be applied to the surface and allowed to dry before the first coat of asphalt is applied.

The waterproofing asphalt shall be applied at a temperature of not less than three hundred (300) degrees Fahrenheit, nor more than three hundred fifty (350) degrees Fahrenheit.

646.03.02 Membrane Waterproofing. Membrane waterproofing shall not be applied to any surface until the Contractor is prepared to follow its application with the placing of the backfill within a sufficiently short time that the waterproofing will not be damaged as a result of exposure to weathering. Any waterproofing membrane which loses its bond with the concrete shall be removed and replaced with new membrane waterproofing by the Contractor at his expense.

Beginning at the low point of the surface to be waterproofed, the waterproofing asphalt shall be thoroughly mopped onto the surface. A strip of fabric of half the width of the roll shall be rolled onto the hot asphalt immediately and carefully pressed into place so as to eliminate all air bubbles and obtain close conformity with the surface. This strip and an adjacent section of the surface of a width equal to slightly more than one-half (½) the width of the fabric being used, shall then be mopped with hot asphalt and a full width of the fabric shall be rolled into this, completely covering the first strip, and shall be pressed into place as before. This second strip and an adjacent section of the concrete surface shall then be mopped with hot asphalt and the third strip of fabric shingled on so as to lap the first strip by not less than two (2) inches. This process shall be continued until the entire surface is covered, each strip of fabric lapping at least two (2) inches over the last strip but one. The entire surface shall then be mopped with hot asphalt. Special care shall be taken at all laps to see that they are thoroughly sealed down.

The work shall be so regulated that at the close of the

day's work the final mopping of asphalt shall have been applied to all the fabric in place.

646.03.03 Dampproofing. The waterproofing asphalt shall be thoroughly mopped onto the surface to be dampproofed. When the first mopping of asphalt has set sufficiently, the entire surface shall then be mopped with the second coating of hot asphalt. Special care shall be taken to see that there are no skips in the coatings and that all surfaces are thoroughly covered.

METHOD OF MEASUREMENT

646.04.01 Measurement. The quantities of membrane waterproofing or dampproofing placed as shown on the plans or directed by the Engineer will be determined by the square yard from measurement of the area covered by the membrane waterproofing or dampproofing.

BASIS OF PAYMENT

646.05.01 Payment. The quantity of membrane waterproofing or dampproofing, measured as provided above, shall be paid for at the contract unit price bid per square yard for "Membrane Waterproofing" or "Dampproofing," which payment shall be full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in applying the waterproofing membrane or dampproofing, complete in place, as shown on the plans and as specified.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Membrane Waterproofing	Square Yard
Dampproofing	Square Yard

SECTION 660

PNEUMATICALLY PLACED CONCRETE MORTAR

DESCRIPTION

660.01.01 General. This work shall consist of lining ditches and channels, slope paving and constructing warped sections and other similar features with mortar pneumatically placed in accordance with these specifications and the special provisions.

Pneumatically placed mortar shall consist of either dry mixed fine aggregate and Portland cement applied by a suitable mechanism, to which mixture the water is added immediately previous to its expulsion from the nozzle, or mortar premixed by mechanical methods and pneumatically applied through a nozzle onto the prepared foundation.

MATERIAL

660.02.01 General. The materials used shall be those prescribed for the several items which constitute the finished work and shall conform with all the requirements for such materials as set forth in this specification and in Division III, "Material Details."

Cement shall be Type II "low-alkali" cement. Sand shall conform to the requirements of subsection 706.03.03, "Fine Aggregate."

The dry mixture shall consist of one (1) part Portland cement to four (4) parts sand, thoroughly mixed in a dry state. Measurement may be either by volume or weight. Before placing the proportioned materials in the hopper of the application gun, all lumps three-eighths (3/8) inch or over shall be removed by screening.

The premixed mortar shall contain not less than six hundred ten (610) pounds of Portland cement per cubic yard, fine aggregate and water. A maximum of thirty (30) percent pea gravel may be substituted for fine aggregate. The maximum size of pea gravel shall be such that one

hundred (100) percent passes the one-half (½) inch screen and at least ninety (90) percent passes the three-eighths (⅜) inch screen.

Mesh reinforcing for ditch lining and slope paving reinforcement shall be of the sizes shown on the plans, fabricated of cold drawn steel wire and need not be galvanized. Mesh reinforcing shall conform to the requirements of Section 505 of the Standard Specifications.

Header boards consisting of two inch by four inch (2″ x 4″) redwood lumber furnished and placed in the concrete slope paving shall be as shown on the plans. Lumber used in the construction of header boards shall be commercial grade heart redwood, S4S.

Nails used in construction of header boards shall be commercial quality galvanized nails.

All concrete mortar for slope paving shall have an integral color pigment added. The color pigment shall consist of a synthetic mineral oxide specifically manufactured for coloring concrete. The integral concrete coloring shall be obtained by mixing the pigment material with the Portland cement, aggregates and water in a sequence and by methods that will result in a uniform mixture.

The color of the finished slope paving surfaces shall conform to Federal Standard Color No. 30324 as shown in Table II of Federal Standard No. 595 or to such other color specified in the special provisions or shown on the plans. The color shall conform to the referee color except that minor deviations in color and tint, representative of the method of mixing and applying the slope paving, will be acceptable.

The Engineer shall be the sole judge of compliance of the test panel construction with the texture and color requirements of these specifications and for conformance to the required color.

CONSTRUCTION

660.03.01 Preparation of Foundation. The subgrade for paved ditches and slope paving shall be formed by excavating to the required depth below the prepared finish

surface grade in accordance with dimensions and design indicated on the plans or as directed by the Engineer.

The subgrade shall be thoroughly compacted. Any soft, spongy or other unsuitable material shall be removed to such depth as directed and backfilled with suitable material and thoroughly compacted. Water shall be sprinkled on the subgrade during compaction and the subgrade shall be sufficiently moist prior to placing concrete mortar to prevent absorption.

660.03.02 Placing. Prior to placing slope paving for use in the work, the Contractor shall construct sufficient test panels to assure the Engineer that the proper color has been obtained and the final panel shall be at least four feet by six feet (4′ x 6′) in size. The panels shall be constructed at the construction site and shall be placed by a method to be used in placing slope pavement.

The Engineer shall be the sole judge of compliance of the test panel construction with the requirement of these specifications.

Header boards shall be installed to conform to the grades of the slope paving, to the dimensions, spaces, and layout shown on the plans.

Header boards shall be held in position with stakes of suitable size and length as shown on the plans.

A constant pressure of not less than forty-five (45) pounds per square inch shall be maintained in the placing machine where the hose length is one hundred (100) feet or less and the pressure shall be increased at least five (5) pounds for each additional fifty (50) feet of hose or fraction thereof.

Water used for hydration at the nozzle shall be maintained at a uniform pressure, which shall not be less than fifteen (15) pounds per square inch greater than the air pressure at the machine.

The nozzle shall be held at such distance and in such position that the flowing stream of material will impinge, as nearly as possible, at right angles to the surface being covered. Any deposits of loose sand shall be cut out.

The Contractor shall do this work only with experienced personnel.

Materials that have been mixed for more than forty-five (45) minutes and have not been incorporated in the work shall not be used, unless otherwise permitted by the Engineer.

Mortar shall not be placed against frosted or frozen surface. If mortar is placed during cold weather it shall be heated and protected during placing and curing as set forth in Section 501, except mortar shall be maintained at a temperature of not less than fifty (50) degrees Fahrenheit for seventy-two (72) hours after placing and at not less than forty (40) degrees Fahrenheit for an additional four (4) days.

The ditch lining and slope paving shall be constructed without expansion joints. Suitable forms shall be used where necessary to insure a full dimension as shown on the plans at the perimeter of the lining.

The mesh reinforcing shall be placed so as to be in the approximate center of the pneumatically placed concrete mortar. All joints shall be lapped six (6) inches and run continuously throughout paving or between headers.

After the work is completed the Contractor shall remove all debris from the work.

660.03.03 Finishing. After the mortar has been placed as nearly as practicable to the required depth, the surface shall be checked with a straightedge, and any low spots or depressions shall be brought up to proper grade by placing additional mortar in such a manner that the finished surface will be reasonably smooth and uniform for the type of work involved.

Loose areas of air-blown mortar shall be removed and replaced by the Contractor at his expense.

The surface finish of the exposed slope paving shall be the equivalent of a wood float finish.

Immediately after completion, the surface shall be covered with wet burlap or wet cotton mats and these kept wet for at least seventy-two (72) hours. When approved by the Engineer, mortar may be cured by the use of waterproof

paper or by means of a liquid membrane, all conforming to the requirements as set forth in Section 702 of the Standard Specifications and these specifications.

METHOD OF MEASUREMENT

660.04.01 Measurement. Pneumatically placed concrete mortar will be measured in square yards of the actual surface covered to the depth shown on the plans.

BASIS OF PAYMENT

660.05.01 Payment. The quantity, measured as provided above, will be paid for at the contract unit price bid per square yard for "Pneumatically Placed Concrete Mortar (....-inch depth)," which payment shall be full compensation for excavation, backfill, furnishing, and installing redwood headers, color pigment, and mortar, and all labor, tools, equipment, and incidentals, and for doing all the work involved in placing the pneumatically placed mortar (including subgrade preparation forms and curing), complete in place, as shown on the plans, and as specified herein, and as directed by the Engineer.

Mesh reinforcement shall be measured and paid for as specified in Section 505 of the Standard Specifications.

Note: If the Contractor elects to place the slope paving by other methods approved by the Engineer, the method of measurement and basis of payment will not be changed.

All payments will be made in accordance with subsection 109.02, "Scope of Payment."

Payment will be made under:

Pay Item	Pay Unit
Pneumatically Placed Concrete Mortar (....-inch depth)	Square Yard

DIVISION III

MATERIALS DETAILS

SECTION 701

PORTLAND CEMENT

SCOPE

701.01.01 Materials Covered. This specification covers the five (5) types of Portland cement as required under pertinent sections of these specifications. Unless otherwise provided, Type II, "low alkali cement," shall be used for all Portland cement concrete, mortar, cement-treated base, and cement-treated subgrade.

PHYSICAL PROPERTIES AND TESTS

701.03.01 Requirements. The cements, except Type II cement, shall meet the requirements set out in the current Standard Specifications for Portland Cement, AASHTO Designation M85.

Type II cement shall conform to the specifications of ASTM Designation C150 with the following exceptions:

(a) The cement shall not contain more than 0.60 percent by weight of alkalies calculated as Na_2O plus 0.658 K_2O when determined by flame photometry, using the direct intensity method in the specifications of ASTM Designation C114.

(b) The percentage of tricalcium silicate shall not be limited.

SECTION 702

CONCRETE CURING MATERIALS AND ADMIXTURES

SCOPE

702.01.01 Materials Covered. This specification covers concrete curing materials, subgrade paper, air-entraining admixtures, water retardants, calcium chloride, and hydrated lime. Attention is directed to Section 722, "Water," for mixing and curing.

PHYSICAL PROPERTIES AND TESTS

702.03.01 Curing Materials. Curing materials shall conform to the requirements of the following tests:

Cotton Mats for Curing Concrete	AASHTO M73
Burlap Cloth made from Jute or Kenaf	AASHTO M182
Waterproof Paper for Curing Concrete	AASHTO M139
Liquid Membrane-Forming Compounds for Curing Concrete	ASTM C309*
Plastic Sheeting	ASTM C171*
Pigmented Curing Compound for Portland Cement Pavement	ASTM C309**
White Polyethylene Sheeting (film) for Curing Concrete	ASTM C171

*Except: (a) The curing compound shall not react harmfully with the components of concrete or contain oils, waxes, or other materials which would prevent bonding of traffic marking paints. In order to obtain proper bond between the concrete and joint fillers, the Contractor will be required to carry on his operations in a manner which will insure that joint recesses are free of the compound at the time the joint material is placed. The film of curing compound shall be continuous, uniform, and free from pinholes, bubbles, or blisters.

(b) The curing compound shall be clear or translucent and contain a fugitive dye to assist in securing uniform coverage. The color shall remain visible for at least one (1) hour after application. The color of the fugitive dye shall disappear within seven (7) days after application.

(c) The curing compound shall be of such viscosity that it may be readily applied by approved pressure spraying equipment at temperatures above forty (40) degrees Fahrenheit.

(d) When applied by pressure spray to the troweled surface of a vertical, damp concrete specimen, one (1) foot square, at the rate of two hundred (200) square feet per gallon, the curing compound shall adhere to the surface in a continuous, tenacious film without running off or appreciable sagging. In spraying the specimen the nozzle of the spray shall be held between four (4) and six (6) inches from the surface of the specimen.

(e) The membrane shall not peel; it shall disappear from the surface by gradual disintegration from exposure to the elements over a period of not less than thirty (30) days nor more than one (1) year, leaving the concrete hard and without discoloration.

(f) Curing material shall be supplied only in clean containers that are in good condition. It shall be delivered to the job in the manufacturer's original container, which shall be clearly marked with the manufacturer's name, trade name of the material, and batch number or symbol by which samples submitted for testing purposes may be identified.

(g) All curing compounds not previously approved shall be tested by a reputable testing laboratory, recognized by the State, who shall certify that the curing compound meets these specifications and requirements. The Contractor shall furnish the Department with this certification prior to using the curing compound.

**Except the loss of water in the water retention test shall not exceed 0.040 gram per square centimeter of surface.

702.03.02 Subgrade Paper. Subgrade paper shall conform to the requirements of AASHTO M74.

702.03.03 Air-Entraining Admixtures. Air-entraining admixtures shall conform to the requirements of ASTM C260.

702.03.04 Admixtures Other Than Air-Entraining. These admixtures shall meet the requirements of ASTM Designation C494 and shall be clearly marked as to Type A, B, C, D, or E. In addition to these requirements, the admixtures may be tested by Test Method No. Nev. T467. The concrete so tested and containing admixtures shall not exceed a change in length as specified in subsection 501.-02.03.

702.03.05 Hydrated Lime. Hydrated lime shall conform to the requirements of ASTM C207, Type N.

702.03.06 White Pigmented Curing Compound. White pigmented curing compound shall conform to the following provisions:

Composition:

Pigment Ingredients	Lbs./100 Gals.
Titanium Dioxide, TT–P–442, Types III or IV	60.8
Whiting[1]	88.5
Mica[2]	30.8
Vehicle Ingredients	
Petroleum Hydrocarbon Resin[3]	322.0
Mineral Spirits TT–T–291E, Type II, Grade A	343.3

Characteristics of Finished Material:

Pigment by weight, percent	20.5	Min.
Weight per gallon in pounds at 77° F.	8.3	Min.
Volatiles, by weight, percent	41.6	Max.
Viscosity at 77° F., K.U.	64	Max.
Fineness of grind, Hegman	5	Min.
Daylight Reflectance, percent (ASTM: C309)	60	Min.
Drying Time[4]:		
Set to touch, hours at 77° F.	2	Max.
Dry through, hours at 77° F.	4	Max.
Water Retention, grams net loss at 24 hours[5]	6	Max.
[1]Oil absorption (Spatula)	13.1	
Surface area, square centimeters per gram	400.0	

Particle size distribution: Micron Diameter	*Percent by Weight Below Indicated Size*
44 (325 mesh)	100.0
40	97.0
30 (450 mesh)	84.0
20 (625 mesh)	60.0
15	42.4
12.5	35.0
10 (1250 mesh)	30.0
7.5	24.0
5	18.0
4	15.0
3	12.0
2	8.5
1	4.0

[2]Apparent density, fourteen (14) pounds per cubic foot maximum; sieve analysis, percent retained on Nos. 140 and 325 sieves, no exact requirement other than that the curing compound must comply with all requirements: moisture, 0.5 percent maximum; grit, 0.5 percent maximum; potassium oxide equivalent, 7 to 11 percent; X-ray diffraction curve shall agree with curves on file with the Department for muscovite mica.

[3]Specific gravity 0.93–1.12; softening point (ASTM Designation: D36) 200 to 230 degrees Fahrenheit; Color (Gardner) 13 max.; iodine number Wijs 180 max.; acid number 0–2; saponification number 0–2. Type of resin selected must be such that viscosity of resin in mineral spirits will provide a curing compound meeting viscosity requirements.

[4]Federal Test Method Standard No. 141, Method 4061, on glass plate, except use 0.003 in. wet film thickness.

[5]Test Method No. Nev. T522 except that the compound shall be applied at a rate of one (1) gallon per two hundred fifty (250) square feet.

The Contractor shall furnish the Engineer with a Certificate of Compliance executed by the manufacturer of white pigmented curing compound. Such certificate shall attest that the curing compound, as produced in the usual course of the manufacturer's trade, conforms to the requirements of these specifications.

702.03.07 White Pigmented Curing Compound—Chlorinated Rubber Base. White pigmented curing compound—chlorinated rubber base shall conform to the following provisions:

Composition:

Pigment Ingredients	Lbs./100 Gals.
Titanium Dioxide, TT–P–442, Types III or IV	100.0
Vehicle Ingredients	
Chlorinated Paraffin, MIL–C–420, Type II, (70 percent Cl_2)	66.0
Chlorinated Paraffin, MIL–C–420, Type I, (43 percent Cl_2)	66.0
Chlorinated Rubber[1]	165.4
Ethylene Glycol Monoethyl Ether Acetate, MIL–E–7125	265.0
Mineral Spirits, TT–T–291E, Type II, Grade A	265.0
Epoxy Resin[2]	2.0

Characteristics of Finished Material:

Pigment, by weight, percent	9.7 Min.
Weight per gallon in pounds at 77° F.	9.1 Min.
Volatiles, by weight, percent	58.1 Max.
Fineness of grind, Hegman	5 Min.
Viscosity at 77° F., K.U.	64 Max.
Daylight Reflectance, percent (ASTM: C309)	60 Min.
Drying Time[3]:	
Set to touch, hours at 77° F.	2 Max.
Dry through, hours at 77° F.	4 Max.
Water Retention, grams net loss at 24 hours[4]	6 Max.
Chlorine[1] percent	65–68
Viscosity, 20 percent in Toluene, Centipoises at 25° C.	9–14
Specific Gravity	1.555 to 1.565
Index of Refraction	1.550 to 1.560

[1]A twenty-five (25) percent concentration in toluene shall show no haziness or turbidity, and when stored for one week at seventy-seven (77) degrees Fahrenheit, shall not corrode the tin plate in a covered tin-coated can.

[2]Liquid, color 5 max. (Gardner), viscosity 100–160 poises at twenty-five (25) degrees Centigrade, epoxide equivalent 180–200.

[3]Federal Test Method Standard No. 141, Method 4061, on glass plate, except use 0.003 in. wet film thickness.

[4]Test Method No. Nev. T522, except that the compound shall be applied at a rate of one (1) gallon per three hundred (300) square feet.

The Contractor shall furnish the Engineer with a Certificate of Compliance executed by the manufacturer of white pigmented curing compound—chlorinated rubber base. Such certificate shall attest that the curing compound, as produced in the usual course of the manufacturer's trade, conforms to the requirements of these specifications.

SECTION 703

BITUMINOUS MATERIALS

SCOPE

703.01.01 Materials Covered. This specification covers the quality of asphalt cement, liquid asphalt, emulsified asphalt, cationic emulsion, and asphalt for waterproofing and dampproofing.

REQUIREMENTS

703.02.01 Contractor's Responsibility. Bituminous material failing the requirements (including tolerances) of the tests hereinafter prescribed shall be subject to the provisions of subsection 109.02, "Scope of Payment," and attention is directed thereto.

703.02.02 Shipping Notice. When shipment of materials arrive on the project after normal working hours, the Contractor shall notify the Engineer sufficiently in advance to make arrangements for an inspector to be present when the material is sampled.

Shipping notices shall be mailed upon making shipment and shall contain the following information:

(a) Consignee and destination.

(b) State contract number.

(c) Delivery point.

(d) Date shipped.

(e) Car initial and number of truck transport delivery ticket number.

(f) Type and grade of material.

(g) Quantity loaded.

(h) Loading temperature.

(i) Net quantity.

(j) Signature of shipper or authorized representative.

One copy of the shipping notice shall be mailed to the State Highway Engineer at Carson City, Nevada, and two copies to the resident engineer of the project to which shipment is made.

PHYSICAL PROPERTIES AND TESTS

703.03.01 Refinery Test Report. Refinery test reports shall be mailed to the resident engineer as soon as tests have been completed, and the reports shall contain the following data:

(a) Date of shipment.

(b) Car initials and number of truck transport delivery ticket number.

(c) Destination and consignee.

(d) State contract number (or State purchase order number, if applicable).

(e) Type and grade of material.

(f) Certificate of grade (certify that material conforms to these specifications, and itemize results on tests performed and date of test).

(g) Signature of refinery's authorized representative.

The Certificate of Compliance shall be used as a basis for permitting immediate use of the material on the job and shall represent conditional acceptance only.

703.03.02 Asphalt Cements. Asphalt cement shall be prepared by the distillation of crude petroleum. This asphalt shall be homogeneous, free from water, and shall not foam when heated to three hundred forty-seven (347) degrees Fahrenheit.

These specifications cover the following viscosity grades: AR–1000, AR–2000, AR–4000, AR–8000, and AR–16000.

The various viscosity grades set forth above shall conform to the requirements and the methods of testing shall be as shown in Table I.

TABLE I—Specifications for Asphalt Cement Road Materials (Viscosity Graded at 140 Degrees Fahrenheit (60 Degrees Centrigrade) on RTFC Residue)

Test	*Nev. Test Method*	*AR–1000*	*AR–2000*	*AR–4000*	*AR–8000*	*AR–16000*	*Allowable Tolerance*
Tests on Residue from RTFC Procedure—Nev. Method T728A*							****
Absolute Viscosity (at 140 deg. F., poise)	T738	750–1,250	1,500–2,500	3,000–5,000	6,000–10,000	12,000–20,000	1.5 Percent ****
Kinematic Viscosity (at 275 deg. F., cs, min.)	T722	140	200	275	400	550	1.5 Percent ****
Penetration (at 77 deg. F., 100g/5 sec., min.)	T717	65	40	25	20	20	4 Percent
Percent of original penetration (at 77 deg. F., min.)	T717		40	45	50	52	None
Ductility (at 77 deg. F., cm. min.)	T720	100**	100**	75	75	75	None
Test on Original Asphalt							
Flash point (C.O.C. °F. Min.)***	T716	400	425	440	450	460	15° F. below
Flash point (P.M.C.T. °F. Min.)***	T714	400	425	440	450	460	15° F. below ****
Solubility in Trichlorethylene (percent, min.)	T710	99	99	99	99	99	13 Percent below Min.

*TFO may be used but RTFC shall be the referee method.

**If the ductility at seventy-seven (77) degrees is less than one hundred (100) cm., the material will be acceptable if its ductility at sixty (60) degrees is more than one hundred (100) cm.

***C.O.C. may be used but P.M.C.T. shall be the referee method.

****When tolerances are expressed in terms of percent, the allowable deviation is calculated as the indicated percentage of the upper or lower specification limit, whichever is applicable.

Asphalt cement not conforming to the requirements of Table I will be assessed demerits in accordance with the graduated increments of the following schedule. Attention is directed to subsection 109.02, "Scope of Payment," where demerits will be evaluated for damages sustained by reason of any noncompliance.

Test Method	Increment	Demerits (each increment of noncompliance)
Nev. T738	2 poises above max. or below min	1
Nev. T722	2 centistokes below min	1
Nev. T717	0.2 millimeter below min	1
Nev. T717	2 percent below min	1
Nev. T720	5 centimeters below min	2
Nev. T716		
Nev. T714	5 degrees below min	1
Nev. T710	0.01 percent below min	1
Nev. T726	Positive	21

703.03.03 Liquid Asphalts. Liquid asphalts shall consist of materials conforming to the following classifications. Rapid curing products, designated by the letters RC, shall consist of paving asphalt with a penetration of approximately 85 to 100 fluxed or blended with a naphtha solvent. Medium curing products, designated by the letters MC, shall consist of paving asphalt fluxed or blended with a kerosene solvent. Slow curing products, designated by the letters SC, shall consist of natural crude oils or residual oils from crude asphaltic petroleum. When tested in accordance with the standard methods of Nevada, the grades of liquid asphalt shall conform to the requirements specified in the tables set forth on pages 808–812.

TABLE II—RAPID CURING PRODUCTS

Test	Nevada Test Method	Grades; Requirements RC–70	RC–250	RC–800	RC–3000	Allowable Tolerance
Flash Point with Tagliabue Open Cup (percent° F.)	T709	.....	80 Min.	80 Min.	80 Min.	15°F. below
Kinematic Viscosity of Asphalt (at 140° F., cs.)	T705	70–140	250–500	800–1600	3000–6000	1.5 percent*
Distillation of Cut-Back Asphalt Products (percent of total distillate to 680° F.)						
to 374° F.	T706	10 Min.	.....	.....	.....	1.0
to 437° F.		50 Min.	35 Min.	15 Min.	.....	1.0
to 500° F.		70 Min.	60 Min.	45 Min.	25 Min.	1.0
to 600° F.		85 Min.	80 Min.	75 Min.	70 Min.	1.0
Residue from distillation to 680° F. (Volume percent by difference)		55 Min.	65 Min.	75 Min.	80 Min.	1.0
Penetration of Bituminous Materials (Residue from distillation 77° F., 100 g., 5 sec.) 0.1 mm	T717	80–120	80–120	80–120	80–120	8 percent*
Ductility of Bituminous Materials (77° F., cms.)	T720	100 Min.	100 Min.	100 Min.	100 Min.	None

Proportion of Bitumen Soluble in Trichlorethylene (percent Min.)	T710	99.5 Min.	99.5 Min.	99.5 Min.	99.5 Min.	13 percent below Min.
Water in Petroleum Products and other Bituminous Materials (percent)	T703	0.2 Max.	0.2 Max.	0.2 Max.	0.2 Max.	None

*When tolerances are expressed in terms of percent, the allowable deviation is calculated as the indicated percentage at the upper or lower specification limit, whichever is applicable.

TABLE III—Medium Curing Products

Test	Nevada Test Method	Grades; Requirements MC–70	MC–250	MC–800	MC–3000	Allowable Tolerance
Flash Point with Tagliabue Open Cup (percent° F.)	T709	100 Min.	150 Min.	150 Min.	150 Min.	15° F. below
Kinematic Viscosity of Asphalt at 140° F., cs.)	T705	70–140	250–500	800–1600	3000–6000	1.5 percent*
Distillation of Cut-Back Asphalt Products (percent of total distillate to 680° F.)						
to 437° F.	T706	20 Max.	0–10	----------	----------	1.0
to 500° F.		20–60	15–55	35 Max.	15 Max.	1.0
to 600° F.		65–90	60–87	45–80	15–75	1.0
Residue from distillation to 680° F. (Volume percent by difference)		55 Min.	67 Min.	75 Min.	80 Min.	1.0
Pentration of Bituminous Materials (Residue from distillation 77° F., 100 g., 5 sec.)	T717	120–250	120–250	120–250	120–250	8 percent
Ductility of Bituminous Materials (77° F., cms.)	T720	100 Min.	100 Min.	100 Min.	100 Min.	None

Proportion of Bitumen Soluble in Trichlorethylene (percent Min.).....T710	99.5 Min.	99.5 Min.	99.5 Min.	99.5 Min.	13 percent below Min.
Water in Petroleum Products and other Bituminous Materials (percent).....T703	0.2 Max.	0.2 Max.	0.2 Max.	0.2 Max.	None

*When tolerances are expressed in terms of percent, the allowable deviation is calculated as the indicated percentage at the upper or lower specification limit, whichever is applicable.

TABLE IV—Slow Curing Products

Test	Nevada Test Method	Grades; Requirements SC–70	SC–250	SC–800	SC–3000	Allowable Tolerance
Flash Point (C.O.C.) °F.	T716	150 Min.	175 Min.	200 Min.	225 Min.	15° F. below
Kinematic Viscosity at 140° F., cs.	T705	70–140	250–500	800–1600	3000–6000	1.5 percent*
Distillation						
Total Dist. to 680° F., Vol. Percent	T706	10–30	4–20	2–12	5 Max.	1.0
Kinematic Viscosity at 140° F., S.	T705	4–70	8–85	20–140	40–350	1.5 percent*
Residue of Spec. Pen. (percent duct. of 100 pen.)	T713	50 Min.	60 Min.	70 Min.	80 Min.	.....
Ductility of Asphalt Residue at 77° F., cm.	T720	100 Min.	100 Min.	100 Min.	100 Min.	None
Solubility in Trichlorethylene, Percent	T710	99.5 Min.	99.5 Min.	99.5 Min.	99.5 Min.	13 percent below Min.
Water in Petroleum Products and Other Bitum. Matls., Percent	T703	0.5 Max.	0.5 Max.	0.5 Max.	0.5 Max.	None

*When tolerances are expressed in terms of percent, the allowable deviation is calculated as the indicated percentage at the upper or lower specification limits, whichever is applicable.

Liquid asphalts not conforming to the requirements of Tables II, III, and IV will be assessed demerits in accordance with the graduated increments of the following schedule. Attention is directed to Subsection 109.02 "Scope of Payment," where demerits will be evaluated for damages sustained by reason of any noncompliance.

Nevada Test Method	Increment		Demerits (each increment of noncompliance)
T716	5 degrees below min.		1
T709	5 degrees below min.		1
T705	RC–MC–SC–70	2 centistokes*	1
	RC–MC–SC–250	10 centistokes*	1
	RC–MC–SC–800	50 centistokes*	1
	RC–MC–SC–3000	100 centistokes*	1
T706	5 percent below min. or above max. per fraction		1
T717	0.1 millimeter above max.		1
	0.1 millimeter below min.		1
T720	5 centimeter below min.		2
T710	0.01 below min.		1
T703	0.1 percent above max.		1

*Above max. or below min.

703.03.04 Emulsified Asphalt. Emulsified asphalt shall conform to the requirements of Tables V and VI for the type and grade specified when tested in accordance with Nevada as is enumerated.

TABLE V—Specifications for Cationic Emulsified Asphalt

Test	Nevada Test Method	Grade; Requirements — Rapid Setting — CRS–1	CRS–2	Medium Setting — CMS–2	CMS–2h	Slow Setting — CSS–1	CSS–1h	Allowable Tolerances
Test on Emulsion[1]								
Furol Viscosity at 77° F., sec.		.....	.....	.....	.....	20–100	20–100	None
Furol Viscosity at 122° F., sec.	T707	20–100	100–400	50–450	50–450	.....	.....	None
Settlement, 5 days,[2] percent difference	T707	5—	5—	5—	5—	5—	5—	None
Sieve Test (Retained on No. 20) percent[3]	T707	0.10—	0.10—	0.10—	0.10—	0.10—	0.10—	None
Aggregate Coating-Water Resistance Test[4]	T707	.....	.....	.....	.....	.....	.....	None
Dry Aggregate (Job) percent Coated		.....	.....	80+	80+	.....	.....	None
Wet Aggregate (Job) percent Coated		.....	.....	60+	60+	.....	.....	None
Cement Mixing Test, percent	T707	.....	.....	.....	.....	2—	2—	None
(Particle charge test)	T707	Positive	Positive	Positive	Positive	.....	.....	None
pH		.....	.....	.....	.....	6.7—	6.7—	None
Distillation Residue, percent by Weight	T707	60+	65+	65	65	57+	57+	1.0
Oil Distillate,[5] percent by Volume of Emulsion	T707	3—	3—	12	12—	.....	.....	None

Tests on Residue								
Penetration, 77° F., 100 g., 5 sec.	T717	100–250	100–250	100–250	40–90	100–200	40–90	15 percent
Solubility in Trichlorethylene	T710	97.5	97.5	97.5	97.5	97.5	97.5	13 percent below min.
Ductility, 77° F., cms.	T720	40+	40+	40+	40+	40+	40+	None

[1]All tests shall be performed within thirty (30) days from the date of emulsion shipment.

[2]The test requirement for settlement may be waived when the emulsified asphalt is used in less than five (5) days; or the purchaser may require that the settlement test be run from the time the sample is received until it is used, if the elapsed time is less than five (5) days.

[3]Except that distilled water is used instead of sodium oleate solution.

[4]Calcium carbonate shall not be added to the job aggregate when making the aggregate coating-water resistance test.

[5]Volume of oil distillate may be determined by reading on the graduated cylinder which is used to collect total distillate.

TABLE VI—Specifications for Anionic Emulsified Asphalts

Test	Nevada Test Method	Grade; Requirements: Rapid Setting RS–1	Rapid Setting RS–2	Medium Setting MS–2	Slow Setting SS–1	Slow Setting SS–1h	Allowable Tolerances
Tests on Emulsion[1]							
Furol Viscosity at 77° F., sec.		20–100	.....	100+	20–100	20–100	None
Furol Viscosity at 122° F., sec.		.....	75–400	.....	.....	.....	None
Residue from Distillation, percent by Weight	T707	57+	62+	62+	57+	57+	1.0
Settlement, 5 days, percent Difference		3—	3—	3—	3—	3—	None
Demulsibility:							
35 ml. of 0.02 N. $CaCl_2$, percent		60+	50+	.....	.....	.....	None
50 ml. of 0.10 N. $CaCl_2$, percent		.....	.....	30—	.....	.....	None
Sieve Test (Retained on No. 20), percent		0.10—	0.10—	0.10—	0.10—	0.10—	None
Cement Mixing Test, percent		.....	.....	.....	2.0—	2.0—	None
Tests on Residue							
Penetration, 77° F., 100 g., 5 sec.	T717	100–200	100–200	100–200	100–200	40–90	15 percent

Solubility in Trichlorethylene, percent[2]	T710	97.5+	97.5+	97.5+	97.5+	97.5+	13 percent below min.
Ductility, 77° F., cms.	T720	40+	40+	40+	40+	40+	None

[1]All tests shall be performed within thirty (30) days from the date of emulsion shipment.
[2]Alternatively, trichloroethylene (not trichloroethane) may be used as the solvent for determining solubility. In case of dispute, however, carbon tetrachloride will be used as the referee solvent.

Emulsified asphalt not conforming to the requirements of Tables V and VI will be assessed demerits in accordance with the graduated increments of the following schedule. Attention is directed to Subsection 109.02, "Scope of Payment," where demerits will be evaluated for damages sustained by reason of any noncompliance.

Test Method	Increment	Demerits (each increment of noncompliance)
Nev. T707 (Furol Viscosity at 77° F., and at 122° F.)	2 seconds above max. or below min.	1
Nev. T707 (Settlement, 5 days, percent difference)	1.0 percent above max.	1
Nev. T707 (Sieve test, percent max.)	0.10 percent above max.	1
Nev. T707 (Cement mixing test)	0.5 percent above max.	1
Nev. T707 (Particle charge test)	Negative charge	21
Nev. T717 (Penetration, 77° F., 100 g., 5 sec.)	0.1 millimeter above max. or below min.	1
Nev. T710 (Solubility)	0.01 below min.	1
Nev. T720 (Ductility 77° F., cm.)	5 centimeters below min.	2

SECTION 704

BASE AGGREGATES

SCOPE

704.01.01 Materials Covered. This specification covers the quality and size of mineral materials used in base courses.

REQUIREMENTS

704.02.01 General. The mineral aggregate shall be the product of approved deposits. The Engineer reserves the right to prohibit the use of aggregates from any source when:

(a) The character of the material is such, in the opinion of the Engineer, as to make improbable the furnishing of aggregates conforming to the requirements of these specifications.

(b) The character of the material is such, in the opinion of the Engineer, that undue additional costs may be accrued by the State.

The mineral aggregate shall be clean, hard, durable, free from frozen lumps, deleterious matter, and harmful adherent coatings.

704.02.02 Deficiencies. If the product of a deposit is deficient in material passing the No. 16 sieve, filler from other approved deposits may be added at the crushing and screening plants. This is not to be construed as a waiver of any of the requirements contained herein.

704.02.03 Plastic Limits. When specified, aggregates shall conform to the applicable requirements of the following table:

TABLE I

Percentage by Weight *Passing 200 Sieve	Plasticity Index Maximum
0.1 to 3.0	15
3.1 to 4.0	12
4.1 to 5.0	9
5.1 to 8.0	6
8.1 to 11.0	4
11.1 to 15.0	3

*Test Method No. Nev. T206.

PHYSICAL PROPERTIES AND TESTS

704.03.01 Drain Backfill. This aggregate shall conform to one of the following grading requirements:

	Percentage by Weight Passing Sieve		
Sieve Sizes	Type 1	Type 2	Type 3
2 Inch	100	....	....
1½ Inch	90–100	....	....
1 Inch	....	100	....
¾ Inch	50–80	90–100	....
⅜ Inch	....	20–55	100
No. 4	24–40	0–10	60–90
No. 16	10–24	....	26–60
No. 100	0–4	0–4	0–4
No. 200	0–2	0–2	0–2

Unless otherwise specified in the contract documents the Contractor may use either Type 1, 2, or 3.

Source Requirement Test: Test Method Nev. T232: Degradation	Type 1	Type 2	Type 3
Passing No. 20, Max	25%	25%	25%
Height, Inches, Max	2.5	2.5	2.5

704.03.02 Type 1 Class A Aggregate Base. This aggregate shall conform to the following requirements:

Sieve Sizes	Percentage by Weight Passing Sieve
1½ Inch	100
1 Inch	80–100
No. 4	30–65
No. 16	15–40
No. 200	2–12

Project Control Tests	Test Method	Requirements
Sieve Analysis	Nev. T206	Above
Sampling Aggregate	Nev. T200	-------
Fractured Faces	Nev. T230	35 Percent Min.
Plasticity Index	Nev. T212	Table 1
Liquid Limit	Nev. T210	35 Max.
Source Requirement Tests	**Test Method**	**Requirements**
Resistance (R Value)	Nev. T115	70 Min.
Percentage of Wear (500 Rev.)	Nev. T233	45 Percent Max.

704.03.03 Type 1 Class B Aggregate Base. This aggregate shall conform to the following requirements:

Sieve Sizes	Percentage by Weight Passing Sieve
1½ Inch	100
1 Inch	80–100
No. 4	30–65
No. 16	15–40
No. 200	2–12

Project Control Tests	Test Method	Requirements
Sieve Analysis	Nev. T206	Above
Sampling Aggregate	Nev. T200	-------
Fractured Faces	Nev. T230	15 Percent Min.
Plasticity Index	Nev. T212	Table 1
Liquid Limit	Nev. T210	35 Max.
Source Requirement Tests	**Test Method**	**Requirements**
Resistance (R Value)	Nev. T115	70 Min.
Percentage of Wear (500 Rev.)	Nev. T233	45 Percent Max.

704.03.04 Type 2 Class A Aggregate Base. This aggregate shall conform to the following requirements:

Sieve Sizes	Percentage by Weight Passing Sieve
1 Inch	100
¾ Inch	90–100
No. 4	35–65
No. 16	15–40
No. 200	2–10

Project Control Tests	Test Method	Requirements
Sieve Analysis	Nev. T206	Above
Sampling Aggregate	Nev. T200	-------
Crushed Particles	Nev. T230	50 Percent Min.
Plasticity Index	Nev. T212	Table 1
Liquid Limit	Nev. T210	35 Max.

Source Requirement Tests	Test Method	Requirements
Resistance (R Value)	Nev. T115	78 Min.
Percentage of Wear (500 Rev.)	Nev. T233	45 Percent Max.

704.03.05 Type 2 Class B Aggregate Base. This aggregate shall conform to the following requirements:

Sieve Sizes	Percentage by Weight Passing Sieve
1 Inch	100
¾ Inch	90–100
No. 4	35–65
No. 16	15–40
No. 200	2–10

Project Control Tests	Test Method	Requirements
Sieve Analysis	Nev. T206	In Standard Specifications
Sampling Aggregate	Nev. T200	.....
Fractured Faces	Nev. T230	35 Percent Min.
Plasticity Index	Nev. T212	Table 1
Liquid Limit	Nev. T210	35 Max.

Source Requirement Tests	Test Method	Requirements
Resistance (R Value)	Nev. T115	70 Min.
Percentage of Wear (500 Rev.)	Nev. T233	45 Percent Max.

704.03.06 Type 3 Class A Aggregate. All requirements will be specified in the special provisions.

704.03.07 Type 3 Class B Aggregate. All requirements will be specified in the special provisions.

704.03.08 Aggregate for Portland Cement Treated Base. This aggregate shall conform to the following requirements:

Sieve Sizes	Percentage by Weight Passing Sieve
1 Inch	100
¾ Inch	90–100
No. 4	35–75
No. 16	15–45
No. 200	2–15

Test	Test Method	Requirements
Sieve Analysis	Nev. T206	Above
Sampling Aggregate	Nev. T200	.....
Sand Equivalent	Nev. T227	20 Min.
Percentage of Wear (500 Rev.)	Nev. T233	45 Percent Max.

SECTION 705

AGGREGATES FOR BITUMINOUS COURSES

SCOPE

705.01.01 Materials Covered. This specification covers the quality and size of local mineral materials and commercial mineral fillers used in bituminous base and surface courses.

REQUIREMENTS

705.02.01 General. The mineral aggregate shall be the product of approved deposits. The Engineer reserves the right to prohibit the use of aggregates from any source when:

(a) The character of the material is such, in the opinion of the Engineer, as to make improbable the furnishing of aggregates conforming to the requirements of these specifications.

(b) The character of the material is such, in the opinion of the Engineer, that undue additional costs may be accrued by the State.

The mineral aggregate shall be clean, hard, durable, free from frozen lumps, deleterious matter, and harmful adherent coatings.

705.02.02 Deficiencies. If the product of any deposit is deficient in the fraction passing the No. 16 sieve, additional filler from other approved deposits meeting the physical requirements may be added. The added material shall be fed to the drier in a uniform manner from a separate stockpile. If the added material is a commercial mineral filler, it shall be uniformly fed directly to the plant. This is not to be construed as a waiver of any of the requirements contained herein.

PHYSICAL PROPERTIES AND TESTS

705.03.01 Plantmix and Roadmix Bituminous Base and Surface Aggregate, Types 1, 2, and 3. The aggregate shall conform to the following requirements:

Sieve Sizes	Percentage by Weight Passing Sieve — Type 1	Type 2	Type 3
1 Inch	100	100	....
¾ Inch	90–100	90–100	....
½ Inch	....	....	100
⅜ Inch	....	63–85	85–100
No. 4	40–65	45–65	50–75
No. 16	15–40	20–40	20–45
No. 200	3–9	3–9	3–10

Project Control Tests	Test Method	Requirements
Sieve Analysis	Nev. T206	Above
Sampling Aggregate	Nev. T200	.....
Fractured Faces	Nev. T230	50 Percent Min. Type 2, 35 Percent Min. for Types 1 and 3
Plasticity Index	Nev. T212	6 Percent Max.
Liquid Limit	Nev. T210	35 Percent Max.

Source Requirement Tests	Test Method	Requirements
Stripping Test	Nev. T209	Satisfactory
Stabilometer Value (Types 1 and 3)	Nev. T303	30 Min.
Stabilometer Value (Type 2)	Nev. T303	35 Min.
Moisture Vapor Susceptibility (Stabilometer Value)	Nev. T312	25 Min.
Swell Test	Nev. T304	0.030" Max.
Percentage of Wear (500 Rev.)	Nev. T233	45 Percent Max.

705.03.02 Plantmix Surface Aggregate, Type 4. The combined aggregates shall conform to the following requirements:

Sieve Sizes	Percentage by Weight Passing Sieve
1 Inch	100
¾ Inch	90–100
⅜ Inch	55–85
No. 4	40–65
No. 16	15–40
No. 200	3–9

Project Control Tests	Test Method	Requirements
Sieve Analysis	Nev. T206	Above
Sampling Aggregate	Nev. T200	.....
Fractured Faces	Nev. T230	90 Percent Min.
Plasticity Index	Nev. T212	6 Percent Max.
Liquid Limit	Nev. T210	30 Percent Max.

Source Requirement Tests	Test Method	Requirements
Stripping Test	Nev. T209	Satisfactory
Stabilometer Value	Nev. T303	37 Min.
Moisture Vapor Susceptibility (Stabilometer Value)	Nev. T312	30 Min.
Swell Test	Nev. T304	0.030" Max.
Percentage of Wear (500 Rev.)	Nev. T233	45 Percent Max.

705.03.03 Plantmix Bituminous Open-Graded Surface Aggregate. The aggregate shall conform to the following requirements:

	Percentage by Weight Passing Sieve	
Sieve Sizes	½ Inch Size	⅜ Inch Size
½ Inch	100	....
⅜ Inch	90–100	100
No. 4	35–55	45–65
No. 16	5–18	12–22
No. 200	0–3	0–4

Project Control Tests	Test Method	Requirements
Sieve Analysis	Nev. T206	Above
Sampling Aggregate	Nev. T200	.....
Fractured Faces	Nev. T230	90 Percent Min.

Source Requirement Tests	Test Method	Requirements
Stripping Test	Nev. T209	Satisfactory
Swell Test	Nev. T304	0.030" Max.
Percentage of Wear (500 Rev.)	Nev. T233	37 Percent Max.
Degradation:		
Passing No. 20 Sieve	Nev. T232	25 Percent Max.
Height, Inches	Nev. T232	2.5 Max.

705.03.04 Commercial Mineral Filler. Commercial mineral filler shall conform to the requirements of AASHTO M17.

705.03.05 Screenings. The screenings shall conform to the following requirements:

Sieve Sizes	Percentage by Weight Passing Sieve: ½ Inch Size	⅜ Inch Size
½ Inch	100	....
⅜ Inch	90–100	100
No. 4	15–35	20–45
No. 16	0–4	0–6
No. 200	0–2	0–2

Project Control Tests	Test Method	Requirements
Sieve Analysis	Nev. T206	Above
Sampling Aggregate	Nev. T200	.....
Fractured Faces	Nev. T230	90 Percent Min.

Source Requirement Tests	Test Method	Requirements
Stripping Test	Nev. T209	Satisfactory
Percentage of Wear (500 Rev.)	Nev. T233	37 Percent Max.
Degradation:		
Passing No. 20 Sieve	Nev. T232	25 Percent Max.
Height, Inches	Nev. T232	2.5 Max.

705.03.06 Sand Blotter. The sand shall conform to the following requirements:

Sieve Sizes	Percentage by Weight Passing Sieve
½ Inch	100
No. 4	90–100
No. 16	30–75
No. 200	0–12

Test	Test Method	Requirements
Sieve Analysis	Nev. T206	Above
Sampling Aggregate	Nev. T200	.....
Organic Impurities	Nev. T498	.....

SECTION 706

AGGREGATES FOR PORTLAND CEMENT PRODUCTS

SCOPE

706.01.01 Materials Covered. This specification covers the quality and size of aggregates used in Portland cement products.

REQUIREMENTS

706.02.01 General. The mineral aggregate shall be the product of approved deposits. The Engineer reserves the right to prohibit the use of aggregates from any source when:

(a) The character of the material is such, in the opinion of the Engineer, as to make improbable the furnishing of aggregates conforming to the requirements of these specifications.

(b) The character of the material is such, in the opinion of the Engineer, that undue additional costs may be accrued by the State.

Before beginning concrete work, the Contractor shall submit in writing to the Engineer the proposed concrete mix design indicating the proportions of cement, water, admixtures and the gradation of the primary aggregate nominal sizes which he proposes to furnish. When the primary coarse aggregate is separated into two sizes, the gradation shall consist of the gradation for each individual size, and the proposed proportions of each individual size, combined mathematically with the fine aggregate to indicate one proposed gradation. Such gradation shall meet the grading requirements shown in the following table (not applicable to lightweight concrete):

Grading Limits of Combined Aggregates

Sieve Size	Percent Passing	
	1½" Max.	¾" Max.
2	100	.....
1½	87–100	.....
1	65–90	100
¾	48–82	80–100
⅜	39–57	46–70
4	30–45	34–50
8	23–38	24–42
16	15–33	17–34
30	8–24	10–25
50	4–13	5–15
100	1–5	2–7
200	0–3	0–3

Should the Contractor change his source of supply, he shall submit in writing to the Engineer the new gradations before their intended use.

PHYSICAL PROPERTIES AND TESTS

706.03.01 Coarse Aggregate. The aggregate shall conform to the following requirements:

Sieve Sizes	Percentage by Weight Passing Sieve						
	Size No. 3 (2″ to 1″)	Size No. 4 (1½″ to ¾″)	Size No. 7 (½″ to No. 4)	Size No. 57 (1″ to No. 4)	Size No. 67 (¾″ to No. 4)	Size No. 357 (2″ to No. 4)	Size No. 467 (1½″ to No. 4)
2½ Inch	100	.....	.....	.....	.....	100	.....
2 Inch	95–100	100	.....	.....	.....	95–100	100
1½ Inch	35–70	90–100	.....	100	.....	.....	95–100
1 Inch	0–15	20–25	.....	95–100	100	35–70	.....
¾ Inch	.....	0–15	100	.....	90–100	.....	35–70
½ Inch	0–5	.....	90–100	25–60	.....	10–30	.....
⅜ Inch	.....	0–5	40–70	.....	20–55	.....	10–30
No. 4	.....	.....	0–15*	0–10*	0–10*	0–5	0–5

*Not more than five (5) percent shall pass No. 8 sieve.

NOTE: Sizes No. 357 and No. 467 shall each be split into two sizes. Size No. 357 shall be furnished in stockpile or bunker in sizes No. 3 (2″ to 1″) and size No. 57 (1″ to No. 4). Size No. 467 shall be furnished in stockpile or bunker in Size No. 4 (1½″ to ¾″) and Size No. 67 (¾″ to No. 4). The two sizes shall be uniformly combined at the mixing plant to comply with the grading requirements of Sizes No. 357 and No. 467 respectively.

Test	Test Method	Requirements
Sieve Analysis	Nev. T499	Above
Sampling Aggregate	Nev. T200	.....
Material Passing 200 Sieve	Nev. T499	1 Percent Max.
Percentage of Wear (100 rev.)	Nev. T233	10 Percent Max.
Percentage of Wear (500 rev.)	Nev. T233	50 Percent Max.
Soundness (5 alterations)	Nev. T470	12 Percent Max. Loss
Clay Lumps	Nev. T490	0.3 Percent Max.

Thin or elongated pieces (length greater than five (5) times maximum thickness) shall not exceed fifteen (15) percent by weight.

706.03.02 Lightweight Aggregates. These aggregates shall conform to the following requirements:

Sieve Size	Percentage by Weight Passing Sieve			
	Fine Natural	Fine Lightweight	1″ Size Coarse	¾″ Size Coarse
1 Inch	.....	.....	95–100	100
¾ Inch	.....	.....	.....	90–100
½ Inch	.....	.....	25–60	.....
⅜ Inch	100	100	.....	20–60
No. 4	95–100	85–100	0–10	0–10
No. 16	45–80	40–80	.....	.....
No. 50	10–35	10–35	.....	.....
No. 100	2–12	5–25	.....	.....
No. 200	0–5	.....	.....	.....

Test	Test Method	Requirements
Sieve Analysis	Nev. T499	Above (a)
Sampling	Nev. T200	.....
Unit Weight (loose oven dry)	Nev. T119	Fine Agg.—70 lb. cu. ft. Max. (b) Coarse Agg.—55 lb. cu. ft. Max. (b) Comb. Fine and Coarse—65 lb. cu. ft. Max. (b)
Organic Impurities	Nev. T498	Satisfactory (c)
Clay Lumps	Nev. T490	2.0 Percent Max.
Test for Staining Materials	Nev. T488	Satisfactory (d)
Mortar Making Properties of Sand	Nev. T472	95 Percent Min. (e)

(a) With the following exceptions: The weight of the test sample for the fine lightweight aggregate shall be in accordance with Table III, and the aggregate when mechanically sieved shall be sieved for only five (5) minutes. The test sample for coarse aggregate shall consist of no less than 0.1 cu. ft. of the material used for the determination of unit weight.

TABLE III

Weight of Sieve Test Sample for Fine Lightweight Aggregates

Nominal Weight of Aggregate Lbs. Per Cubic Foot	Weight of Test Sample, Grams
25–35	150
35–45	200
45–55	250
55–65	300
65–70	350

(b) The unit weight of successive shipments of lightweight aggregate shall not differ by more than ten (10) percent from that of the sample submitted for acceptance tests.

(c) Aggregates tested and showing color darker than the standard shall be rejected unless it can be demonstrated that the discoloration is due to small quantities of materials not harmful to the concrete.

(d) Aggregates tested and showing stain darker than "heavy stain" (stain index of 80) or darker shall be tested by chemical procedure, and aggregates that contain 1.5 mg. or more of ferric oxide (Fe_2O_3) per 200 gram sample shall be rejected for use.

(e) Fine aggregate failing in the test for organic impurities (Nev. T498) may be used provided that when tested for effect of organic impurities on strength of mortar, the relative strength at seven (7) and twenty-eight (28) days calculated in accordance with (Nev. T472) is not less than ninety-five (95) percent.

706.03.03 Fine Aggregate. This aggregate shall conform to the following requirements:

Sieve Sizes	Percent By Weight Passing Sieve
⅜ Inch	100
No. 4	95–100
No. 16	45–80
No. 50	10–35
No. 100	2–12
No. 200	0–5

Test	Test Method	Requirements
Sieve Analysis	Nev. T499	Above
Sampling Aggregate	Nev. T200	----------
Soundness (5 alterations) (Sodium sulphate)	Nev. T470	10 Percent Max. Loss
Clay Lumps	Nev. T490	1.0 Percent Max.
Lightweight Pieces in Agg.	Nev. T487	1.0 Percent Max.
Percentage of Particles of Less than 1.95 Sp. Gr.	Nev. T486	3.0 Percent Max.
Organic Impurities	Nev. T498	Satisfactory (a)
Mortar Making Properties	Nev. T472	95 Percent Min. (b)

(a) Aggregates tested and showing color darker than the standard shall be rejected unless they pass the "Mortar Making Properties" test (Nev. T472).

(b) Fine aggregate failing in the test for organic impurities (Nev. T498) may be used provided that when tested for effect of organic impurities on strength of mortar, the relative strength at seven (7) and twenty-eight (28) days calculated in accordance with (Nev. T472) is not less than ninety-five (95) percent.

706.03.04 Grout and Mortar Sand. This aggregate shall conform to the following requirements:

Sand for grout and mortar shall conform to the size requirements of 706.03.03, "Fine Aggregate," except if the Contractor elects, he may screen the sand over a No. 8 screen to produce the following:

Sieve Sizes	Percent By Weight Passing Sieve
No. 8	100
No. 50	15–40
No. 100	0–10
No. 200	0–5

Test	Test Method	Requirements
Sieve Analysis	Nev. T499	Above
Sampling Aggregate	Nev. T200	.....
Mortar Making Properties	Nev. T472	95 Percent Min. (a)
Organic Impurities	Nev. T498	Satisfactory (b)

(a) Fine aggregate failing in the test for organic impurities (Nev. T498) may be used provided that when tested for effect of organic impurities on strength of mortar, the relative strength at seven (7) and twenty-eight (28) days calculated in accordance with (Nev. T472) is not less than ninety-five (95) percent.

(b) Aggregates tested and showing color darker than the standard shall be rejected unless they pass the mortar making properties test (Nev. T472).

706.03.05 Stone for Masonry and Riprap. This stone shall conform to the following requirements:

Source Requirement Tests	Test Method	Requirements
Percentage of Wear (500 Rev.)	Nev. T233	45 Percent Max.
Specific Gravity	Nev. T111	2.50 Min.
*Degradation	Nev. T232	
Passing No. 20		25 Percent Max.
Height, Inches		2.5 Max.

*NOTE: To be used for selected projects only and as shown in those special provisions.

SECTION 707

JOINT MATERIAL

SCOPE

707.01.01 Material Covered. This specification covers the quality requirements for poured filler, preformed fillers, and resilient and rubber type gaskets used in the construction of bridges, culverts, sidewalks, etc.

PHYSICAL PROPERTIES AND TESTS

707.03.01 Joint Fillers. Preformed fillers for joints shall conform to the requirements of AASHTO M213, ASTM D1751, Fiber Type, and shall be punched to admit the dowels where called for on the plans. The filler for each joint shall be furnished in a single piece for the full depth and width required for the joint unless otherwise authorized by the Engineer. When the use of more than one piece is authorized for a joint, the abutting ends shall be fastened securely and held in place, by stapling or other positive fastening satisfactory to the Engineer.

707.03.02 Rubber Gaskets. The ring gaskets shall conform to the requirements of AASHTO M198.

707.03.03 Waterstops. Waterstops shall conform to the following requirements:

(a) Natural Rubber—

Test	Test Method	Requirements
Tension Testing of Vulcanized Rubber	ASTM D412	Tensile strength 3,500 lbs. Min. p.s.i.—Elongation at breaking of 550 percent. Unit stress (300 percent) 1,100 lbs. p.s.i. Min. Unit stress (500 percent) 2,800 lbs. p.s.i. Min.

Test for Accelerated aging of Vulcanized Rubber by the Oxygen Pressure Method	ASTM D572	After 7 days in air at 158° (±2°) F. or after 48 hours in oxygen at 158° (±2°) F. and 300 lbs. p.s.i., the tensile strength and elongation shall not be less than 65 percent of the original.
Test for Indentation of Rubber by Means of a Durometer	ASTM D2240	55 to 65 (hardness).

Natural rubber waterstops shall be manufactured from a stock composed of a high grade compound made exclusively from new plantation rubber reinforced carbon black, zinc oxide, accelerators, antioxidants, and softeners. This compound shall contain not less than seventy-two (72) percent by volume of new plantation rubber.

(b) Synthetic Rubber—

Test	Test Method	Requirements
Tension Testing of Vulcanized Rubber	ASTM D412	Tensile strength 2,500 lbs. p.s.i. Min. Elongation at breaking of 425 percent.
Testing for Accelerated Aging of Vulcanized Rubber by the Oxygen Pressure Method	ASTM D572	After 7 days in air at 158° (±2°) F. or after 48 hours in oxygen at 158° (±2°) F. and 300 lbs. p.s.i., the tensile strength and elongation shall not be less than 65 percent of the original.
Test for Indentation of Rubber by Means of a Durometer	ASTM D2240	50 to 70 (hardness).

(c) Polyvinyl Chloride—

Test	Test Method	Requirements
Polyvinyl Chloride Waterstops	Corps. of Engr. CRD–C572	Compliance of paragraph 6.

707.03.04 Pourable Joint Sealer. The pourable joint sealer for bridges shall be a polyurethane sealant furnished and placed as hereinafter specified.

Polyethylene foam shall be commercial quality, with a continuous, impervious, glazed top surface, suitable for retaining the liquid polyurethane sealant in the joint while hardening.

A primer, furnished by the manufacturer of the sealant, shall be applied to the sides of the groove and to all exposed vertical surfaces in the joint prior to placing the polyurethane sealant. The primer shall be dry prior to placing sealant.

TWO COMPONENT MACHINE MIXED POLYURETHANE SEALANT

Classification

This specification describes a two component, machine mixed, polyurethane joint sealant. This sealant, when properly applied against a clean sound surface, will reject foreign material, resist infiltration of water into the joint, and withstand up to plus twenty-five (25) percent movement. The use of a primer against the joint faces is required.

Mixing Material for Test Specimens

Mix vigorously, equal volumes of the two components (total volume not more than one-half (½) pint) for forty-five (45) seconds by hand using a square tipped one (1) inch stiff spatula. Incorporate as little air as possible. Pour samples within thirty (30) seconds after mixing. Do not scrape side of mixing vessel.

Test Sample Preparation

(a) Prime one surface of eight (8) one inch by two inch by three inch (1″ x 2″ x 3″) test blocks made according to Test Method No. Calif. 413. Prepare four (4) one-half inch by one-half inch by two inch (½″ x ½″ x 2″) specimens of sealant using teflon or amalgamated brass spacers. The two (2) inch side of the sealant shall be parallel to the two (2) inch side of the test block. After twenty-four (24) hours at seventy-seven (77) degrees plus or minus three (3)

degrees Fahrenheit place test specimens in an oven at one hundred fifty-eight (158) degrees plus or minus two (2) degrees Fahrenheit for seven (7) days. Condition the samples for eight (8) hours at seventy-seven (77) degrees plus or minus three (3) degrees Fahrenheit before testing.

(b) Cast a smooth sheet of sealant one-eighth (⅛) inch thick against a sheet of mylar plastic, cure for twenty-four (24) hours at seventy-seven (77) degrees plus or minus three (3) degrees Fahrenheit, then for forty-eight (48) hours at one hundred fifty-eight (158) degrees plus or minus two (2) degrees Fahrenheit. Cut a tensile test specimen as required in Test Method No. Calif. 429.

Testing

(a) Elongate two (2) tensile test specimens to one hundred fifty (150) percent one and one-fourth (1¼) inches, and measure modulus in total pounds (a). Use one and one-fourth (1¼) inch spacers to maintain one hundred fifty (150) percent extension. Condition specimens for seven (7) days at seventy-seven (77) degrees plus or minus three (3) degrees Fahrenheit, remove spacers and place test specimens on a glass surface so that the two one inch by three inch (1″ x 3″) surfaces of each specimen bear directly on the glass. At two (2), three (3), and five (5) minute intervals lift the test specimen carefully to help relieve any friction which may restrict the recovery of the sealant. Measure the width on the sealant (distance between two inch by three inch (2″ x 3″) face of blocks) five (5) minutes after relaxation (b). Again extend the test specimen to one hundred fifty (150) percent, insert one and one-fourth (1¼) inch spacers and cut a notch about one-sixteenth (1/16) inch deep, parallel to the three (3) inch block dimension and across the center of the sealant surface. Examine the sealant twenty-four (24) hours later (c).

(b) Extend two (2) specimens one hundred (100) percent (one (1) inch), insert one (1) inch spacers and immerse in distilled water at seventy-seven (77) degrees plus or minus three (3) degrees Fahrenheit for seven (7) days and observe (d).

(c) Place the tensile test specimen in a jig which will extend the center from one (1) inch to two (2) inches (one hundred (100) percent elongation of center section) and place in Atlas Fadeometer for one hundred (100) hours. Remove specimen and examine (e).

Specification Values

(a) Modulus at one hundred fifty (150) percent elongation, pounds, eight to seventy-five (8–75).

(b) Width of sealant after seven (7) days extension and one (1) hour recovery, inches, twenty-one thirty-seconds ($^{21}/_{32}$) max.

(c) Condition twenty-four (24) hours after notching—Sealant must not fail completely in adhesion or cohesion.

(d) Condition of water immersed specimen at seven (7) days—Notch or loss of bond one-fourth (¼) inch, max.

(e) Condition of specimen after one hundred (100) hours in Fadeometer—No more than slight checking or cracking.

In addition to the above, sealant shall be self-leveling but cure rapidly enough to avoid flow after application on grades up to fifteen (15) percent. The grease cone penetration at twenty-four (24) hours shall be forty-five to one hundred twenty (45–120) when tested according to Test Method No. Nev. T531.

Directions for Use

All manufacturers' instructions shall be carefully followed.

Mixing of one or both components separately before using may be necessary.

Material which has been exposed to the atmosphere for more than twenty-four (24) hours shall not be used.

Equipment used shall conform to the recommendations of the manufacturer of the sealant.

The Contractor shall furnish the Engineer with a Certificate of Compliance executed by the manufacturer of pourable joint sealer. Such certificate shall attest that the pourable joint sealer as produced in the usual course of the manufacturer's trade, conforms to these specifications.

707.03.05 Asphalt Plank. Asphalt plank shall conform to the requirements of ASTM Designation: D517 for Plain Asphalt Plank.

707.03.06 Preformed Elastic Joint Sealer. Preformed elastic joint sealer and lubricant adhesive shall conform to the following requirements:

Preformed elastic joint sealer shall be an extruded vulcanized elastromeric virgin polychloroprene material. The lubricant adhesive shall be a one component virgin polychloroprene compound containing only soluble phenolic resins blended with antioxidants and acid acceptors in an aromatic hydrocarbon solvent.

The preformed elastic joint sealer shall be resilient, heat, oil and ozone resistant. It shall not soften excessively or become excessively brittle between the temperatures of minus thirty (30) degrees Fahrenheit and one hundred sixty (160) degrees Fahrenheit. The joint sealer shall be furnished in extruded strip form and all surfaces shall be smooth. The extruded shape shall be symmetrical and be of uniform cross sectional shape and of uniform thickness and shall conform to the following:

Property	Test Procedure	Physical Requirements
Hardness, Type A, Durometer	ASTM D676	55 ± 5
Tensile Strength, Min. p.s.i.	ASTM D412	2000
Elongation at break, Min. percent	ASTM D412	250
Ozone Resistance, 20 percent Elongation, 300 pphm 104° F., 70 hrs. (Sample to be solvent wiped before test to remove any traces of surface impurities)	ASTM D1149	No cracks
Oven aging 70 hours at 212° F.	ASTM D573	.....
Tensile Strength, Max. percent Decrease	.....	–30
Elongation, Max. percent Decrease	.....	–40
Hardness, Max. change	.....	+10/–0
Oil Swell, ASTM Oil #3 70 hours/212° F.	ASTM D471	.....
Max. Volume Change	.....	+80

Property	Test Procedure	Physical Requirements
Max. Wt. Increase at Specific Gravity 1.35±3	.....	+45
High Temperature Recovery 70 hours/212° F. under 50 percent deflection, percent	*	85
Low Temperature Recovery 22 hours/20° F. under 50 percent deflection, percent	*	83

*See method of test.

The lubricant adhesive shall be homogeneous and shall remain workable from five (5) degrees Fahrenheit to one hundred twenty (120) degrees Fahrenheit. Each lot of the adhesive shall be in containers with the manufacturer's name or trademark and the date of manufacture plainly marked. Adhesive shall be stored at a temperature of fifty (50) degrees Fahrenheit to eighty (80) degrees Fahrenheit and shall be used within two hundred seventy (270) days after the date of its manufacture.

The lubricant adhesive shall conform to the following requirements:

Average net weight per gallon, lbs	7.84 ± 5%
Solids content by weight, percent	22–28

Each lot of the preformed elastic joint sealer, and lubricant adhesive furnished under these specifications shall be identified as specified herein and shall be products which have been tested by a reputable testing laboratory, recognized by the State, who shall certify that the materials meet these specifications and requirements. The Contractor shall furnish the Department with these certifications prior to using the material.

METHODS OF TEST

Low and High Temperature Recovery Tests

(a) Apparatus

1. Compression Clamp. A compression clamp consists of two or more flat steel plates known as a Method "B" ASTM compression set clamp (ASTM D395–61); or

a vise having parallel plates on jaws; or any basic device by which uniform compression can be applied to a specimen. The device should be capable of accepting a five (5) inch long specimen.

2. Steel Spacers. If compression clamps are used, steel spacer bars will be required to allow proper spacing of the steel plates.

3. Air Oven. This piece of apparatus shall meet the requirements of ASTM E145–59T, Type II, Grade A. The oven shall be provided with proper temperature control to maintain the specified temperature within a permissible variation of plus or minus two (2) degrees Fahrenheit.

4. Low Temperature Box. This piece of apparatus can be any refrigerated box capable of maintaining a temperature variation of plus or minus two (2) degrees Fahrenheit on temperature settings within the range of plus twenty (20) degrees Fahrenheit to minus twenty (20) degrees Fahrenheit.

5. Dial Gage—Vernier Caliper—Micrometer. A dial gage, vernier caliper, or micrometer graduated in thousands of an inch shall be used for measurements.

(b) Samples. Samples of fabricated seals shall be approximately five (5) inches long and shall be taken at random from each new shipment of seals.

(c) Test Procedure.

1. In the heat tests that material should be tested as furnished in production. Samples should be washed with water prior to testing to remove any foreign material or dust, and thoroughly dried. There should be no talcing of internal surfaces of the seal. Outside surfaces may be dusted to prevent sticking to the steel compression plates.

In cold tests talcing of internal seal surfaces may be desirable.

2. Deflect the sample between parallel plates to fifty (50) percent of original top width. Width measurement shall be taken in the center of the five (5) inch length. Prior to compression the sample shall be placed in a horizontal position in such a manner that the plane between lip tips is perpendicular to the compression plates. As the

sample is being compressed, care should be taken to insure that the "V" section of the sample top be folded so that it projects inward towards the inner web section.

3. High Temperature. Expose the clamp assembly and compressed sample in an oven for seventy (70) hours at two hundred twelve (212) degrees Fahrenheit plus or minus two (2) degrees. Do not pre-heat the clamp assembly. When the oven aging period is completed, remove the clamp assembly and immediately unclamp the test specimen. Cool the test specimen at room temperature (73+4) on a wooden surface for one (1) hour before measuring the heat aged recovery width. The measurement shall be made at the location at which the original width was determined.

Low Temperature. Expose the clamp assembly and compressed sample in a low temperature box for the time and temperature specified. When the cold aging period is completed, unclamp the test specimen at the test temperature; allow it to recover in a free state at the test temperature for one (1) hour. At this point measure the recovery width at the test temperature. The measurements shall be made at the location at which the original width was determined.

(d) Calculations. Calculate the recovery, expressed as a percentage of the original width, as follows:

$$\text{Percent Recovery} = \frac{\text{Recovered Width} \times 100}{\text{Original Width}}$$

(e) Any cracking visible after recovery testing is basis for rejection.

(f) Any evidence of bond between any of the webs after high temperature recovery is also basis for rejection even though recovery requirement is met.

SECTION 708

CONCRETE AND CLAY PIPE AND DRAINS

SCOPE

708.01.01 Materials Covered. This specification covers the quality of clay pipe, nonreinforced concrete pipe, and reinforced concrete pipe used for culverts, siphons, pressure conduits, sewers, and storm drains. Also the quality of perforated pipe used in underdrains.

PHYSICAL PROPERTIES AND TESTS

708.03.01 Reinforced Concrete Pipe. This pipe shall conform to the requirements of AASHTO M170 for the specified diameters and strength classes. Elliptical pipe shall be furnished where specified. Unless otherwise specified, pipe wall design and use of elliptical reinforcement in circular pipe are optional.

Precast reinforced concrete end sections shall conform to the requirements of the cited specifications to the extent to which they apply.

708.03.02 Nonreinforced Concrete Pipe. This pipe shall conform to the requirements of AASHTO M86 for the specified diameters and strength classes.

708.03.03 Perforated Concrete Pipe. This pipe shall conform to the requirements of AASHTO M175 or to ASTM C444 for the specified diameters and strength classes.

708.03.04 Clay Pipe. This pipe shall conform to the requirements of AASHTO M65 for pipe with full circular cross section, for the specified diameter and strength class. When specified, the bell shall have integral spacer lugs to provide for an annular opening and self-centering feature.

708.03.05 Bituminous Fiber Pipe. This pipe shall

conform to the requirements of AASHTO M177, ASTM D1861 or D1862.

708.03.06 Perforated Bituminous Fiber Pipe. This pipe shall conform to the requirements of AASHTO M177 for the specified diameters. Unless otherwise specified, either Type 1 or Type 2 couplings may be furnished.

SECTION 709

METAL PIPE AND DRAINS

SCOPE

709.01.01 Material Covered. This specification covers the quality of metal pipes, metal arch pipes, metal end sections, structural plate pipe, and perforated metal pipe used for culverts, drainage structures, conduits, and underdrains.

PHYSICAL PROPERTIES AND TESTS

709.03.01 Corrugated Metal Pipe and Pipe Arches. These conduits and the coupling bands shall conform to the requirements of AASHTO M36 and M36–73I for the specified sectional dimensions and spelter coating. Shop-formed elliptical pipe and shop strutted pipe shall be furnished where specified.

Special sections, such as elbows, tees and wyes for these conduits shall be of the same gage as the conduit to which they are joined, and shall conform to applicable requirements of AASHTO M36.

Minimum gages for conduits and coupling bands shall be as indicated for two and two-thirds (2⅔) by one-half (½) inch corrugated steel pipe as shown on the standard plan sheet R–1.3.1 entitled "Allowable Fill Heights for Culverts," unless otherwise indicated on the plans and in the proposal.

Three (3) by one (1) inch corrugations designed for the same or greater maximum fill height, as shown in the tables on said standard plan sheet, may be substituted for the two and two-thirds (2⅔) by one-half (½) inch corrugations.

Two (2) by one-half (½) inch and two and two-thirds (2⅔) by one-half (½) inch corrugated aluminum pipe designed for the same or greater maximum fill height, as shown in the tables on said plan sheet, may be substituted for two and two-thirds (2⅔) by one-half (½) inch corrugated steel pipe when an aluminum alternate is specifically allowed in the special provisions.

When metal end sections are required, the following requirements shall pertain:

(a) Metal end sections shall be of the gage shown on the plans.

(b) The end of the pipe shall be finished with annular corrugations to conform to metal end section so that no leakage results from the connection; however, other designs may be used if approved by the Engineer.

(c) Where connector sections are used the connector section shall be helical or annular as required to match the type of pipe used.

709.03.02 Bituminous Coated Corrugated Metal Pipe and Pipe Arches. These conduits and the coupling bands shall conform to the requirements of AASHTO M190 for the specified sectional dimensions, gages, and type of bituminous coating. Coupling bands shall be fully coated with bituminous material. Shop-formed elliptical pipe and shop strutted pipe shall be furnished where specified.

Special sections, such as elbows and flared end sections, for these conduits shall be of the same gage as the conduit to which they are joined, and shall conform to the applicable requirements of AASHTO M190. Coating and invert paving shall be of the type specified. Coating shall be as required for Type A unless otherwise specified.

When asbestos bonded bituminous coating is specified, these requirements shall equally apply and in addition the special process of embedding asbestos fiber in the molten metallic bonding medium shall be used to bond the bituminous coating.

709.03.03 Corrugated Aluminum Pipe. This pipe shall conform to the requirements of AASHTO M196.

709.03.04 Corrugated Metal Pipes for Downdrains. Downdrain flumes and pipe shall conform to the requirements of AASHTO M36. Type III inlets shall conform to the requirements of AASHTO M36. Type I and Type II inlets shall conform to the requirements of ASTM A93 except two (2.00) ounce coating shall be required. When

specified, pipe, flumes, and inlets shall be bituminous coated conforming to the requirements of AASHTO M190. All anchor assemblies, hardware, and accessories shall conform to the requirements of ASTM A153 and ASTM A123.

709.03.05 Corrugated Metal Pipe for Underdrains. This pipe shall conform to the requirements of AASHTO M36, Type III for the specified diameters. Unless otherwise specified, any one of the first three classes shown may be furnished.

709.03.06 Bituminous Coated Corrugated Metal Pipe for Underdrains. This pipe shall conform to the requirements of AASHTO M36 and shall be coated with bituminous material to meet requirements of AASHTO M190, Type A coating, except that minimum coating thickness shall be 0.03 inch. Coupling bands shall be full coated. The specified minimum diameter of perforations shall apply after coating.

709.03.07 Corrugated Aluminum Pipe for Underdrains. This pipe shall conform to the requirements of AASHTO M197.

709.03.08 Structural Plate Pipe and Pipe Arches. This pipe shall conform to the requirements of AASHTO M167.

SECTION 710

STRUCTURAL AND EYEBAR STEEL

SCOPE

710.01.01 Material Covered. This specification covers the quality of structural and eyebar steel used in highway structures.

REQUIREMENTS

710.02.01 Defects. Finished rolled material shall be free from cracks, flaws, injurious seams, laps, blisters, ragged and imperfect edges, and other defects. It shall have a smooth, uniform finish, and shall be straightened in the mill before shipment.

Material shall be free from loose mill scale, rust pits, or other defects affecting its strength or durability.

The Engineer reserves the right to reject material which he deems unsuitable for the purpose intended even though the material meets the requirements of the mill tolerances.

710.02.02 Charpy V-notch Test. All steels used in and designated as load carrying members subject to tensile stress, shall comply with all the requirements specified for Charpy V-notch test in the various AASHTO Designations for the steels involved. Sampling and testing procedures shall be in accordance with the requirements of the applicable AASHTO Designations.

PHYSICAL PROPERTIES AND TESTS

710.03.01 Standard Steel. This steel shall conform to the requirements of ASTM A36 and the Supplementary Requirements S1 and S2.

710.03.02 High Strength-Low Alloy Structural Manganese Vanadium Steel. This steel shall conform to the requirements of ASTM A441.

710.03.03 High Tensile Strength Bolts. This steel shall conform to the requirements of ASTM A325.

710.03.04 Stainless Steel Bolts. This steel shall conform to the requirements of ASTM A276.

710.03.05 Welded Seamless Steel Pipe. This steel shall conform to the requirements of ASTM A53 (Grade B).

710.03.06 Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes. This steel shall conform to the requirements of ASTM A500 (Grade B) except the minimum tensile strength shall be fifty-five thousand (55,000) p.s.i.

710.03.07 Shear Connector Studs. This steel shall conform to the requirements of ASTM A108, Grade 1015, or 1020. Flux-retaining caps shall be low carbon grade suitable for welding and shall conform to the requirements of ASTM A109.

710.03.08 Pins and Rollers. Pins or rollers nine (9) inches or less in diameter shall be forged and heat treated or cold finished carbon-steel shafting. Pins or rollers more than nine (9) inches in diameter shall be forged and heat treated in accordance with the requirements of ASTM A235.

SECTION 711

ALUMINUM FOR BRIDGE RAIL

SCOPE

711.01.01 Material Covered. This specification covers the quality of aluminum alloy used in bridge rail.

PHYSICAL PROPERTIES AND TESTS

711.03.01 Aluminum Alloy for Pipe. This pipe shall conform to the requirements of ASTM B241 Alloy 6061–T6 or 6063–T6.

711.03.02 Aluminum Alloy Tubing. This tubing shall conform to the requirements of ASTM B221 Alloy 6061–T6 or 6063–T6.

711.03.03 Cast Aluminum Alloy. This alloy shall conform to the requirements of AASHTO M193, Alloy A344–T4.

711.03.04 Aluminum Alloy Shims. This alloy shall conform to the requirements of ASTM B209 Alloy 1100–0.

SECTION 712

MISCELLANEOUS METAL

SCOPE

712.01.01 Material Covered. This specification covers the type and quality of miscellaneous metals used in various highway construction.

PHYSICAL PROPERTIES AND TESTS

712.03.01 Steel Castings. This steel shall conform to the requirements of ASTM A27, Grade 65–35.

712.03.02 Gray Iron Castings. These castings shall conform to the requirements of ASTM A48, Class 40.

712.03.03 Malleable Castings. These castings shall conform to the requirements of ASTM A47, Grade 32510.

712.03.04 Wrought Iron Plates. These plates shall conform to the requirements of ASTM A42.

712.03.05 Bronze Castings. These castings shall conform to the requirements of ASTM B22, Copper Alloy No. 863.

712.03.06 Welding Materials. Materials used for welding shall conform to the current Specifications for Welded Highway and Railway Bridges of the American Welding Society and current AASHTO Standard Specifications for Welding of Structural Steel Highway Bridges.

712.03.07 Steel Piles. This steel ("H" Piles and Sheet Piling) shall conform to the requirements of ASTM A36.

712.03.08 Steel Shell for Piles. This steel shall conform to the requirements of ASTM A252, Grade 2.

SECTION 713

REINFORCEMENT

SCOPE

713.01.01 Materials Covered. This specification covers the quality of bar steel, fabricated reinforcement and welded steel wire used in the reinforcement of concrete.

PHYSICAL PROPERTIES AND TESTS

713.03.01 Bar Steel Reinforcement. This steel shall conform to the applicable following requirements:

Test	Test Method	Requirements
Deformed Billet-Steel Bars for Concrete Reinforcement	ASTM A615	Grade 40, 60 (a)
Axle-Steel Deformed Bars for Concrete Reinforcement	ASTM A617	Grade 40, 60 (a)
Spiral Reinforcement	ASTM A615	Grade 60 (a)

(a) With the following exception: If Reinforcing Steel Bars fail to meet the minimum unit stress when calculated on the basis of ASTM A615 Section 10.1.3, the material may be considered acceptable if minimum specification requirements are satisfied by computing the unit stress "Section Area" Method described in Nevada Test Method T484.

713.03.02 Fabricated Steel Bar or Rod Mats Reinforcement. This steel shall conform to the requirements of ASTM A184.

713.03.03 Welded Steel Wire Fabric Reinforcement. This steel shall conform to the requirements of ASTM A185.

713.03.04 Prestressing Steel. Prestressing reinforcement shall be high-tensile-strength steel wire, high-tensile-strength seven-wire strand or high-tensile-strength alloy bars as called for on the plans or in the special provisions.

High-tensile-strength steel wire shall conform to the requirements of ASTM Designation A421, except that the steel may be made by the basic oxygen process.

High-tensile-strength seven-wire strand shall conform to the requirements of ASTM Designation A416 with the exceptions shown in the following table:

Nominal Diameter of Strand (inches)	Breaking Strength Minimum (pounds)	Nominal Area of Strand (sq. inch)	Nominal Weight of Strand (lbs. per 1,000 ft.)	Yield Strength —Requirements— Initial Load (pounds)	Minimum Load at 1 Percent Exten. (pounds)
3/8	23,000	0.085	292	2,300	19,600
7/16	31,000	0.117	400	3,100	26,350
1/2	41,300	0.153	525	4,130	35,100

High-tensile-strength alloy bars shall be stress relieved and then cold stretched to a minimum of one hundred thirty thousand (130,000) p.s.i. After cold stretching, the physical properties shall be as follows:

Minimum Ultimate Tensile Strength.....145,000 p.s.i.
Minimum Yield Strength, Measured by the 0.7 Percent Extension Under Load Method Shall Be Not Less Than.....130,000 p.s.i.
Minimum Modulus of Elasticity.....25,000,000 p.s.i.
Minimum Elongation in 20-bar Diameters After Rupture.....4 percent
Diameter Tolerance.....+0.03", —0.01"

Testing Prestressing Reinforcement and Anchorages. All wire, strand, or bars to be shipped to the site shall be assigned a lot number and tagged for identification purposes. Anchorage assemblies to be shipped shall be likewise identified.

All samples submitted shall be representative of the lot to be furnished, and, in the case of wire or strand, shall be taken from the same master roll.

All of the materials specified for testing shall be furnished free of cost and shall be delivered in time for tests to be made well in advance of anticipated time of use.

The vendor shall furnish for testing the following samples selected from each lot. If ordered by the Engineer, the selection of samples shall be made at the manufacturer's plant by the inspector.

(a) Pretensioning Method. For pretensioned strands, samples at least five (5) feet long shall be furnished of each strand size. A sample shall be taken from each end of every coil.

(b) Post-Tensioning Method. The following lengths shall be furnished:

1. For wires requiring heading—five (5) feet.
2. For wires not requiring heading—sufficient length to make up one parallel-lay cable five (5) feet long consisting of the same number of wires as the cable to be furnished.
3. For strand to be furnished with fittings—five (5) feet between near ends of fittings.
4. For bars to be furnished with threaded ends and nuts—five (5) feet between threads at ends.

(c) Anchorage Assemblies. Two anchorage assemblies shall be furnished, complete with distribution plates of each size or type to be used, if anchorage assemblies are not attached to reinforcement samples.

713.03.05 Cold-Drawn Steel Wire for Spiral Reinforcement. This steel shall conform to the requirements of ASTM A82.

SECTION 714

PAINT

SCOPE

714.01.01 Materials Covered. This specification covers the quality, color, and number of applications of paint used in painting the various materials of highway construction. Attention is directed to Section 715, "Galvanizing," for galvanized coatings.

REQUIREMENTS

714.02.01 Certificates. The Contractor shall furnish the Engineer with written certification that all required tests have been satisfactorily completed and that the materials thereof comply with all the requirements. Samples will be taken when required by the Engineer.

PHYSICAL PROPERTIES AND TESTS

714.03.01 Iron and Steel Use Items. The Contractor may choose from SSPC (Steel Structures Painting Council) Alkyd Paint System Specifications 2.00, Phenolic Paint System 3.00, or Vinyl Paint System 4.00 when metal rail, bridge or pedestrian rail, and guardrail are specified to receive paint or when painting structural steel, miscellaneous iron, and steel standards. The color of paint shall be as shown on the plans or specified in the special provisions.

The Contractor shall submit to the Engineer for approval a letter indicating his choice of system, accompanied by certificates attesting that the ingredients chosen meet the applicable specifications and requirements prior to application of any paint.

714.03.02 Timber Use Items. Cattle guard wings, bridge railings, right of way markers, sign posts, and miscellaneous timber structures specified to receive paint.

Purpose	Number of Coats	Color	General Type	Formula or Specification
Prime	1	White	Mixed Pigment Exterior Wood Primer	*TT–P–25 *TT–P–25
Intermediate (first coat after primer)	1	Cream	Titanium Lead, Zinc Oxide	*TT–P–102 Class B
Finish (second coat after primer)	1	White	Titanium Lead, Zinc Oxide	*TT–P–102 Class B
Trim, Lettering and Indications (used when so indicated on plans)	1	Black	Titanium Lead, Zinc Oxide	*TT–P–61

*Federal specifications.

714.03.03 Concrete Use Items. Concrete end posts (bridges), raised traffic bars, and miscellaneous concrete specified to receive paint.

Purpose	Number of Coats	Color	General Type	Formula or Specification
Finish	1	White	Water Thinned	Acrylic Resin or Synthetic Latex Alkyd Emulsion

714.03.04 Aluminum Use Item. Aluminum bridge railing and posts specified to receive paint shall be prepared for painting with a chemical conversion coating conforming to the requirements of Federal Specification MIL–C–5541. The coating shall be applied in accordance with the manufacturer's specifications and recommended sequence of operations.

The Contractor may use any of the paint systems specified for use on iron or steel in subsection 714.03.01 for painting aluminum, and shall submit to the Engineer for approval a letter indicating his choice of system as required for iron or steel.

SECTION 715

GALVANIZING

SCOPE

715.01.01 Material Covered. This specification covers the quality and thickness of galvanize used on various material when called for on the plans or designated in the specifications.

PHYSICAL PROPERTIES AND TESTS

715.03.01 Products One-eighth (⅛) Inch Thick and Thicker. Galvanizing of products fabricated from rolled, pressed, and forged steel shapes, plates, bars, and strip shall conform to the requirements of ASTM Designation A123.

715.03.02 Rail Elements. All rail elements shall be galvanized in accordance with AASHTO Designation M180, Type 1.

715.03.03 Hardware. Bolts, nuts, washers, and fastenings shall be galvanized in accordance with the requirements of ASTM Designation A153.

SECTION 716

SIGN MATERIALS

SCOPE

716.01.01 Materials Covered. This specification covers the kind and quality of materials used in the construction and fabrication of "Construction Signs," "Temporary Signs," and "Permanent Signs."

REQUIREMENTS

716.02.01 General. The following materials shall conform to the requirements as noted:

Portland Cement Concrete	Section 501
Reinforcing Steel	Section 505

716.02.02 Certificates. It shall be the Contractor's responsibility to ascertain that all required tests have been made by qualified testing laboratories as approved by the Department. The Contractor shall furnish the Engineer with a written certification that all required tests have been satisfactorily completed and that materials and fabrication thereof comply with all the requirements.

All materials shall be approved prior to use.

PHYSICAL PROPERTIES AND TESTS

716.03.01 Reflective Sheeting. The reflective sheeting shall consist of spherical lens elements embedded within a transparent plastic having a smooth, flat outer surface (Type I); or spherical lens elements adhered to a synthetic resin and encapsulated by a flexible, transparent, weatherproof plastic having a smooth outer surface (Type II). All sheeting shall be weather resistant and shall have a protected, pre-coated adhesive backing.

Color tolerance shall be within the limits of the FHWA Color Tolerance Charts. The instrumental testing restrictions noted on the FHWA Color Tolerance Charts relative to retroflective materials may be disregarded to the following extent:

As an alternative to visual testing, instruments providing a system of diffuse illumination and unidirectional viewing

may be used as a preliminary means of establishing that the colors meet the required CIE limits. In the event of any dispute concerning the results of instrumental testing, the visual test shall prevail.

The diffuse day color of the reflective sheeting shall conform to the requirements of the CIE Chromaticity Coordinate Limits hereinafter specified and shall be determined in accordance with ASTM Designation: E97 "Standard Method of Test for 45-Deg. Directional Reflectance of Opaque Specimens by Filter Photometry." (Geometric characteristics must be confined to illumination incident within 10 deg. of and centered about a direction forty-five (45) deg. from the perpendicular to the test surface; viewing is within fifteen (15) deg. of and centered about the perpendicular to the test surface. Conditions of illumination and observation must not be interchanged.) The standards to be used for reference shall be the Munsell Papers. Papers must be recently calibrated on a spectrophotometer.

The test instrument shall be one of the following:

(a) Gardner multipurpose Reflectometer.

(b) Gardner Model AC–2a Color Difference Meter.

(c) Meeco Model V Colormaster.

(d) Hunterlab D25 Color Difference Meter.

The reflective sheeting shall include a pre-coated pressure sensitive adhesive or a tack free heat activated adhesive either of which shall be applied exactly as specified by the sheeting manufacturer to recommended, properly prepared flat surfaces without necessity of additional coats on the reflective sheeting or application surface.

Type I Reflective Sheeting

(a) Photometric Requirements. The reflective sheeting shall have the following minimum brightness values at 0.2 degrees and 0.5 degrees and 1.5 degrees divergence expressed as average candlepower per square foot (candelas per lux per square meter) of material. Measurements shall be conducted in accordance with standard testing procedures for reflex-reflectors of Federal Specification L–S–300A, "Sheeting and Tape, Reflective, Nonexposed Lens Adhesive Backing," paragraph 4.4.7 or as amended.

Div. Ang. Inc. Ang.	Silver-White No. 1			Silver-White No. 2			Yellow		
	.2°	.5°	1.5°	.2°	.5°	1.5°	.2°	.5°	1.5°
−4°	70	30	4	80	41	4	50.0	25.0	5.0
40°	14.5	8.5	1.5	16.5	9.5	2.0	11.5	7.0	1.5
	Red			Blue			Green		
	.2°	.5°	1.5°	.2°	.5°	1.5°	.2°	.5°	1.5°
	14.5	7.5	1.0	4	2	0.6	9	4.5	1.0
	3.0	1.5	0.3	0.9	0.4	0.08	1.8	1.5	0.2
	Orange								
	.2°	.5°	1.5°						
	25.0	13.5	1.5						
	1.0	0.8	0.1						

(b) Wet Performance. The wet performance measurements shall be conducted in accordance with standard rainfall tests specified in Federal Specification L–S–300A and the brightness of the reflective sheeting totally wet by rain shall not be less than ninety (90) percent of the preceding values.

(c) Color. The diffuse day color of Type I reflective sheeting shall conform to the following:

Type I—CIE Chromaticity Coordinate Limits

									(Y) Reflectance		Ref. Std. Munsell Paper
	x	y	x	y	x	y	x	y	Min.	Max.	
Silver-White Nos. 1 and 2	.320	.310	.360	.360	.338	.377	.300	.328	34.0	----	5.1GY6.91/1.2
Yellow	.482	.450	.532	.465	.505	.494	.475	.485	29.0	40.0	1.25Y6/12
Red	.602	.317	.664	.336	.644	.356	.575	.356	8.0	11.0	8.2R3.78/14.0
Green	.140	.354	.179	.372	.147	.435	.120	.420	4.0	7.0	.65/BG2.84/8.45
Blue	.147	.075	.176	.091	.176	.151	.106	.113	1.0	2.4	5.8PB1.32/6.8
Orange	.535	.375	.535	.399	.582	.417	.607	.393	19.77	30.05	2.5YR5.5/14.0

(d) Lens Elements. The reflective sheeting shall possess stable and durable spherical lens elements which, following extraction, shall show no deterioration following submersion in a 5N solution of sulphuric acid (H_2SO_4) for thirty (30) minutes at seventy-two (72) degrees Fahrenheit (twenty-three (23) degrees Centigrade).

(e) Adhesive. The reflective sheeting shall include a pre-coated pressure sensitive adhesive or a tack-free heat activated adhesive, either of which may be applied without necessity of additional adhesive coats on the reflective sheeting or application surface.

The protective liner attached to the adhesive shall be removed by peeling without soaking in water or other solvents and shall be easily removed after accelerated storage for four (4) hours at one hundred and fifty (150) degrees Fahrenheit (sixty-five (65) degrees Centigrade) under weight of 2.5 pounds per square inch (0.18 kg. per square cm.).

The adhesive shall form a durable bond to smooth, corrosion and weather-resistant surfaces. The reflective sheeting, applied to cleaned and etched aluminum test panels, shall adhere securely, forty-eight (48) hours after application, at temperatures of minus thirty (30) degrees to two hundred (200) degrees Fahrenheit (minus thirty-five (35) degrees Centigrade to ninety-three (93) degrees Centigrade). The adhesive bond shall be sufficient to render the applied sheeting vandal-resistant and prevent its shocking off when jabbed with a spatula at minus ten (10) degrees Fahrenheit (minus twenty-three (23) degrees Centigrade). The sheeting shall resist peeling from the application surface when a 5 lb./in. width (2.27 kg. per 2.54 cm. width) force is applied as outlined in ASTM Designation: D903.

(f) Film. The reflective sheeting shall have sufficient strength and flexibility so that it can be handled, processed, and applied according to the recommendations of the sheeting manufacturer without appreciable stretching, tearing, or other damage. It shall permit application over and conformance to moderate, shallow embossing characteristics of certain sign borders and symbols. Following liner removal, the reflective sheeting shall not shrink more than

one thirty-second ($\frac{1}{32}$) inch (0.79 mm.) in ten (10) minutes nor more than one-eighth ($\frac{1}{8}$) inch (3.18 mm.) in twenty-four (24) hours in any dimension per nine (9) inch (22.9 cm.) square at seventy-two (72) degrees Fahrenheit (twenty-three (23) degrees Centigrade) and fifty (50) percent RH.

The sheeting when applied according to manufacturer's recommendations to cleaned and etched .020″ x 2″ x 8″ (5.08 mm. x 5.0 cm. x 20.3 cm.) aluminum, conditioned (twenty-four (24) hours) and tested at seventy-two (72) degrees Fahrenheit and fifty (50) percent RH shall be sufficiently flexible to show no cracking when bent around a three-fourths ($\frac{3}{4}$) inch (19.05 mm.) mandrel.

(g) Surface. The sheeting surface shall be smooth and flat, facilitate cleaning and wet performance, and exhibit eighty-five (85) degrees glossmeter rating of not less than forty (40) (ASTM Designation: D523). The sheeting surface shall be readily processed and compatible with recommended transparent and opaque process colors and show no loss of the color coat with normal handling, cutting, and application.

The sheeting shall permit cutting and color processing at temperatures of sixty to one hundred (60–100) degrees Fahrenheit (fifteen to thirty-eight (15–38) degrees Centigrade) and relative humidities of twenty to eighty (20–80) percent. The sheeting shall be heat-resistant and permit force curing without staining of unapplied sheeting at temperatures up to one hundred fifty (150) degrees Fahrenheit (sixty-five (65) degrees Centigrade) and up to two hundred (200) degrees Fahrenheit (ninety-three (93) degrees Centigrade) on applied sheeting. The sheeting surface shall be solvent resistant such that it may be cleaned with gasoline, V.M. & P. naphtha, mineral spirits, turpentine, methanol and xylol.

(h) Durability. Reflective sheetings, processed, applied to approved sign base materials, and cleaned, in accordance with manufacturer's recommendations for their use on traffic control signs shall be capable of performing satisfactorily for the number of years stated in Table I if the sheetings have not deteriorated due to natural causes to the extent that: (1) the sign is ineffective for its intended

purpose when viewed from a vehicle, or (2) the average nighttime reflective brightness is less than that specified in Table I.

TABLE I—Type I

Sheeting Color	Average min. candlepower per foot candle per sq. ft. at 0.2° divergence and −4° incidence	Satisfactory Performance Life
Silver-White No. 1	30	7 years
Silver-White No. 2	36	7 years
Yellow	20	7 years
Red	5	7 years
Blue	2	7 years
Green	3	7 years
Orange	10	3 years

Type II Reflective Sheeting

(a) Photometric Requirements. The reflective sheeting shall have the following minimum brightness values at .2°, .5°, and 1.5° divergence expressed as average candlepower per foot-candle per square foot (candelas per lux per square meter) of material. Measurements shall be conducted in accordance with standard photometric testing procedures for reflex-reflectors, paragraph 4.4.7 of Federal Specification L–S–300A, "Sheeting and Tape, Reflective; Non-exposed Lens Adhesive Backing" or as amended.

Div. Ang. Inc. Ang.	Silver-White			Yellow			Red		
	.2°	.5°	1.5°	.2°	.5°	1.5°	.2°	.5°	1.5°
–4°	250.0	95.0	4.0	150.0	57.0	3.0	35.0	13.0	0.7
40°	120.0	54.0	2.0	70.0	30.0	1.5	17.0	7.5	0.3

	Green			Orange		
	.2°	.5°	1.5°	.2°	.5°	1.5°
	30.0	11.0	0.4	60.0	20.0	1.0
	4.0	2.0	0.1	25.0	13.0	0.7

(b) Wet Performance. Wet performance measurements shall be conducted in accordance with standard rainfall test specified in Federal Specification L–S–300A and the brightness of the reflective sheeting, totally wet by rain, shall not be less than ninety (90) percent of the above values.

(c) Color. The diffuse day color of Type II reflective sheeting shall conform to the following:

Type II—CIE Chromaticity Coordinate Limits

	x	*y*	*x*	*y*	*x*	*y*	*x*	*y*	*(Y) Reflectance* Min.	Max.	*Ref. Std. Munsell Papers*
Silver-White	.302	.289	.286	.306	.324	.344	.342	.327	30.0	....	5PB7/0.7
Green	.152	.523	.211	.395	.172	.372	.105	.503	3.0	8.0	9.0G3.3/9.5
Yellow	.483	.462	.510	.490	.560	.440	.534	.414	16.0	32.0	1.25Y6/12
Red	.608	.288	.700	.298	.644	.352	.608	.352	4.0	8.0	8R3.2/13
Orange	.535	.375	.535	.399	.582	.417	.607	.393	19.8	30.0	2.5YR5.5/14.0

(d) Lens Elements. The reflective sheeting shall possess stable and durable spherical lens elements which, following extraction, shall show no deterioration following submersion in a 5N solution of sulphuric acid (H_2SO_4O) for thirty (30) minutes at seventy-two (72) degrees Fahrenheit (twenty-three (23) degrees Centigrade).

(e) Adhesive. The reflective sheeting shall include a pre-coated pressure sensitive adhesive or a tack free heat activated adhesive either of which shall be applied exactly as specified by the sheeting manufacturer to recommended, properly prepared flat surfaces without necessity of additional adhesive coats on the reflective or application surface.

The protective liner attached to the adhesive shall be removed by peeling without soaking in water or other solvents and shall be easily removed after accelerated storage for four (4) hours at one hundred and fifty (150) degrees Fahrenheit (sixty-five (65) degrees Centigrade) under weight of 2.5 pounds per square inch (0.18 kg. per square cm.).

The adhesive shall form a durable bond to smooth, corrosion and weather resistant surfaces. The reflective sheeting, applied to cleaned and etched aluminum test panels, shall adhere securely, forty-eight (48) hours after application, at all normal application temperatures up to one hundred and fifty (150) degrees Fahrenheit (ninety-three (93) degrees Centigrade) after the panels are conditioned for twenty-four (24) hours at minus ten (10) degrees Fahrenheit (minus thirty-five (35) degrees Centigrade), the adhesive bond shall be sufficient to render the applied sheeting vandal-resistant and show no cracking when the surface of the reflective sheeting is exposed to the impact of a two (2) pound (0.9 kg.) weight with a five-eighths (⅝) inch (15.9 mm.) rounded tip dropped from a ten (10) inch pound (11.4 cm.kg.) setting on a Gardner Variable Impact Tester, IG–1120M. The sheeting shall resist peeling from the application surface when a five (5) lb./in. width (2.27 kg. per 2.54 cm. width) force is applied as outlined in ASTM Designation: D903.

(f) Film. The reflective sheeting shall have sufficient

strength and flexibility so that it can be handled, processed, and applied according to the recommendations of the sheeting manufacturer without appreciable damage. Following liner removal, the reflective sheeting shall not shrink more than one sixty-fourth (1/64) inch (0.40 mm.) in twenty-four (24) hours in any dimension per nine (9) inch (22.9 cm.) square at seventy-two (72) degrees Fahrenheit, (twenty-three (23) degrees Centigrade) and fifty (50) percent RH.

The sheeting with liner removed, conditioned for twenty-four (24) hours at seventy-two (72) degrees Fahrenheit and fifty (50) percent RH shall be sufficiently flexible to show no cracking when bent around one-eighth (1/8) inch (3.18 mm.) mandrel with adhesive side contacting mandrel. Note: For ease of testing, spread talcum powder on adhesive to prevent sticking to mandrel.

(g) Surface. The sheeting surface shall be smooth and facilitate cleaning and wet performance, and exhibit eighty-five (85) degrees gloss meter rating of not less than fifty (50) (ASTM Designation: D523). The surface of the sheeting with the heat activated adhesive shall be readily processed in accordance with recommendations of the sheeting manufacturer, compatible with recommended transparent and opaque process colors and show no loss of the color coat with normal handling, cutting, and application.

The sheeting shall permit cutting and color processing at temperatures of sixty (60) degrees, minus one hundred (100) degrees Fahrenheit (fifteen (15) degrees, minus thirty-nine (39) degrees Centigrade) and relative humidities of twenty to eighty (20–80) percent. The sheeting surface shall permit cleaning by wiping with a clean soft rag dampened in V.M. & P. naphtha or mineral spirits.

(h) Impact Resistance. The sheeting, applied according to manufacturer's recommendations to cleaned etched 0.40″ x 3″ x 5″ (1 mm. x 7.6 cm. 12.7 cm.) aluminum (6061–T6) and conditioned for twenty-four (24) hours at seventy-two (72) degrees Fahrenheit (twenty-three (23 degrees Centigrade) and fifty (50) percent humidity shall show no cracking when face of panel is subjected to impact

of a two pound (0.9 kg.) weight with five-eighths (⅝) inch (15.9 mm.) rounded tip at ten (10) inch pound (11.4 cm. kg.) setting on a Gardner Variable Impact Tester (IG–1120).

(i) Durability. Reflective sheetings, processed, applied to approved sign base materials, and cleaned, in accordance with manufacturer's recommendations for their use on traffic control signs, shall be capable of performing satisfactorily for the number of years stated in Table II if the sheetings have not deteriorated due to natural causes to the extent that: (1) the sign is ineffective for its intended purpose when viewed from a vehicle, or (2) the average nighttime reflective brightness is less than that specified in Table II.

TABLE II—Type II

Sheeting Color	Average min. candlepower per foot-candle per sq. ft. at 0.2° divergence and —4° incidence	Satisfactory Performance Life
Silver-White	200	10
Green	24	10
Yellow	120	10
Red	28	5
Orange	48	3

716.03.02 Porcelain Enamel Sign Faces. Porcelain enamel signs shall be furnished with porcelain enamel especially formulated for use in the manufacture of porcelain enamel signs. The porcelain enamel shall be of inorganic material substance and fired for such duration and in such temperatures as will fuse the porcelain enamel to the metal to produce the proper gloss and color. These temperatures shall be within the range of one thousand three hundred (1,300) and one thousand six hundred (1,600) degrees Fahrenheit. The porcelain enamel shall be of weather resistant type that will stand weathering effects of normal atmosphere. Finish surface shall have a reading of between fifty (50) and seventy (70) maximum units, as measured on a gloss meter when read at forty-five (45) degrees angle, ASTM Designation: C–346.

Signs shall be coated on both faces and edges with one ground coat of porcelain enamel fused to the metal at

temperature within the range of one thousand three hundred (1,300) to one thousand six hundred (1,600) degrees Fahrenheit. Over both faces shall be applied such succeeding coats as may be necessary, so fused as to produce a single integral sign. Sign backs shall have one cover coat of porcelain enamel in addition to the ground coat which shall be of the same color as the background of the sign face.

The maximum coating thickness shall not exceed 0.020 inch unless the specified color design calls for three or more coatings in which case the maximum coating thickness shall not exceed 0.028 inch on the face of the sign carrying letters. The thickness on each face of double face signs shall not exceed 0.028 inch. Coating thickness shall be determined by a suitable thickness gage having an accuracy of 0.001 inch.

716.03.03 Aluminum Sign Panels (for Reflective Sheeting. Sheet aluminum for sign panels shall be of 0.125 inch aluminum alloy alclad 5155–H36 or 6061–T6 and shall conform to specifications for ASTM Designation: B209.

Sign panel sections shall be fabricated of standard width aluminum sheets not less than four (4) feet wide, except that not more than two (2) sheets for any one sign may be cut not less than eighteen (18) inches in width, so as to provide sign widths to nearest six (6) inch increments. Panel sections shall run from the top edge to the bottom edge of the sign without horizontal joints.

The aluminum shall be free of all corrosion, white rust, and dirt. All sign dimensions, metal gage, and bolt holes shall conform to the requirements set forth on the plans and in these specifications. Metal degreasing will be required on all sheet aluminum and shall be performed by one of the following methods:

(a) Vapor degreasing. Signs shall be completely immersed in a saturated vapor of trichlorethylene or perchlorethylene. Trade mark printing shall be removed with lacquer thinner or a controlled alkaline cleaning system, and rinsed thoroughly with running water.

(b) Alkaline degreasing. Signs shall be completely

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 to be removed. Signs shall then be thoroughly rinsed with running water.

Whenever reflective sheeting is required on the sign, the aluminum shall be etched by one of the following methods:

1. Acid etch. The aluminum shall be well-etched in a six (6) to eight (8) percent phosphoric acid solution at one hundred (100) degrees Fahrenheit and rinsed thoroughly with running cold water, followed with a hot water tank rinse.

2. Alkaline etch. Etch well the pre-cleaned aluminum in an alkaline etching material that is controlled by titration. Time, temperature, and concentration shall be as specified by the solution manufacturer. Smut shall be removed with an acidic, chromium compound type solution as specified by the solution manufacturer and the sign then rinsed thoroughly.

3. The surface etch shall provide a clean, mat, non-shine or non-glare finish suitable for the application of paint or sheeting and for the unpainted back or reverse side of highway signs.

After the degreasing and etching process, the aluminum shall be dried by use of a forced air drier.

Metal shall not be handled, except by device or clean canvas gloves between all cleaning operations and the application of the sign background material. There shall be no opportunity for the aluminum to come in contact with greases, oils, or other contaminants prior to the application of the background material.

Fabrication of all metal parts shall be accomplished in a uniform and workmanlike manner. All fabrication, including cutting, shall be completed prior to the cleaning process. Metal panels shall be cut to size and shape and shall be free of buckles, warp, dents, cockles, burrs, and other defects resulting from fabrication. The surface of all sign panels shall be a plane surface.

716.03.04 Steel Sign Panels (for Porcelain Enamel). Panels shall be carbon-steel sheets conforming to the specifications of ASTM Designation: A245, Grade C, or of ASTM Designation: A283, Grade D. Sheet steel for sign panels shall be of 18 gage "Enameling iron or steel" commercially identified, manufactured and processed for production of porcelain enameled signs. If the Contractor proposes other metal, Department of Highways shall be notified and must approve in writing the substitute prior to fabrication. The sheet shall be free of dents and other surface defects.

Sign panel sections shall be fabricated of standard width sheets not less than four (4) feet wide, except that not more than two (2) sheets for any one sign may be cut not less than two (2) feet in width, so as to provide sign widths to nearest six (6) inch increments. Panel sections shall run from top edge to the bottom edge of the sign without horizontal joints.

Fabrication of all metal parts is to be performed in a uniform and workmanlike manner. All iron and steel fabrication including shearing, cutting and hole-punching, shall be performed prior to enameling. All sign surfaces and edges shall be free of defect resulting from fabrication. All sizes indicated on the drawings are punched size before enameling. All porcelain enamel as applied to steel sheeting shall not spall or peel from the base metal.

716.03.05 Overhead Sign Structures and Sign Frames. The materials used in the fabrication of overhead sign structures and footings shall conform to the following requirements:

(a) Sign frames. Bars, plates, and shapes shall be structural steel conforming to the specifications of ASTM Designation: A36.

(b) Sign pipe posts. Pipe posts shall be welded or seamless steel pipe conforming to the specifications of ASTM Designation: A53, Grade B. At the option of the Contractor, posts may be fabricated from structural steel conforming to the specifications of ASTM Designation:

A36 or of ASTM Designation: A283, Grade D, except that plates more than one (1) inch in thickness shall be structural steel conforming to the specifications of ASTM Designation: A373.

(c) Sign steel walkway gratings. Steel walkway gratings shall be furnished and installed in accordance with details shown on the plans and the following provisions:

1. Gratings shall be the standard product of an established grating manufacturer.

2. Material for gratings shall be structural steel conforming to the specifications of ASTM Designation: A36.

3. For welded type gratings, each joint shall be full resistance welded under pressure to provide a sound, completely beaded joint.

4. For mechanically locked gratings, the method of fabrication and interlocking of the members shall be approved by the Engineer, and the fabricated grating shall be equal in strength to the welded type.

5. After fabrication, gratings shall be hot-dip galvanized.

6. Gratings shall be accurately fabricated and free from warps, twists, or other defects affecting their appearance or serviceability. Ends of all rectangular panels shall be square. The tops of the bearing bars and cross members shall be in the same plane. Gratings distorted by the galvanizing process shall be straightened.

(d) Bolts and Nuts. Bolts and nuts shall conform to the specifications of ASTM Designation: A307. Bolted connections shall conform to the provisions in subsection 506.03.10, "Bolts and Bolted Connections."

(e) Bearing plates and gusset or stiffener plates shall be of the sizes and dimensions shown on the plans and shall be galvanized after fabrication. Steel shall conform to ASTM Designation: A36. Galvanizing shall conform to ASTM Designation: A123. All welding shall conform to the requirements set forth in subsection 506.03.20, "Welding."

(f) Anchor bolts, nuts and washers shall be of structural carbon steel conforming to Section 710, "Structural and Eyebar Steel," and shall be galvanized in accordance with

ASTM Designation: A153, or cadmium plated in accordance with ASTM Designation: A165 Type TS. The top portion of anchor bolts shall be galvanized or cadmium plated to such extent that the galvanized or cadmium plated portion will extend at least two (2) inches into concrete. Anchor bolts shall be of the size, shape and length as shown on the plans.

(g) All bolts, nuts, clamps and metal washers not otherwise noted shall be galvanized or cadmium plated. Cadmium plating shall conform to the specifications of ASTM Designation: A165, minimum thickness as prescribed for grade Type TS and galvanizing shall conform to the requirements of ASTM Designation: A153.

(h) Steel sign panels shall be mounted using one-fourth inch by twenty (¼″ x 20) flat head, brass machine screws with a No. 14 brass, nickel plated, asbestos backed, finishing washer and one brass nut with a flat brass washer and lock washer for each machine screw. Lock washers shall be plain phosphor bronze or beryllium copper, shakeproof and externally toothed. Where obstructions prevent the normal installation of nuts, the frame shall be drilled and tapped to accept the screw. The exposed portion of fastening hardware on the face of the sign panels shall be painted out using commercial quality touch-up enamel that matches the background.

(i) Supporting frame shall be manufactured in accordance with the plans and in accordance with the requirements herein specified. All metal parts shall be galvanized after fabrication, in accordance with the provisions of Section 715. When permission is granted by the Engineer to zinc coat a surface by means other than hot-dip galvanizing, the metalizing process shall be used to place the zinc. Metalizing shall be performed in accordance with the AWS Specifications and the thickness of the sprayed zinc coat shall be at least 5 mils.

(j) Truss frames shall be fabricated to the largest practical sections prior to galvanizing. Splice locations shall be submitted to the Engineer for approval and the Contractor shall not commence fabrication until such splice locations are approved.

(k) All welding in the fabrication of the structure shall be done by welders qualified in accordance with AWS requirements using the inert-gas shielded-arc method. All welds shall be free of cracks, blow holes and other irregularities and shall be wire brushed or otherwise cleaned and all the work shall be done in a neat and workmanlike manner. No field welding on any part of the structural assembly will be permitted.

Note: Before fabrication is started, five (5) sets of shop drawings for each overhead sign structure shall be submitted to the Engineer for approval.

716.03.06 Sign Hardware and Related Materials. Bearing plates and gusset or stiffener plates shall be of the sizes and dimensions shown on the plans and shall be galvanized after fabrication. Steel shall conform to ASTM Designation: A36. Galvanizing shall conform to ASTM Designation: A123. All welding shall conform to the requirements set forth in subsection 506.03.20, "Welding."

All bolts, nuts, clamps and metal washers shall be of structural, carbon steel conforming to Section 710 and may be galvanized or cadmium plated as hereinafter stated.

Anchor bolts, nuts and washers shall be of structural carbon steel conforming to Section 710, "Structural and Eyebar Steel," and shall be galvanized in accordance with ASTM Designation: A153, or cadmium plated in accordance with ASTM Designation: A165 Type TS. The top portion of anchor bolts shall be galvanized or cadmium plated to such extent that the galvanized or cadmium plated portion will extend at least two (2) inches into concrete. Anchor bolts shall be of the size, shape and length as shown on the plans.

Aluminum alloy tubular stiffeners shall be schedule 40 pipe fabricated of 6061–T6 aluminum alloy and shall conform to the specifications of ASTM Designation: B241.

Steel pipe for posts shall conform to the specifications of ASTM Designation: A 120 and shall be galvanized.

Galvanized steel pipe posts shall be of the diameter and length shown on the plans. The top of the posts shall be

fitted with a cover. Posts showing damage shall be repaired or rejected.

The straps, bars and braces used on single support signs shall be of aluminum alloy 6061–T6 and shall conform to ASTM Designation: B209.

Stringers for horizontal supporting structural members shall be of 6061–T6 or 6062–T6 aluminum alloy and shall conform to ASTM Designation: B308, Alloy GS11A.

All bolts, nuts, clamps and metal washers in contact with aluminum shall be cadmium plated. All other bolts, nuts, clamps and metal washers shall be galvanized or cadmium plated. Cadmium plating shall conform to the specifications of ASTM Designation: A165, minimum thickness as prescribed for grade Type TS and galvanizing shall conform to the requirements of ASTM Designation: A153.

Wood posts and braces for sign supports shall be constructed of Douglas Fir, West Coast Hemlock, or any other equivalent stress rated wood material, at the option of the contractor. Said wood material shall be construction grade, free of heart center, minimum stress rating of 1200f, and shall be graded in accordance with the provisions contained in Section 718. Sweep shall not exceed 0.08 feet in 10 feet.

The expansion assembly for fastening the aluminum tubing to the aluminum Z-bars shall be manufactured of a zinc die casting alloy which contains copper, aluminum and magnesium. The anchor bolt for the expansion assembly shall be cadmium plated and shall conform to the specifications of ASTM Designation: A165, minimum thickness as prescribed for grade Type TS.

SECTION 717

TIMBER PILES

SCOPE

717.01.01 Materials Covered. This specification covers the quality of round timber piles.

REQUIREMENTS

717.02.01 Certificates. Inspection certificates shall be furnished without extra charge with each shipment of timber piles. These certificates shall be issued by the inspection agency under whose rules the material was manufactured and graded.

Timber piles to be treated shall be inspected prior to treatment by an inspector designated by the Engineer. The inspector shall stamp each pile on the butt end with a stamp which shall make an impression that is readily legible after treatment. The stamp shall be copyrighted and a true impression filed with the Department of Highways.

PHYSICAL PROPERTIES AND TESTS

717.03.01 General. Timber piles shall conform to the requirement of ASTM Designation D25.

SECTION 718

TIMBER

SCOPE

718.01.01 Materials Covered. This specification covers the quality requirements for structural timber, lumber, guardrail posts, markers, and miscellaneous items.

REQUIREMENTS

718.02.01 Grades. Grades furnished shall be as noted on the plans or in the special provisions.

718.02.02 Certificates of Inspection. Inspection certificates shall be furnished without extra charge with each shipment of timber. These certificates shall be issued by the inspection agency under whose rules the material was manufactured and graded.

PHYSICAL PROPERTIES AND TESTS

718.03.01 Species. The standard commercial and botanical names recognized by these specifications are described as follows:

Standard Commercial Name	Botanical Name
Cedar, Port Orford	Chamaecyparis lawsoniana
Fir, Douglas (coast)	Pseudotsuga taxifolia (coast type)
Fir, Douglas (inland)	Pseudotsuga taxifolia (inter-mountain type)
Hemlock, West Coast	Tsuga Heterophylla
Larch	Larix Occidantalis
Redwood, California	Sequoia sempervirens

718.03.02 Grades. Structural timber and lumber shall meet the requirements for the numerical stress shown on the plans, or as may be otherwise specified, when graded by rules developed in accordance with AASHTO M168. Any commercial grading rules that will provide material of an equal or greater stress value may be used.

The West Coast Lumber Inspection Bureau and the Western Wood Products Association grading rules shall be included as grading rules which may be used. Grading rules in effect on the date of advertisement of bids shall govern.

Guardrail posts and blocks shall meet the following requirements:

Douglas Fir or Western Larch shall conform to the requirements for "No. 1 Structural," grade as set forth in paragraph 131-b of the grading rules of the West Coast Lumber Inspection Bureau or paragraph 80.11 of the grading rules of the Western Wood Products Association.

West Coast Hemlock shall conform to the requirements for "Select Structural," grade as set forth in paragraph 131-a of the grading rules of the West Coast Lumber Inspection Bureau or paragraph 80.10 of the grading rules of Western Wood Products Association.

SECTION 719

TIMBER PRESERVATIVES

SCOPE

719.01.01 Materials Covered. This specification covers the type and quality of materials used in the preservative treatment of timber.

PHYSICAL PROPERTIES AND TESTS

719.03.01 Preservatives. Timber preservatives shall conform to the requirements of AASHTO M133.

SECTION 720

GUARDRAIL MATERIALS

SCOPE

720.01.01 Materials Covered. This specification covers the quality and kind of material used in the construction of guardrail.

REQUIREMENTS

720.02.01 Certificates. Two certified copies of mill test reports showing the chemical and physical characteristics from each heat from which metal is used shall be furnished by the Contractor.

Certificates for wood posts shall be furnished in accordance with subsection 718.02.02, "Certificates of Inspection."

Rail members, bolts, nuts, and other fittings shall be interchangeable with similar parts regardless of source.

PHYSICAL PROPERTIES AND TESTS

720.03.01 Rail Members. The beam-type members, comprising rail members and end or terminal pieces, shall be formed from (1) open-hearth, basic oxygen, or electric-furnace steel sheets, galvanized after fabrication, or (2) aluminum alloy sheets as the Contractor may elect. The thickness of steel sheets before galvanizing, and the thickness of aluminum sheets shall be not less than 0.100 inch (nominal 12 gage and allowing for tolerances). The metal in the members shall meet the minimum requirements of the following table:

Strength Requirements for Beam-Type Rail Members

	Rail	End Piece
Ultimate Tensile Strength	67,000 p.s.i.	.....
Yield Point Strength	.....	25,000 p.s.i.
Elongation in Two-Inch Gage Length	12 percent	.....
Total Ultimate Strength at Splices	80,000 lbs.	80,000 lbs.

Steel members shall be galvanized in accordance with Section 715, "Galvanizing."

720.03.02 Fittings. All bolts, nuts, washers, and other fittings for beam-type guardrail shall be steel and of a quality adequate to develop the specified strength of rail splices and to provide a post connection withstanding a five thousand (5,000) pound side pull in either direction.

All bolts, nuts, and washers shall be five-eighths (⅝) inch size. Bolts shall be buttonhead style and nuts shall be hexagonal. Bolts and nuts shall be coarse-threaded (11 per inch), with nuts tapped oversize not to exceed one thirty-second ($\frac{1}{32}$) inch. Outside dimensions of boltheads, nuts and washers shall have the following minimums: boltheads, one and one-fourth (1¼) inches; nuts, fifteen-sixteenths ($\frac{15}{16}$) inch; and washers, one and one-half (1½) inches. Splice bolts shall be one and one-fourth (1¼) inches in length, and post connection bolts shall be of lengths required to fit the post dimension and extend beyond the tightened nuts thereon within limits of one-fourth (¼) to one-half (½) inch. Washers, one-eighth (⅛) inch thick, shall be provided for use under nuts on all post bolts, and under any nut which has a width of less than one and one-sixteenth ($1\frac{1}{16}$) inches.

All fittings shall be galvanized in accordance with Section 715, "Galvanizing."

720.03.03 Reflector Plates. Reflector plates shall be fabricated from eleven (11) gage steel sheet or 0.148 inch thick aluminum sheet alloy 6061–T6. Nails for fastening reflector plates to the guardrail post shall be either galvanized metal or aluminum. Steel reflector plates shall be galvanized. Reflectorized material for reflector plates shall conform to the requirements of subsection 721.03.03, "Reflectors."

720.03.04 Cable End Anchor Assemblies. Cable end anchor assemblies for metal beam guard railing shall conform to the following provisions:

The anchor plate shall be fabricated of steel conforming to the specifications of ASTM Designation: A36.

The anchor rod shall be fabricated of steel conforming to the specifications of ASTM Designation: A575 or A576, Grade 1020. The eye may be drop forged or formed with a full penetration weld. The eye shall develop one hundred (100) percent of the rod strength.

All bolts and nuts shall conform to the specifications of ASTM Designation: A307, and be galvanized in accordance with the provisions in Section 715.

Anchor cable shall be three-fourths (¾) inch preformed, six (6) by nineteen (19), wire strand core or independent wire rope core (IWRC), galvanized, right regular lay, manufactured of improved plow steel with a minimum breaking strength of 21.4 tons. Two certified copies of mill test reports of each manufactured length of cable used shall be furnished to the Engineer.

Thimbles shall be commercial quality, galvanized steel. Cable clips shall be commercial quality drop forged galvanized steel.

The swaged fitting and stud assembly shall be of steel conforming to the requirements of American Iron and Steel Institute Designation: C1035, and shall be annealed, galvanized, suitable for cold swaging. The swaged fitting and stud assembly shall develop one hundred (100) percent of the breaking strength of the cable.

One sample of cable properly fitted with swaged fitting and right hand thread stud at both ends as specified above, three (3) feet in total length, shall be furnished the Engineer for testing.

SECTION 721

OBJECT MARKERS AND GUIDE POSTS

SCOPE

721.01.01 Materials Covered. This specification covers the quality and kind of materials used in the construction of object markers and guide posts.

REQUIREMENTS

721.02.01 Certificates. Without expense to the Department, two certificates covering each order of material (plates, reflectors, and posts) shall be furnished by the manufacturer, certifying that the product complies with the specifications. Certificates shall be delivered to the Engineer in charge at the jobsite at the time of, or prior to, delivery of the order.

For steel used in posts, the Contractor shall furnish two certified copies of mill test reports showing the chemical and physical characteristics from each heat.

PHYSICAL PROPERTIES AND TESTS

721.03.01 Metal Posts. Posts shall be steel conforming to ASTM Designation A570 Grade C.

Metal posts shall be galvanized in accordance with Section 715, "Galvanizing."

721.03.02 Target Plates. (a) Base Metal. Base metal for target plates shall be zinc-coated steel sheet or aluminum sheet.

The zinc-coated steel sheet shall comply with Federal Specification QQ–S–775 Steel Sheet, carbon, zinc-coated Type 1, Classes d and e, except that the zinc-coated surface shall withstand a one hundred eighty (180) degree bend on itself at room temperature without flaking the coating. The zinc-coated surface shall be prepared for painting by the application of phosphate coating. Surface preparation shall conform to the following requirements:

The phosphatizing process shall be accomplished without damaging or removing the galvanized coating from the steel base metal. Any evidence of damage or removal of the zinc coating shall be cause for rejection of the entire lot.

The aluminum sheet shall be prepared for painting with a chemical conversion coating conforming to the requirements of Federal Specification MIL–C–5541. The coating shall be applied in accordance with the manufacturer's specifications and recommended sequence of operation. Two copies of certified mill tests of the aluminum sheets shall be furnished to the Engineer.

Target plates shall be fabricated from 20 gage steel sheet or 0.050 inch thick aluminum sheet, alloy 3005–H14.

Fabrication of all metal parts shall be accomplished in a uniform and workmanlike manner. Plates shall be cut to size and shape and the holes punched for mounting bolts and reflectors in accordance with the details shown on the plans. Surfaces and edges of the plates shall be free from defects resulting from fabrication.

(b) Paint. Target plates shall have satisfactory paint adherence.

The plates shall be coated with baked enamel conforming to the following provisions:

The enamel finish coat for plates shall comply in all respects with the requirements of Federal Specification TT–E–489, Class B baking type enamel, with the added requirement that the yellowness index of the white enamel shall not exceed 0.08 when tested in accordance with Federal Test Method Standard No. 141, Method 6131.

Application of the baking enamel may be by spray, roller, or dip, at the option of the manufacturer. Other methods may be used provided they are approved prior to use. The dry film thickness of the baked enamel coating on the galvanized steel plates shall be not less than 2.0 mils on both front and back surfaces. The dry film thickness on both front and back surfaces of the aluminum plates shall be not less than 1.5 mils on each side if enamel is applied by spray or dip method and not less than 1.0 mil if enamel is applied by continuous roller coat method.

The coating shall be uniform throughout and shall be smooth and free from flow lines, streaks, blisters, or other surface imperfections.

The finished plates shall be free from dents and defects. The maximum surface deviation from a horizontal plane on which the finished plate lies shall not exceed 0.25 inch.

721.03.03 Reflectors. (a) Photometric Requirements. Each reflective delineator shall have the following minimum brightness values at two (2) degrees divergence expressed as candlepower per foot-candle. Measurements shall be conducted in accordance with standard photometric testing procedures for reflex reflectors of the Society of Automotive Engineers.

Angle of Incidence	Silver-White		Yellow	
Divergence Angle	.2	.5	.2	.5
0 Degrees	9.0	3.8	5.3	2.3
15 Degrees	8.0	3.4	4.4	2.0
30 Degrees	5.4	2.9	2.7	1.2
45 Degrees	2.6	1.1	1.0	0.5

The brightness of the reflective sheeting, totally wet by rain, shall not be less than ninety (90) percent of the above values. Wet performance measurements shall be conducted in conformance with standard rainfall tests specified in Military Specification MIL–R–13689A, or as amended.

(b) Durability. The delineator surface may be readily refurbished by cleaning and clear overcoating in accordance with the manufacturer's recommendations.

SECTION 722

WATER

SCOPE

722.01.01 Material Covered. This specification covers the quality of water for use in preparing cement concrete or soil-cement mixtures, and for wetting embankment, backfill, subgrade, and gravel base and surfacing courses.

REQUIREMENTS

722.02.01 General. All water for embankments, backfill, subgrade, gravel base, landscaping, and surface courses and cement concrete curing shall be free from an excessive amount of acids, alkali, oil, and other substances which, in the opinion of the Engineer, will cause damage to the above mentioned items.

PHYSICAL PROPERTIES AND TESTS

722.03.01 Concrete Use. Samples submitted for tests shall each consist of two (2) quarts of water, obtained and shipped in clean glass containers carefully packed and labeled. Tests shall be made in accordance with AASHTO Designation: T26, Standard Method of test for quality of water to be used in concrete.

Any indication of unsoundness, marked change in time of setting, or a reduction of more than ten (10) percent in strength from results obtained with concrete mixtures containing the water of satisfactory quality shall be sufficient cause for rejection of the water under tests.

SECTION 723

HARDWARE

SCOPE

723.01.01 Materials Covered. This specification covers the quality of bolts, nuts, washers, drift pins, dowels, nails, spikes, and other metal fastenings.

PHYSICAL PROPERTIES AND TESTS

723.03.01 Galvanizing. Galvanizing, when required, shall meet the current Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware, ASTM Designation A153.

723.03.02 Bolts, Nuts, Dowels, and Drift Bolts. Bolts, nuts, dowels, and drift bolts shall conform to the requirements of the current Specification for Steel Machine Bolts and Nuts and Tap Bolts, ASTM Designation A307, Grade A, unless otherwise specified.

723.03.03 Washers. Cast washers shall be of cast iron of the O-gee type. The diameter shall be not less than three and one-half (3½) times the diameter of the bolts for which it is used. The diameter of the hole shall be one-eighth (⅛) inch larger than the diameter of the bolt.

Flat malleable washers shall be of malleable iron with ribs properly proportioned to develop the full strength of the bolt and, unless otherwise shown on the plans, the diameter shall be not less than three and one-half (3½) times the diameter of the bolt for which it is used and its thickness equal to one-half (½) the diameter of the bolt. The diameter of the hole shall be one-eighth (⅛) inch larger than the diameter of the bolt.

SECTION 724

FENCE MATERIALS

SCOPE

724.01.01 Materials Covered. This specification covers the quality of barbed wire, woven wire, and chain-link fabric fencing, fence posts, gates, and miscellaneous fence hardware.

REQUIREMENTS

724.02.01 Samples and Certificates of Inspection. The Contractor shall supply the Engineer with three (3) line posts for testing purposes, the posts to be elected at random by the Engineer.

Without expense to the Department, two certificates covering each order of material shall be furnished by the manufacturer, certifying that the various metal components comply with the requirements herein. The certificates shall be delivered to the Resident Engineer at the time, or prior to, delivery of the order.

PHYSICAL PROPERTIES AND TESTS

724.03.01 Wood Posts. Intermediate braced posts and braces shall be of the same type as line posts.

End, gate, and corner post assemblies, including bracing timber, shall be sawed and shall conform to the grading requirements of Section 718, "Timber." They shall be of Douglas Fir, Larch, or Southern Pine.

Line posts and intermediate braced posts and bracing shall be round and shall be of Douglas Fir, Southern Pine, Lodge Pole Pine, or Larch manufactured from sound live trees well seasoned and free from large knots, shakes, or splits or other defects which will impair their strength or durability. The posts and braces shall be peeled to remove all outer bark and all inner cambium bark, except an occasional strip of inner bark may remain if not over one-half

(½) inch wide or three (3) inches long. All knots shall be trimmed flush with the side, spurs and splinters removed, and ends cut square.

Line posts and intermediate braced posts and braces shall not be less than seven (7) feet long and all other posts shall be not less than eight (8) feet long.

The small end of round line posts and braces shall be between three and one-half (3½) and four and one-half (4½) inches in cross sectional dimension; the small end of the intermediate braced posts shall be between five and one-half (5½) and six and one-half (6½) inches in cross sectional dimension. The allowable taper from end to end of round posts and braces shall not exceed one and one-half (1½) inches.

All posts and braces shall be pressure treated with Creosote, Creosote-Coal Tar solution or Pentachlorophenol solution in accordance with Section 719 of the Standard Specifications and modifications contained in these specifications.

The minimum weight of Pentachlorophenol solution retained per cubic foot of post shall be six (6) pounds. Pentachlorophenol solution shall consist of five (5) percent pure Pentachlorophenol in light petroleum.

All posts and braces shall be treated with the same type of preservative.

When pressure treated materials have been damaged or when it has been absolutely necessary to cut or bore into them, after delivery to the jobsite, all exposed untreated wood shall be carefully field treated with preservative applied either by thorough swabbing or by an approved bolt-hole treater as the Contractor may elect.

724.03.02 Metal Posts. Tubular posts shall be galvanized standard-weight steel pipe conforming to the requirements of the current Standard Specification for Black and Hot-Dipped Zinc (Galvanized) Welded and Seamless Steel Pipe for Ordinary Uses, ASTM Designation A120, except that the hydrostatic test will not be required.

The base metal for the manufacture of other steel sections used for posts and braces shall be of good commercial quality weldable steel.

Posts and braces shall conform to the following requirements:

For Chain-Link Fence 72 Inches and Less

Location	Type	Min. Size	Min. Weight Pounds Per Linear Foot
End, corner and pull	Pipe	2.351 O.D.	3.10
Line	Pipe	1.869 O.D.	2.31
	H-Section	1.815	2.66
Braces	Pipe	1.630 O.D.	1.93
	H-Section	1.44	2.16
Gate-single to 6 ft. or double to 12 ft., incl.	Pipe	2.351 O.D.	3.10
Gate-single over 6 ft. to 13 ft. or double over 12 ft. to 26 ft., incl.	Pipe	3.960 O.D.	8.65
Gate-single over 13 ft. to 18 ft., incl.	Pipe	6.599 O.D.	18.02

For Standard Type A Fencing

Location	Type	Min. Size	Min. Weight Pounds Per Linear Foot
End, corner pull and *gate	Pipe	2.351 O.D.	3.10
Line	T or H-Section		1.3
Braces	Pipe	1.630 O.D.	1.93

*Size of gate posts shall be as set forth for chain-link fence (see table).

Gate posts for standard Type A fencing shall be as set forth in the Standard Specifications for chain link fence except that for single gates over thirteen (13) feet to eighteen (18) feet the posts shall be pipe, 3.960 O.D. (min.) weighing not less than 8.65 lbs. per lin. ft.

Metal posts (other than tubular) shall be manufactured of steel conforming to Federal Commercial Standard CS

184–51 or ASTM Designation: A283 or A306. Metal posts (other than tubular) shall be manufactured to the tolerances and workmanship as provided in Federal Commercial Standard CS 184–51.

Line posts shall be provided with tapered anchor plates attached securely thereto. The anchor plates shall weigh not less than 0.67 pound and have a minimum area of fifteen (15) square inches. The top edge of the anchor plate shall be from twenty-two (22) to twenty-six (26) inches above the bottom end of the line post for Type A and Type C fence and this dimension shall be eighteen (18) to twenty-two (22) inches for Type DA and Type DC fence. The anchor plate may be omitted provided the post is set in concrete. Each post shall be furnished with galvanized wire clamps as follows: One clamp for each strand of barbed wire, and clamps for the top, bottom and at not more than fourteen (14) inch intervals between top and bottom for mesh fencing.

Line posts (other than tubular) shall be galvanized or painted with anticorrosive paint. The posts shall be drilled, notched, or studded to facilitate fastening the fence and shall be provided with a suitable anchor plate. Each post shall be furnished with not less than seven (7) galvanized wire clamps.

724.03.03 Barbed Wire. Barbed wire may be either steel or aluminum alloy.

Steel barbed wire shall conform to the requirements of ASTM Designation A121. The coating weight shall be Class 1 unless otherwise specified.

Barbed wire shall be composed of two (2) strands of No. 12½ gage (Stl.W.G.) wire with four (4) point barbs of 14 gage spaced not more than five (5) inches apart.

Aluminum alloy barbed wire shall be manufactured of aluminum alloy conforming to ASTM Designation B211, alloy 5052–0 for the line wire and alloy 5052–H38 for the barbs.

724.03.04 Woven Wire. Woven wire shall conform to the requirements of ASTM A116, No. 12½ Farm.

724.03.05 Chain-Link Fabric. Chain-link fabric and required fittings and hardware shall conform to the requirements of AASHTO M181.

The wire used in the manufacture of the fabric shall be 11 gage for all fence seventy-two (72) inches or less in height.

724.03.06 Staples, Brace Wire, and Nails. Brace wire shall be 8 gage, medium temper, fifty-five thousand (55,000) to seventy-five thousand (75,000) p.s.i. tensile strength and shall be galvanized in accordance with the requirements specified for barbed wire.

Staples shall be made from No. 9 U.S. Steel Wire Gage Galvanized and shall be of the L-shaped (Strong-Hold) type. The long shank shall be threaded one and three-fourths (1¾) inches long.

724.03.07 Metal Gates. (a) Drive Gates for Standard Fencing. The gate frames shall be constructed of not less than one (1) inch galvanized standard weight pipe conforming to the dimensions, nominal weights, and galvanizing specified in the current ASTM Designation A53 (hydrostatic test will not be required). Galvanized tubular steel braces shall be placed vertically in each gate, and corner and brace joints shall be so secured that the gate will retain a true rectangular shape.

The wire mesh shall be rectangular mesh or two (2) inch diamond mesh and shall be galvanized in accordance with the requirements herein specified for woven wire fabric.

(b) Drive Gate for Chain-Link Fencing. The gate frame shall be constructed of not less than one and one-half (1½) inch galvanized standard weight pipe conforming to the dimension, nominal weights, and galvanizing specified under the current ASTM Designation A53 (hydrostatic test will not be required). Gate frames shall be cross-trimmed with galvanized three-eighths (⅜) inch adjustable truss rods. The corners of the gate frames shall be fastened together and reinforced with malleable iron fittings designed for the purpose of welding.

Chain-link fence fabric as specified for the fence shall be attached to the gate frame by the use of stretcher bars and tie wires as specified for fence construction and suitable tension connectors spaced at approximate one (1) foot intervals.

(c) Walk Gates. Unless otherwise specified, walk gates shall be three and one-half (3½) feet wide and of the height corresponding to the adjacent fence.

The gate frame shall be constructed of not less than three-fourths (¾) inch galvanized standard weight pipe conforming to the dimension, nominal weights, and galvanizing specified under the current ASTM Designation A53 (hydrostatic test will not be required).

The gate frame shall be filled with fabric meeting the requirements for fabric as specified herein.

The gate shall be furnished complete with approved hinges, latches, and auxiliary braces as required.

SECTION 725

ELASTOMERIC BEARING PADS

SCOPE

725.01.01 Materials Covered. This specification covers the material in elastomeric bearing pads as herein specified and shall include plain bearings (consisting of elastomer only) and laminated bearings (consisting of layers of elastomer restrained at their interfaces by bonded laminates).

The elastomer portion of the elastomeric compound shall be one hundred (100) percent virgin natural polyisoprene (natural rubber) meeting the requirements of Table A or one hundred (100) percent virgin chloroprene (neoprene) meeting the requirements of Table B, as specified by the Engineer. Compounds of nominal hardness between the values shown may be used and the test requirements interpolated. When test specimens are cut from the finished product a ten (10) percent variation in "Physical Properties" will be allowed.

REQUIREMENTS

725.02.01 Certificate of Inspection. Elastomeric bearing pad material shall be tested by a reputable testing laboratory, recognized by the State, who shall certify that the material meets these specifications and requirements. The Contractor shall furnish the Department with this certification prior to using the material.

PHYSICAL PROPERTIES AND TESTS

725.03.01 General.

TABLE A

ASTM Standard	Physical Properties	50	60	70
		Duro	Duro	Duro
	Hardness ASTM D2240	50±5	60±5	70±5
	Tensile strength, min. p.s.i. ASTM D412	2500	2500	2500
	Ultimate elongation, minimum percent	450	400	300

	Heat Resistance			
	Change in durometer hardness, max. points...	+10	+10	+10
D573 70 Hr. at 158° F.	Change in tensile strength, max. percent	—25	—25	—25
	Change in ultimate elongation, max. percent	—25	—25	—25
	Compression Set			
D395 Method B	22 hours at 158° F., max. percent	25	25	25
	Ozone			
D1149	25 pphm ozone in air by volume 20 percent strain 100° F. ± 2° F., 48 hours mounting procedure D518, Procedure A	No Cracks	No Cracks	No Cracks
	Adhesion			
D429, B	Bond made during vulcanization, lbs. per inch	40	40	40
	Low Temperature Test			
D746 Procedure B	Brittleness at —40° F.	No Failure	No Failure	No Failure

TABLE B

ASTM		50	60	70
Standard	Physical Properties	Duro	Duro	Duro
	Hardness ASTM D2240	50±5	60±5	70±5
	Tensile strength, min. p.s.i. ASTM D412	2500	2500	2500
	Ultimate elongation, min. percent	400	350	300

	Heat Resistance			
D573 70 Hr. at 212° F.	Change in durometer hardness, max. points	+15	+15	+15
	Change in tensile strength, max. percent	—15	—15	—15
	Change in ultimate elongation, max. percent	—40	—40	—40
	Compressive Set			
D395 Method B	22 hours at 212° F., max. percent	35	35	35
	Ozone			
D1149	100 pphm ozone in air by volume, 20 percent strain 100° F. ± 2° F., 100 hours mounting procedure D518, Procedure A	No Cracks	No Cracks	No Cracks
	Adhesion			
D429, B	Bond made during vulcanization lbs. per inch	40	40	40
	Low Temperature Test			
D746 Procedure B	Brittleness at —40° F.	Duro No Failure	No Failure	No Failure

Laminates shall be:

Rolled mild steel sheets conforming to AASHTO M183 (ASTM A36) or ASTM A570, Grade C or D, or

Fabric reinforcement woven from one hundred (100) percent glass fibers of "E" type yarn with continuous fibers. The minimum thread count in either direction shall be twenty-five (25) threads per inch. The fabric shall have either a crowfoot or an 8 Harness Satin weave. Each ply

of fabric shall have a breaking strength of not less than eight hundred (800) pounds per inch of width in each thread direction when three (3) inch by thirty-six (36) inch samples are tested on split drum grips. Fabric reinforcements shall be single ply at top and bottom surfaces of the pad and double ply within the pad. The bond between double plies shall have a minimum peel strength of twenty (20) pounds per inch.

725.03.02 Manufacturing Requirements. Plain bearings may be molded individually, cut from previously molded strips or slabs or extruded and cut to length. Cut edges shall be at least as smooth as ANSI 250 finish. Unless otherwise shown on the plans, all components of a laminated bearing shall be molded together into an integral unit, and all edges of the nonelastic laminations shall be covered by a minimum of one-eighth (⅛) inch of elastomer except at laminate restraining devices and around holes that will be entirely closed on the finished structure.

725.03.03 Tolerances. Tolerances, relative dimensions, finishes and appearance, flash, and rubber-to-metal bonding, shall meet the requirements below as defined in the Rubber Handbook, 2nd Edition, published by the Rubber Manufacturers Association, Inc., 444 Madison Avenue, New York 22, N.Y.

Symbol Requirement—

A3	Commercial dimensional tolerances, Table III, Page 15.
F3	Commercial Finish, Table V, Page 20.
B2	Class 2, Method B, Minimum bond destructive value, Table VII, Page 25.
Grade 2	Bond destructive value at forty (40) lbs. per inch width, Table VIII, Page 25.
T.063	Tear trim tolerance no hand trimming required, Table VI, Page 23.

725.03.04 Quality Assurance. Whenever practical, the mechanical properties of the finished bearing shall be verified by laboratory test.

The following values shall be met under laboratory testing conditions of full size bearings:

(a) Compressive strain of any layer of an elastomeric bearing shall not exceed seven (7) percent at eight hundred (800) p.s.i. average unit pressure, or at the design dead load plus live load pressure if so indicated on the plans.

(b) The shear resistance of the bearing shall not exceed thirty (30) p.s.i. for fifty (50) durometer, forty (40) p.s.i. for sixty (60) durometer or fifty (50) p.s.i. for seventy (70) durometer, Table A compounds; nor fifty (50) p.s.i. for fifty (50) durometer, seventy-five (75) p.s.i. for sixty (60) durometer or one hundred ten (110) p.s.i. for seventy (70) durometer, Table B compounds at twenty-five (25) percent strain of the total effective rubber thickness after an extended four (4) day ambient temperature of minus twenty (20) degrees Fahrenheit.

SECTION 726

ROADSIDE MATERIALS

SCOPE

726.01.01 Materials Covered. This specification covers the materials used in erosion control, landscaping, and irrigation systems.

REQUIREMENTS

726.02.01 Certificates and Samples. (a) Topsoil. The Contractor shall obtain from the State Department of Agriculture, a certificate stating that the area from which the topsoil is to be obtained is free from noxious weeds.

Before imported topsoil is brought on the jobsite, a ten (10) pound sample shall be submitted to the Engineer for approval. The sample shall be accompanied by a current report, furnished by the Contractor, from a recognized testing laboratory indicating the particle size, clay content, the pH factor, and electrical conductivity of the sample.

(b) Fertilizer. The fertilizer containers shall have the manufacturer's guaranteed statement of analysis clearly marked, all in accordance with State and Federal laws.

(c) Humus. Before bulk humus is brought to the jobsite, a ten (10) pound sample shall be submitted to the Engineer for approval. The sample shall be accompanied by a current report, furnished by the Contractor, from a recognized testing laboratory indicating the moisture retention capacity, organic matter (based on dry weight), mineral matter (ash), silica (acid insoluable ash), nitrogen (based on dry weight), pH factor, and the amount of Douglas Fir bark.

(d) Plants. All plants shall be first-class nursery grown representatives of their normal species and shall be true to type or name as shown on the plans and shall conform to the American Standard for Nursery Stock, No. 1 grade, American Association of Nurserymen, Inc., latest edition, ASA Spec. Z 60.1 and shall be tagged in accordance with the most recent standard practice recommended by the

American Association of Nurserymen and to the latest edition of Standardized Plant Names, American Joint Committee on Horticultural Nomenclature.

All plants shall comply with Federal and State laws requiring inspection for plant diseases and infestations. Inspection certificates required by law shall accompany each shipment of plants, and certificates shall be delivered to the Engineer. All shipments of pines will be accompanied by certificates for USDA Quarantine No. 63, for White Pine blister rust, and Nevada Quarantine No. 54.05 for European Pine shoot moth.

(e) Seeds. The Contractor shall furnish to the Engineer, duplicate copies of a statement signed by the vendor certifying that each lot of seed has been tested by a recognized seed testing laboratory within six (6) months before the date of delivery on the project.

(f) Irrigation Materials. It shall be the Contractor's responsibility to ascertain that all required tests have been made by qualified testing laboratories as approved by the Department. The Contractor shall furnish the Engineer with a written certification that all required tests have been satisfactorily completed and that materials and fabrication thereof comply with all the requirements.

All materials shall be approved prior to use.

PHYSICAL PROPERTIES AND TESTS

726.03.01 Topsoil. Topsoil shall consist of fertile, friable soil of loamy character, and shall contain an amount of organic matter normal to the region. It shall be obtained from well-drained arable land and shall be reasonably free from subsoil, refuse, roots, heavy or stiff clay, stones larger than one (1) inch in largest dimension, coarse sand, sticks, brush, litter, and other deleterious substances. Topsoil shall be capable of sustaining healthy plant life.

Requirements for topsoil shall be as follows:

Particle Size	3/8 inch Max.
Clay Content	20 percent Max. (by weight)
pH Factor	6.4 to 7.4
Electrical Conductivity	0.5 to 1.0 mmhos. per centimeter of the saturation paste extract

726.03.02 Fertilizer. Fertilizer shall be a standard commercial grade of organic or inorganic fertilizer of the kind and quality specified in the contract documents. It may be separate or in a mixture containing the percentage of total nitrogen, available phosphoric acid and water-soluble potash in the amounts specified. All fertilizers shall be furnished in standard unopened containers with weight, name of plant nutrients and manufacturer's guaranteed statement of analysis clearly marked, all in accordance with State and Federal laws.

Acceptable commercial fertilizer will be specified in one of the following forms:

(a) A dry free-flowing granular fertilizer, suitable for application by agricultural fertilizer spreader.

(b) A soluble fertilizer ground to a fineness that will permit complete suspension of insoluble particles in water, suitable for application by power sprayer.

(c) A granular or pelleted fertilizer, suitable for application by blower equipment.

(d) A non-volatile liquid fertilizer.

726.03.03 Humus. Humus shall be processed, composted, fine ground bark of White Fir, Pine, or Redwood, or a mixture of these in any proportion. Humus shall be free of lumps and/or clods and shall be fine enough so that one hundred (100) percent of the material will pass a one-half (½) inch screen, and eighty-five (85) percent will pass a No. 6 screen.

Requirements for humus shall be as follows:

Moisture retention capacity	35 Percent Min.
Organic matter based on dry weight	95 Percent Min.
Mineral matter (ash)	5 Percent Max.
Silica (acid insoluble ash)	3 Percent Max.
Nitrogen based on dry weight	0.8 Percent Min.
pH value based on 1:5 solution	4.0 to 6.0 Max.
Douglas Fir Bark	0 Percent

726.03.04 Mulch. (a) Hay or Straw. All hay or straw mulch materials shall be in an air-dried condition free of noxious weeds, weed seeds, and other materials

detrimental to plant life. Unless otherwise specified in the contract documents, hay or straw mulch material shall be of approved field grasses indigenous to the area.

Mulch shall also conform to the following requirements:

Moisture Content	12.0% ± 3.0%
Organic Matter (Oven-dried Basis)	99.6% ± 0.2%
Ash Content	0.8% ± 0.2%
Water Holding Capacity (Grams of Water/100 Grams of Fiber)	1150 Minimum

(b) Wood Cellulose Fiber. Wood cellulose fiber mulch shall be specially processed wood fiber containing no growth or germination inhibiting factors and shall be dyed a suitable color to facilitate inspection of the placement of the material.

(c) Wood Chips and Shavings. Shavings shall be manufactured from any clean soft wood.

Wood chips shall be manufactured from any clean, green softwood. Chips from kiln-dried or air-dried material will not be accepted. Chips shall be produced by machinery equipped with knives or blades which cut rather than shred or break the material. Chips shall be graded so that substantially all chips are from one-half (½) inch to three (3) inches in length, one-half (½) inch to one and one-half (1½) inches in width and from one-eighth (⅛) inch to one-half (½) inch in thickness.

Chips produced from tree trimmings which contain leaves or small twigs will not be accepted.

726.03.05 Jute Matting. Jute matting shall be of a uniform open plain weave of undyed and unbleached single jute yarn. The yarn shall be of a loosely twisted construction and shall not vary in thickness by more than one-half its normal diameter. Jute matting shall be furnished in rolled strips as follows:

(a) Length approximately fifty (50) yards.

(b) Matting width shall be forty-eight (48) inches with an average weight of 0.92 pounds per square yard. A tolerance of plus or minus one (1) inch in width and five (5) percent in weight will be allowed.

726.03.06 Plants. All plants shall be first-class nursery grown representatives of their normal species and shall be true to type or name as shown on the plans and shall conform to the American Standard for Nursery Stock, No. 1 grade, American Association of Nurserymen, Inc., latest edition, ASA Spec. Z 60.1 and shall be tagged in accordance with the most recent standard practice recommended by the American Association of Nurserymen and to the latest edition of Standardized Plant Names, American Joint Committee on Horticultural Nomenclature.

726.03.07 Seeds. Grasses, legumes, or cover crop seed shall be furnished in standard containers on which shall be shown the following information:

(a) Seed name.

(b) Lot number.

(c) Net weight.

(d) Percentage of purity.

(e) Percentage of germination (in case of legumes percentage of germination to include hard seed.

(f) Percentage of weed seed content and inert material clearly marked for each kind of seed in accordance with applicable State and Federal laws.

(g) No noxious weed seed present.

Seed which has become wet, moldy or otherwise damaged in transit or storage will not be accepted. Seed shall be at least ninety-five (95) percent pure and shall have a minimum of eighty-five (85) percent germination.

726.03.08 Tree Ties. Tree ties shall be strips of vinyl coated nylon, durable, non-hardening long-life material approximately one (1) inch wide and approximately 10 mils thick, or other suitable material approved by the Engineer.

A number 10-gage galvanized wire encased in at least one-half (½) inch black rubber hose may be used when permitted by the Engineer.

726.03.09 Pipe and Fittings. Pipe shall be standard weight, hot dipped galvanized iron or steel pipe, threaded

and coupled. Pipe shall meet the current requirements of ASTM Designation A120, and shall be furnished in standard lengths. All pipe fittings shall be standard threaded galvanized malleable iron fittings.

Asbestos cement pipe conduit shall be Type II, Class 2400 asbestos cement pipe conforming to the requirements of ASTM Designations: C428 and C644 and shall be of the size shown on the plans.

Plastic pipe, except soaker lines, shall be polyvinyl chloride (PVC) 1120 or 1220 pressure pipe as shown in the irrigation system legend on the plans. All PVC pipe shall be extruded from one hundred (100) percent virgin material, and shall be National Sanitation Foundation (NSF) approved. All plastic pipe, except soaker lines, shall be Class 200. Bell end PVC pipe may be used in lieu of plain end pipe and couplings.

Fittings for PVC plastic pipe shall be rigid polyvinyl chloride, Standard Weight, Schedule 40, and shall be solvent weld type except as shown on plans. Fittings for PVC pipe shall have higher bursting pressure than the pipe.

Plastic pipe for soaker lines shall be flexible polyvinyl chloride (PVC) conforming to ASTM Designation: D2287. This material shall have a Shore durometer hardness, A scale, of 90 to 99 and a specific gravity of 1.40 to 1.44.

All PVC plastic pipe shall be homogeneous throughout and shall be smooth inside and outside, free from cracks, holes, foreign materials, dents, wrinkles and blisters.

726.03.10 Control Tubing. Control tubing shall be copper refrigerator tubing meeting the current requirements of ASTM Designation B280 in the size specified on the plans.

726.03.11 Gate Valves. Gate valves, when called for on the plans, shall be heavy duty bronze conforming to the requirements of ASTM Designation B62.

726.03.12 Quick Coupler Valves. Quick coupler valves shall have a service rating not less than one hundred fifty (150) p.s.i. for non-shock cold water. Body of the

valves shall be a single piece construction of cast leaded semi-red brass alloy No. 5–A as given in ASTM Designation B145.

726.03.13 Masonry. Hollow load-bearing concrete masonry blocks shall conform to the requirements of ASTM Designation: C90.

Hollow non-load-bearing concrete masonry blocks shall conform to the requirements of ASTM Designation: C129.

SECTION 727

CONCRETE SURFACE FINISHING MATERIAL

SCOPE

727.01.01 Materials Covered. This specification covers the types and quality of concrete surface finishing materials.

PHYSICAL PROPERTIES AND TESTS

727.02.01 Requirements. Bonded grout finishing material shall conform to the following requirements:

(Except as noted herein tests shall be made in accordance with test method indicated. Federal standard test methods are as contained in Publication Federal Test Methods Standard No. 141.)

(a) Viscosity—110–115 K.U., using pin paddle. (Federal Standard Method No. 4281.)

(b) Total solids (Federal Standard Method No. 4042):

1. By weight—sixty-five (65) percent min.
2. By volume—forty-eight (48) percent min.

(c) Flexibility—Pass one-eighth (⅛) inch mandrel when spread 12 mils wet on a tin panel, air dried sixteen (16) hours and oven dried sixteen (16) hours at one hundred twenty (120) degrees Fahrenheit. Panel shall show no mud cracking, or no loss in adhesion to the panel when bent. (Federal Standard Method No. 6221.)

(d) Water resistance—No softening when tested as follows: Spread a 12 mil film on tin panel, allow to air dry forty-eight (48) hours. Immerse in water for sixteen (16) hours, and allow to dry for eight (8) hours. There shall be no effect on the material. (ASTM D1647.)

(e) Weatherometer durability—Expose a 12 mil film applied to asbestos-cement board for five hundred (500) hours in an Atlas Twin-Arc weatherometer. There shall be no erosion, cracking, softening, or other visible defects in the coating. (Federal Standard Method No. 6152.)

SECTION 728

EPOXY

SCOPE

728.01.01 Materials Covered. These specifications are intended to specify epoxy that will meet service requirements for highway construction.

Epoxy shall be furnished as two (2) components which shall be mixed together at the site of the work.

REQUIREMENTS

728.02.01 Sampling and Testing. Epoxy shall not be used prior to sampling and testing unless its use is permitted prior to said sampling and testing in accordance with the provisions in subsection 106.05, "Certificates of Compliance."

All tests will be conducted in accordance with the latest test methods of the American Society for Testing and Materials, Federal Test Method Standard No. 141, and methods in use by the Department of Highways.

728.02.02 Certificates. Without expense to the Department, two certificates covering each order of material shall be furnished by the manufacturer, certifying that the product complies with the specifications. Certificates shall be delivered to the Engineer in charge at the jobsite at the time of, or prior to, delivery of the order.

728.02.03 Packaging, Labeling, and Storing. Each component shall be packaged in steel containers not larger than five (5) gallons in volume. When the components are to be mixed at a ratio of two (2) parts A to one (1) part B, by volume, the container containing component B shall be one-half (½) the volume of the container containing component A. The containers shall have lug type crimp lids with ring seals, shall be new, not less than 24-gage, shall otherwise meet U.S. Department of Transportation

Hazardous Materials Shipping Regulations, and shall be well sealed to prevent leakage. If a lining is used in the containers, it shall be of such character as to resist any action by the components. Each container shall be clearly labeled with the designation (Component A or B), type (Standard or Rapid) if applicable, manufacturer's name, date of manufacture, batch number (a batch shall consist of a single charge of all components in a mixing chamber), all directions for use specified elsewhere and the following warning:

CAUTION

This material will cause severe dermatitis if it is allowed to come in contact with the skin or eyes. Use gloves and protective creams on the hands. Should this material contact the skin, wash thoroughly with soap and water. Do not attempt to remove this material from the skin with solvents. If any gets in the eyes, flush for ten (10) minutes with water and secure immediate medical attention.

Attention is directed to the characteristic of some epoxy components to crystallize or thicken excessively prior to use when stored at temperatures below thirty-five degrees Fahrenheit. Any material which shows evidence of crystallization or a permanent increase in viscosity or settling of pigments which cannot be readily redispersed with a paddle shall not be used.

728.02.04 Directions for Use. At the time of mixing, components A and B shall be at a temperature between sixty (60) degrees Fahrenheit, and eighty-five (85) degrees Fahrenheit, unless otherwise specified. Any heating of the adhesive components shall be done by application of indirect heat. Immediately prior to mixing, each component shall be thoroughly mixed with a paddle. Separate paddles shall be used to stir each component. Immediately prior to use, the two (2) components shall be thoroughly mixed together in the specified ratios. When mixed, all adhesives except coal tar modified epoxy, shall have a

uniform gray color without black or white streaks. No solvent shall be added to any epoxy.

After mixing, all epoxies shall be placed in the work and any overlaying or inserted material which is to be bonded to the work by the epoxy shall also be placed before thickening of the epoxy has begun. Surfaces upon which epoxy is to be placed shall be free of rust, paint, grease, asphalt, and loose and deleterious material. When epoxy is used as a binder to make epoxy concrete or mortar, the two (2) components of epoxy shall be thoroughly mixed together before the aggregate is added and, unless otherwise specified, the mix proportions shall consist of one (1) part of binder to approximately four (4) parts of aggregate, by volume. Aggregate for use in epoxy concrete and mortar shall be clean and shall have a moisture content of not more than 0.50 percent when tested by Test Method No. Nev. 112. All surfaces against which epoxy concrete and mortar are to be placed shall be primed with a coat of the epoxy used just prior to placing the mortar.

TYPES OF EPOXIES

728.03.01 Binder (Adhesive), Epoxy Resin Base.

Classification

This specification covers a low viscosity liquid polysulfide extended epoxy formulated primarily for use in making high-strength epoxy concrete and epoxy mortar, in fastening metal anchors in vertical holes in concrete and in pressure grouting of cracks in concrete. Thick sections of this epoxy are not suitable for use in freeze-thaw environments.

Composition

COMPONENT A

	Lbs./ 100 gals.
Epoxy Resin[1]	934
Titanium Dioxide, Federal Specification ASTM Designation: D476, Type III or IV	28.0

[1]Viscosity, 5–7 poises at 25° Centigrade; epoxide equivalent 175–195; Color (Gardner), 5 maximum; manufactured from epichlorohydrin and bisphenol A. The reactive diluent shall be butyl glycidyl ether.

COMPONENT B

	Lbs./ 50 gals.
Polysulfide Polymer[2]	403
2, 4, 6-Tri (Dimethylaminomethyl) Phenol[3]	93.4
Talc[4]	9.3
Carbon Black[5]	1.9

[2]Specific gravity, 1.24–1.30 at 20°/20° Centigrade; viscosity, 700–1200 centipoise, Brookfield at 25° Centigrade; pH water extract, 6.0–8.0; moisture content, 0.1 percent maximum; pour point, —15° Fahrenheit; average molecular weight, 1000; flash point, degrees Fahrenheit, Cleveland Open Cup, 390 minimum; sulfur content, percent, 36–40; color, Hellige, 9–12. The product shall be a difunctional mercaptan made from 98 mole percent of vis (2-chloroethyl) formal and 2 mole percent of trichloropropane.

[3]Formula weight, 265; specific gravity at 25°/25° Centigrade, 0.973; refractive index, 1.514 at 25° Centigrade; distillation range 96 percent at 130°–160° Centigrade (0.5–1.5 mm.); flash point, Tag Open Cup, 300° Fahrenheit minimum; water content, 0.06 percent maximum.

[4]Percent passing U.S. No. 325 sieve, 94–96; maximum particle size, 70 microns; oil absorption (Gardner-Coleman), 6–7 ml. per 20 grams; fineness in oil (Hegman) 1–2; specific surface, 0.5–0.6 square meter per gram; consistency (40 percent suspension in linseed oil), 55–60 KU.

[5]Surface area, square meters/gram, 115–130; particle diameter, millimicrons, 18–30; pH, 7.5–8.5; fixed carbon (moisture free), percent, 96–98; volatile matter, percent, 2–4; oil absorption, stiff paste endpoint, CCS/gram, 0.80–0.90.

The ingredients in Components A and B shall be thoroughly dispersed such that each component forms a fluid mixture.

Tests

All tests shall be performed in accordance with Test Method No. Nev. T502.

Characteristics of Components

Viscosity, Brookfield No. 2 Spindle at 20 rpm, Poise	
Component A	5 to 10
Component B	7 to 15
Density, lbs. per gallon at 77° Fahrenheit	
Component A	9.45 to 9.65
Component B	10.00 to 10.20

Characteristics of Combined Components

Gel time, minutes	15 to 30

The infrared curves of the vehicle components shall match those on file in the Department of Highways.

Directions for Use

The mixing ratio is two (2) parts by volume of Component A to one (1) part by volume of Component B. No

more material shalll be mixed than can be used within ten (10) minutes from the time mixing operations are started.

728.03.02 Coal Tar Modified Epoxy Resin.

Classification

This specification covers a low viscosity liquid coal tar extended epoxy formulated primarily for use with a cover of aggregate as a black seal and skid resistant surfacing for Portland cement concrete and for use in making low strength epoxy concrete and epoxy mortar. This epoxy is suitable for use in freeze-thaw environments.

Composition

COMPONENT A
(Modified Epoxy Resin)

This material shall be based on a liquid epoxy resin obtained from the condensation of bisphenol A and epichlorohydrin. It shall have the following physical characteristics:

Property	Specified Value
Viscosity, 77° Fahrenheit, poise	8–16
Epoxide Equivalent	225–275
Ash Content, percent by Wt.	0.2 max.
Volatile Content, mls. distillate	3 max. below 350° F.
(Unmodified Resin)	
Viscosity, 77° Fahrenheit, poise	100–160
Epoxide Equivalent	180–195

COMPONENT B
(Modified Amine Hardening Agent for Component A)

This material shall be the hardening agent for the modified epoxy resin, and shall be composed of a bitumen which has been specially treated with a modified aliphatic polyamine. It shall have the following physical characteristics:

Property	Specified Value
Viscosity, 77° Fahrenheit, poise	2–8
Alkalinity, eq/100 gms.	0.19–0.27
Water, percent by Wt.	2.0 max.
Ash, percent by Wt.	0.5 max.
Volatile Content, mls. distillate	3 max. below 375° F.

Properties of cured coal tar modified epoxy resin

Resistance to Water Solutions	Specified Value
Distilled Water (7 days 77° Fahrenheit) percent	0.6 (cast bar) max.
Saturated Calcium Chloride, percent	0.5 max.

Low Temperature Creep	Specified Value
Initial	0.005″ min.
24 hours	0.010″ min.
7 days	0.015″ min.

Tensile Properties (On Laboratory Cast Sheet ⅛ inch thick)

Property	Specified Value
Tensile Strength, p.s.i. at 77° Fahrenheit	400 min.
Tensile Elongation, percent at 77° Fahrenheit	35 min.
Volatile Content, percent	2 max.
Gel Time, minutes	25–50
Shore D Hardness at 77° Fahrenheit instantaneous reading after 24 hours	35–65

Tests

All tests shall be performed in accordance with Test Method No. Nev. T503 within six (6) months of the time of use.

Directions for Use

Equal parts, by weight or volume, of Components A and B shall be mechanically batch mixed, or continuously mixed in automatic paving equipment which provides continuous metering, mixing, and application at a controlled rate. If the components are to be batch mixed, mixing shall be performed with a propellor type stirrer, or other power driven agitator attached to a one-half (½) inch heavy duty drill. Care must be exercised to thoroughly incorporate material at the sides and bottom of the mixing container.

When mixed in batches, the mixing time shall be five (5) minutes at sixty (60) degrees to eighty (80) degrees Fahrenheit or three (3) minutes at eighty (80) degrees to one hundred (100) degrees Fahrenheit and the batch size shall not exceed five (5) gallons.

The mixed material will set quickly if allowed to remain in large mass, due to the heat generated as the two (2) components react. Pot life in large quantities (one (1) gallon to five (5) gallons) is approximately:

Material Temperature	Pot life (measured from beginning of mixing)
60–70° F.	18 minutes
70–80° F.	12 minutes
80–90° F.	10 minutes
90–100° F.	8 minutes

728.03.03 Epoxy Resin Adhesive for Bonding New Concrete to Old Concrete.

Classification

This specification covers a low viscosity paste polysulfide extended epoxy formulated primarily for use in bonding new Portland cement concrete to old Portland cement concrete and in fastening metal anchors in horizontal holes in concrete. This epoxy is available in 2 types: Type I for general use and Type II for use when cure temperatures are below sixty (60) degrees Fahrenheit, or when a faster cure is required. Thick sections of this epoxy are not suitable for use in freeze-thaw environments.

Composition—Type I

COMPONENT A

	Lbs./100 gals.
Epoxy Resin[1]	918
Resin Grade Asbestos[2]	*34.0
Titanium Dioxide, Federal Specification TT–P–442, Type I or II	18.4
Glycerine, ASTM Designation: D1257	2.75
Silicone Anti-Foam, Type Q	0.09

COMPONENT B

	Lbs./50 gals.
Polysulfide Polymer[3]	406
2, 4, 6-Tri (Dimethylaminomethyl) Phenol[4]	45.9
Dimethylaminomethyl Phenol[5]	45.9
Resin Grade Asbestos[2]	†16.0
Carbon Black[6]	0.46
Silicone Anti-Foam, Type Q	0.05

Composition—Type II

COMPONENT A

	Lbs./100 gals.
Epoxy Resin[1]	918
Resin Grade Asbestos[2]	*34.0
Titanium Dioxide, Federal Specification TT–P–442, Type I or II	18.4
Glycerine, ASTM Designation: D1257	2.75
Silicone Anti-Foam, Type Q	0.09

COMPONENT B

	Lbs./50 gals.
Polysulfide Polymer[3]	403
2, 4 ,6-Tri (Dimethylaminomethyl) Phenol[4]	91.7
Resin Grade Asbestos[2]	†16.0
Carbon Black,[6]	0.46
Silicone Anti-Foam, Type Q	0.05

[1]Viscosity, 5–7 poises at 25° Centigrade; epoxide equivalent 175–195; Color (Gardner), 5 maximum; manufactured from epichlorohydrin and bisphenol A. The reactive diluent shall be butyl glycidyl ether.

[2]Specific Gravity, grams per ml., 2.45; moisture content, percent by weight, 2.0 maximum; surface area, square meters per gram, 60 approximately; reflectance, G.E. brightness, 72–76; nature of surface charge, electropositive (cationic); pH in water, 9.5; bulking value, gallons per 100 lbs., 4.8; oil absorption (DOP), pounds per 100 lbs., 120; refractive index, Nd 25° Centigrade, 1.54–1.56; wet bulk density in water, after dispersion, 2 grams per liter, settling after 1 hr., 100 ml. clear maximum; dry bulk density; pounds per cubic foot, 4.

[3]Specific gravity, 1.24–1.30 at 20°/20° Centigrade; viscosity, 700–1200 centipoise, Brookfield at 25° Centigrade; pH water extract, 6.0–8.0; moisture content, 0.1 percent maximum; pour point, —15° Fahrenheit; average molecular weight, 1000; flash point, degrees Fahrenheit, Cleveland Open Cup, 390 minimum; sulfur content, percent 36–40; color, Hellige, 9–12. The product shall be a difunctional mercaptan made from 98 mole percent of bis (2-chloroethyl) formal and 2 mole percent of trichloropropane.

[4]Formula weight 265; specific gravity at 25°/25° Centigrade, 0.973; refractive index, 1.514 at 25° Centigrade; distillation range 96 percent at 130–160° Centigrade (0.5–1.5 mm.); flash point, Tag Open Cup, 300° Fahrenheit minimum; water content, 0.06 percent maximum.

[5]Formula weight 151; specific gravity at 25°/25° Centigrade, 1.023; refractive index, 1.530 at 25° Centigrade, distillation range, 78 percent at 80–130° Centigrade (2 mm.); flash point, Tag Open Cup, Dip 215° Fahrenheit, Sweep 227.5° Fahrenheit; water content, 1.0 percent maximum.

[6]Surface area, square meters/gram, 115–130; particle diameter, milimicrons, 18–30; pH, 7.5–8.5; fixed carbon (moisture free), percent, 96–98; volatile matter, percent, 2–4; oil absorption, stiff paste endpoint, CCS/gram, 0.80–0.90.

*A range of 31 to 37 lbs. is permitted if necessary to achieve proper viscosity and shear ratio.

†A range of 14.5 to 17.5 lbs. is permitted if necessary to achieve proper viscosity and shear ratio.

The ingredients in Components A and B shall be thoroughly dispersed such that each component forms a uniform paste.

Tests

All tests shall be performed in accordance with Test Method No. Nev. T504.

Characterstics of Components, Types I and II

Brookfield Viscosity, Helipath Spindle TB, Poise at at 77° Fahrenheit

Component A	200 to 450
Component B	200 to 450
Density, lbs. per gallon at 77° Fahrenheit	
Component A	9.50 to 9.75
Component B	10.05 to 10.31
Shear Ratio, A and B Components	2.5 minimum
Percentage of entrapped air, A and B	2.0 maximum

Characteristics of Combined Components

Gel time, minutes, Type I	25 to 50
Gel time, minutes, Type II	15 to 30

Color, Type I and II—Approximately that of Color No. 26134 of Federal Standard No. 595.

The infrared curves of the vehicle components shall match those on file in the Department of Highways.

Directions for Use

The mixing ratio is two (2) parts by volume of Component A to one (1) part by volume of Component B. When measuring as individual Components A and B, stir and tap the measuring containers to remove possible air voids. Do not mix more material than can be spread within eight (8) minutes from the time mixing operations are started. The spreading rate shall be sufficient to thoroughly coat the surface. Spread the mixed adhesive by brush or roller over thoroughly cleaned concrete at a rate not exceeding forty (40) square feet per gallon. On very rough surfaces the spreading rate shall be twenty-five (25) square feet per gallon. The new concrete shall be placed against the adhesive coating on the old concrete within fifteen (15) minutes after spreading at temperatures below ninety (90) degrees Fahrenheit or within ten (10) minutes at temperatures above ninety (90) degrees Fahrenheit.

728.03.04 Rapid Set Epoxy Adhesive for Pavement Markers.

Classification

This specification covers a high viscosity paste rapid set epoxy formulated primarily for use in bonding pavement markers to Portland cement concrete and asphalt concrete.

Composition

COMPONENT A

	Parts by Weight
Epoxy Resin[1]	90.00
Orthocresol Glycidyl Ether[2]	10.00
Titanium Dioxide, ASTM Designation: D476, Type III or IV	3.00
Talc[3]	50.00
Resin Grade Asbestos[4]	*3.00
Silicone Anti-Foam Type Q	0.01

COMPONENT B

High Functionality Polymercaptan Hardener[5]	60.00
2, 4, 6-Tri (Dimethylaminomethyl) Phenol[6]	7.00
Polysulfide Polymer[7]	35.00
Carbon Black[8]	0.10
Talc[3]	50.58
Resin Grade Asbestos[4]	*3.00
Silicone Anti-Foam Type Q	0.01

*A range of 2.70 to 3.30 is permitted if necessary to achieve proper viscosity and hear ratio.

[1]Di glycidyl ether of bisphenol A, viscosity, 100–160 poise at 25° Centigrade; epoxide equivalent 180–200, Color, Gardner 1933, 3 max.

[2]Viscosity at 25° Centigrade, 5–10 Centipoise, Weight per gallon 9.00–9.10 pounds. Epoxide equivalent 180–200.

[3]Percent passing U.S. No. 325 sieve, 99 minimum; Hegman Rating, 3–4; oil absorption (spatula), 32–35: reflectance (green filter), 92–94.

[4]Specific gravity, grams per ml., 2.45; moisture content, percent by weight, 2.0 maximum; surface area, square meters per gram, 60 approximately; reflectance, G.E. brightness, 72–76; nature of surface charge, electropositive (cationic); pH in water, 9.5; bulking value, gallons per 100 lbs., 4.8; oil absorption (DOP), pounds per 100 lbs., 120; refractive index Nd 25° Centigrade, 1.54–1.56; wet bulk density in water, after dispersion, 2 grams per liter, settling after 1 hr., 100 ml. clear maximum; dry bulk density, pounds per cubic foot, 4.

[5]Liquid polymercaptan resin, viscosity 100–130 poise at 25° Centigrade; specific gravity 1.14–1.16; mercaptan value, 3.6 meq/gram. Color, Gardner 1933, 1. Infrared curve shall match the curve on file in the Department of Highways.

[6]Formula weight 265; specific gravity at 25°/25° Centigrade, 0.973; refractive index 1.514 at 25° Centigrade; distillation range 96 percent at 130° Centigrade to 160° Centigrade (0.5–1.5 mm.); flash point. Tag Open Cup, 300° Fahrenheit minimum; water content 0.06 percent maximum.

[7]Specific gravity, 1.24–1.30 at 20°/20° Centigrade; viscosity, 700–1200 centipoise, Brookfield at 25° Centigrade; pH water extract 6.0–8.0; moisture content, 0.1 percent maximum; pour point —15° Fahrenheit; average molecular weight, 1000; flash point, degree Fahrenheit, Cleveland Open Cup, 390 minimum; sulfur content, percent 36–40; color, Hellige, 9–12. The product shall be difunctional mercaptan made from 98 mole percent of bis (2-chloroethyl) formal and 2 mole percent of trichloropropane.

[8]Surface area, square meters/gram, 115–130; particle diameter, millimicrons, 18–30; pH, 7.5–8.5; fixed carbon (moisture free), percent, 96–98; volatile matter, percent, 2–4; oil absorption, stiff paste endpoint, CCS/gram, 0.80–0.90.

Tests

All tests shall be performed in accordance with Test Method No. Nev. T500.

Characteristics of Components

Test	Requirements	
	Component A	Component B
Viscosity, Poise, TE Helepath, Spindle at 77° F.	1750 to 4000	1750 to 4000
Shear Ratio, Minimum at 77° F.	2.0	2.0
Density, lbs. per gallon at 77° F.	11.95 to 12.3	11.95 to 12.3
Skinning (original container)	None	Slight
Infrared Curves, Components A and B	Shall match curves in Test Method No. Nev. T500	
Storage Stability	The Components A and B shall not change in viscosity and shear ratio by more than ±15 percent when stored for 2 weeks in closed containers at 115° F., ±2° F. All measurements shall be made at 77° F. using the same spindle and apparatus as in Item I above.	
	The adhesive shall meet all other requirements for 12 months from date of manufacture. There shall be no settling of the fillers that cannot be easily redispersed with a paddle.	
Percent Air, maximum	2.0	2.0

Characteristics of Combined Components

	Requirements
Gel time, minutes	7 min.
Bond Strength to Concrete, Time, minutes (maximum) to reach not less than 200 p.s.i.—	
at 77° F., ±2° F.	35
at 50° F., ±2° F.	45
at 30° F., ±2° F.	85
Slant Shear Strength—	
24 hours at 77° F., ±2° F., p.s.i.	1000 min.
24 hours at 77° F., ±2° F., plus water soak, p.s.i.	800 min.
Tensile Adhesion and Cohesion—	
Class II polyester marker bottom, p.s.i.	475 min.
Class III and IV ceramic marker bottom, p.s.i.	700 min.
Class III and IV ceramic marker bottom, including post cure, p.s.i.	700 min.
Reflective pavement marker bottom, p.s.i.	500 min.
Color of Mixed Components	Approximately that of Color No. 26152 of Federal Standard No. 595.

Directions for Use

Just before use, components A and B shall be mixed in a one-to-one ratio by volume. When automatic proportioning and mixing machine is used, the temperature of the components shall be maintained by indirect heating or cooling, so that the adhesive will meter, mix and extrude properly. The maximum temperature shall be such that after proper mixing there shall be no excess flow of adhesive from under the marker.

728.03.05 Standard Set Epoxy Adhesive for Pavement Markers.

Classification

This specification covers a high viscosity paste standard set epoxy formulated primarily for use in bonding pavement markers to Portland cement concrete and asphalt concrete.

Composition

COMPONENT A

	Parts by Weight
Epoxy Resin[1]	100.0
Titanium Dioxide, ASTM Designation: D476, Type III or IV	7.31
Resin Grade Asbestos[2]	*5.00
Talc[3]	37.64

COMPONENT B

N-Aminoethyl Piperazine[4]	23.16
Nonylphenol[5]	52.00
Carbon Black[6]	0.22
Talc[3]	77.37
Resin Grade Asbestos[2]	†1.00

*A range of 4.50 to 5.50 is permitted if necessary to achieve proper viscosity and shear ratio.

†A range of 0.90 to 1.10 is permitted if necessary to achieve proper viscosity and shear ratio.

[1]Viscosity, 5–7 poises at 25° Centigrade; epoxide equivalent 175–195; Color (Gardner), 5 maximum; manufactured from epichlorohydrin and bisphenol A. The reactive diluent shall be butyl glycidyl ether.

[2]Specific gravity, grams per ml., 2.45; moisture content, percent by weight, 2.0 maximum; surface area, square meters per gram, 60 approximately; reflectance, G.E. brightness, 72–76; nature of surface charge, electropositive (cationic); pH in water, 9.5; bulking value, gallons per 100 lbs., 4.8; oil absorption (DOP), pounds per 100 lbs., 120; refractive index, Nd 25° Centigrade, 1.54–1.56; wet bulk density in water after dispersion, 2 grams per liter, settling after 1 hr., 100 ml. clear maximum; dry bulk density, pounds per cubic foot, 4.

[3]Percent passing U.S. No. 325 sieve, 94–96; maximum particle size, 70 micron; oil absorption (Gardner-Coleman), 6–7 ml. per 20 grams; fitness in oil (Hegman) 1–2; specific surface, 0.5–0.6 square meter per gram; consistency (40 percent suspension in linseed oil) 55–60 KU.

[4]Color (APHA) 50 maximum; amine value 1250–1350 based on titration which reacts with the 3 nitrogens in the molecule; appearance clear and substantially free of suspended matter.

[5]Color (APHA) 50 maximum; hydroxyl number 245–255; distillation range, degree Centigrade at 760 mm. first drop 285 minimum, 5 percent, 298 minimum, 95 percent, 325 maximum; water, percent (K.F.), 0.05 maximum.

[6]Surface area, square meters/gram, 115–130; particle diameter, millimicrons, 18–30; pH, 7.5–8.5; fixed carbon (moisture free), percent, 96–98; volatile matter, percent, 2–4; oil absorption, stiff paste endpoint, CCS/gram, 0.80–0.90.

Tests

All tests shall be performed in accordance with Test Method No. Nev. T500.

Characteristics of Components

Test	Requirements	
	Component A	Component B
Viscosity, Poise, TD Helipath spindle at 77° F.	1000 to 3000	1000 to 3000
Shear Ratio, Minimum at 77° F.	2.0	2.0
Density, lbs. per gallon at 77° F.	11.5 to 11.8	11.8 to 12.1
Skinning (original container)	None	None
Infrared Curves, Components A and B	Shall match curves in Test Method No. Nev. T500.	
Storage Stability	The Components A and B shall not change in viscosity and shear ratio by more than ±15 percent when stored for 2 weeks in closed containers at 115° F., ±3° F. All measurements shall be made at 77° F. using the same spindle and apparatus as in Item 1 above.	
	The adhesive shall meet all other requirements for 12 months from date of manufacture. There shall be no settling of the fillers that cannot be easily redispersed with a paddle.	
Percent Air, maximum	2.0	2.0

Characteristics of Combined Components

	Requirements
Gel time, minutes	8 to 13
Bond Strength to Concrete, Time (maximum) to reach not less than 200 p.s.i. at 77° F., ±2° F.	3.5 hours
Slant Shear Strength—	
24 hours at 77° F., ±2° F., p.s.i.	2200 min.
24 hours at 77° F., ±2° F., plus water soak, p.s.i.	1500 min.
Tensile Adhesion and Cohesion	
Class II polyester marker bottom, p.s.i.	475 min.
Class III and IV ceramic marker bottom, p.s.i.	700 min.
Class III and IV ceramic marker bottom, including post cure, p.s.i.	700 min.
Reflective pavement marker bottom, p.s.i.	500 min.
Color of Mixed Components	Approximately that of Color No. 26152 of Federal Standard No. 595.

Directions for Use

Just before use, components A and B shall be mixed in a one-to-one ratio by volume. When automatic proportioning and mixing machine is used, the temperature of the components shall be maintained by indirect heating or cooling, so that the adhesive will meter, mix and extrude properly. The maximum temperature shall be such that after proper mixing there shall be no excess flow of adhesive from under the marker.

728.03.06 Binder (adhesive), Epoxy Resin Base, Alkylbenzene Extended.

Classification

This specification covers a medium viscosity liquid alkylbenzene extended epoxy formulated primarily for use with aggregate as a gray seal and skid resistant surfacing for Portland cement concrete and for preparing low strength epoxy mortar and epoxy concrete. This epoxy is suitable for use in freeze-thaw environments.

Composition

COMPONENT A

	Parts by Weight
Epoxy Resin[1]	85.00
Orthocresol Glycidyl Ether[2]	15.00
Alkylbenzene[3]	11.12
Titanium Dioxide ASTM Designation: D476, Type III or IV	5.19
Colloidal Silica[4]	0.70
Dinonyl Phenol, distilled grade[5]	11.12
Silicone Anti-Foam Type Q	0.01

COMPONENT B

Alkylbenzene[3]	32.15
Colloidal Silica[4]	1.75
N-Aminoethylpiperazine[6]	23.47
Nonyl Phenol[7]	23.47
Dinonyl Phenol, distilled grade[5]	25.46
Carbon Black[8]	0.03
Silicone Anti-Foam Type Q	0.01

[1]Di glycidyl ether of bisphenol A, viscosity 100–160 poise at 25° Centigrade; epoxide equivalent 180–200, Color, Gardner 1933, 3 max.

[2]Viscosity at 25° Centgrade, 5–10 Centipoise, weight per gallon 9.00–9.10 pounds. Epoxide equivalent 180–200.

[3]This is a synthetic alkylbenzene in which the alkyl side chain is highly branched and contains, on the average, 13 carbon atoms. It shall have the following properties:

Weight per gallon in pounds at 77° F.	7.0–7.4
Flash, Cleveland Open Cup, degrees Fahrenheit	280 min.
Color (APHA)	25 max.
Viscosity at 100° F., centistokes (ASTM Designations: D88 and D446)	8.0–8.4
Bromine Number (grams bromine/100 grams oil)	0.03 max.
Sediment and water, vol., percent	Nil
Distillation, degrees Fahrenheit, ASTM Designation: D477:	
5 percent recovered	547–557
95 percent recovered	599–609

[4]SiO_2 (moisture-free basis), 99 percent minimum; refractive index, 1.46; surface area, 175–225 square meters per gram; particle size 0.015 microns; pH (4 percent aqueous dispersion), 3.5–4.2; pour density, 2.3 lbs./cu. ft. maximum; free moisture at 105° Centigrade, 1.0 percent maximum.

[5]Color, Gardner (ASTM Designation: D1544), 3 maximum; weight per gallon in pounds at 77° Fahrenheit, 7.5–7.7; hydroxyl number (acetylation), 145–165; refractive index at 25° Centigrade, nD=1.496–1.506; boiling range at 760 mm., 5–10 percent distilled over at 325° Centigrade by ASTM Designation: D1078.

[6]Color (APHA) 50 maximum; amine value 1250–1350 based on titration which reacts with the 3 nitrogens in the molecule; appearance clear and substantially free of suspended matter.

[7]Color (APHA) 50 maximum; hydroxyl number 241–255; distillation range, degrees Centigrade at 760 mm. first drop, 295 minimum, 5 percent, 297 minimum, 95 percent, 325 maximum; water, percent (K.F.), 0.05 maximum.

[8]Surface area, square meters/gram, 115–130; particle diameter, millimicrons, 18–30; pH, 7.5–8.5; fixed carbon (moisture free), percent, 96–98; volatile matter, percent, 2–4; oil absorption, stiff paste endpoint, CCS/gram, 0.80–0.90.

Tests

All tests shall be performed in accordance with Test Method No. Nev. T505.

Characteristics of Components

COMPONENT A

Weight per gallon, pounds at 77° F.	9.2 min.
Viscosity, poise, Brookfield	12–26
Epoxide equivalent	220–244

COMPONENT B

Weight per gallon, pounds at 77° F.	7.5 min.
Viscosity, poise, Brookfield	12–26
Amine value on vehicle	281–303
Shear Index	1.9 min.

Infrared curves of the vehicle components shall match those on file in the Department of Highways.

Characteristics of Combined Components

Gel Time, minutes	17–23
When cured for 7 days at 77° F. ± 3° F.:	
Bond Strength, p.s.i.	200 min.
Tensile Strength, p.s.i.	450 min.
Tensile Elongation, percent	60 min.
Shore D Hardness	40 min.
Color	Approximately that of Colors Nos. 36314 to 36492 of Federal Standard No. 595

Directions for Use

The mixing ratio is one (1) part by volume of Component A to one (1) part by volume of Component B. No more material shall be mixed than can be used within 10 minutes from the time mixing operations are started.

728.03.07 Binder (Adhesive), Epoxy Resin Base, Fast Setting.

Classification

This specification covers a medium viscosity liquid rapid set epoxy formulated primarily for use in making high-strength epoxy concrete and epoxy mortar where low curing temperatures are expected or when a fast cure is required. This epoxy is not formulated for use in bonding of new Portland cement concrete to old Portland cement

concrete. This epoxy is suitable for use in freeze-thaw environments.

Composition

COMPONENT A

	Parts by Weight
Epoxy Resin[1]	100
Alkylbenzene[2]	10
Nonyl Phenol[3]	9.3
Titanium Dioxide ASTM Designation: D476, Type III or IV	2.0
Silicone Anti-Foam Type Q	0.01

COMPONENT B

High Functionality Polymercaptan Hardener[4]	40.0
2, 4, 6-Tri (Dimethylaminomethyl) Phenol[5]	2.0
N-aminoethyl Piperazine[6]	16.6
Carbon Black[7]	0.03
Silicone Anti-Foam Type Q	0.01

[1]Di glycidyl ether of bisphenol A, viscosity, 100–160 poise at 25° Centigrade; epoxide equivalent 180–200. Color, Gardner 1933, 3 max. No reactive diluent shall be used.

[2]This is a synthetic alkylbenzene in which the alkyl side chain is highly branched and contains, on the average, 13 carbon atoms. It shall have the following properties:

Weight per gallon in pounds at 77° F	7.0–7.4
Flash, Cleveland Open Cup, degrees Fahrenheit	280 min.
Color (APHA)	25 max.
Viscosity at 100° F., centistokes (ASTM Designations: D88 and D446)	8.0–8.4
Bromine Number (grams bromine/100 grams oil)	0.03 max.
Sediment and water, vol., percent	Nil
Distillation, degree Fahrenheit, ASTM Designation: D477:	
5 percent recovered	547–557
95 percent recovered	599–609

[3]Color (APHA) 50 maximum; hydroxyl number 241–255; distillation range, degrees Centigrade at 760 mm. first drop, 295 minimum, 5 percent, 297 minimum, 95 percent, 325 maximum; water, percent (K.F.), 0.05 maximum.

[4]Liquid polymercaptan resin, viscosity 100–130 poise at 25° Centigrade; specific gravity 1.14–1.16; mercaptan value, 3.6 meq./gram. Color, Gardner 1933, 1. Infrared curve shall match the curve on file in the Department of Highways.

[5]Formula weight 265; specific gravity at 25°/25° Centigrade, 0.973; refractive index 1.514 at 25° Centigrade; distillation range 96 percent at 130° Centigrade to 160° Centigrade (0.5–1.5 mm.); flash point, Tag Open Cup, 300° Fahrenheit minimum; water content 0.06 percent maximum.

[6]Color (APHA) 50 maximum; amine value 1250–1350 based on titration which reacts with the 3 nitrogens in the molecule; appearance clean and substantially free of suspended matter.

[7]Surface area, square meters/gram, 115–130; particle diameter, millimicrons, 18–30; pH, 7.5–8.5; fixed carbon (moisture free), percent, 96–98; volatile matter, percent, 2–4; oil absorption, stiff paste endpoint, CCS/gram, 0.80–0.90.

Tests

All tests shall be performed in accordance with Test Method No. Nev. T507.

Characteristics of Adhesive

Viscosity:	
Component A, poise	25–45
Component B, poise	35–55
Gel Time, minutes	6–10
Compression Strength, p.s.i.	10,000 min.

Directions for Use

The mixing ratio is two (2) parts by volume of Component A to one (1) part by volume of Component B. Aggregate shall be added immediately after Components A and B are thoroughly mixed. The epoxy mortar or concrete shall be placed as soon as possible. The useful work life of the mortar will depend on temperature but will be about ten to fifteen (10–15) minutes at seventy-five (75) degrees Fahrenheit. All surfaces shall be primed with mixed epoxy.

728.03.08 Binder (Adhesive), Epoxy Resin Base, Fast Setting, Alkylbenzene Extended.

Classification

This specification covers a medium viscosity liquid rapid set alkylbenzene extended epoxy formulated primarily for use with aggregate as a gray seal and as a skid resistant surfacing for Portland cement concrete and for use in making low strength epoxy concrete and epoxy mortar where low curing temperatures are expected or when a fast cure is required. This epoxy is suitable for use in freeze-thaw environments.

Composition

COMPONENT A

	Parts by Weight
Epoxy Resin[1]	100.00
Nonyl Phenol[2]	19.70
Alkylbenzene[3]	19.70
Colloidal Silica[4]	1.50
TiO_2 ASTM Designation D476, Type III or IV	1.62
Silicone Anti-Foam Type Q	0.01

COMPONENT B

High Functionality Polymercaptan Hardener[5]	40.00
N-Aminoethylpiperazine[6]	17.00
2, 4, 6-Tri (Dimethylaminomethyl) Phenol[7]	2.00
Carbon Black[8]	0.03
Alkylbenzene[8]	34.52
Nonyl Phenol[2]	34.52
Colloidal Silica[4]	1.75
Silicone Anti-Foam Type Q	0.01

[1]Di glycidyl ether of bisphenol A, viscosity, 100–160 poise at 25° Centigrade; epoxide equivalent 180–200. Color, Gardner 1933, 3 max. No reactive diluent shall be used.

[2]Color (APHA) 50 maximum; hydroxyl number 241–255; distillation range, degrees Centigrade at 760 mm. first drop, 295 minimum, 5 percent, 297 minimum, 95 percent, 325 maximum; water, percent (K.F.), 0.05 maximum.

[3]This is a synethetic alkylbenzene in which the alkyl side chain is highly branched and containing, on the average, 13 carbon atoms. It shall have the following properties:

Weight per gallon in pounds at 77° F.	7.0–7.4
Flash, Cleveland Open Cup, degrees Fahrenheit	280 min.
Color (APHA)	25 max.
Viscosity at 100° F., centistokes (ASTM Designations: D88 and D446	8.0–8.4
Bromine Number (grams bromine/100 grams oil)	0.03 max.
Sediment and water, vol., percent	Nil
Distillation, degrees Fahrenheit, ASTM Designation: D447:	
5 percent recovered	547–557
95 percent recovered	599–609

[4]SiO_2 (moisture-free basis), 99 percent minimum; refractive index, 1.46; surface area, 175–225 square meters per gram; particle size 0.015 microns; pH (4 percent aqueous dispersion), 3.5–4.2; pour density, 2.3 lbs./cu. ft. maximum; free moisture at 105° Centigrade, 1.0 percent maximum.

[5]Liquid polymercaptan resin, viscosity 100–130 poise at 25° Centigrade; specific gravity 1.14–1.16; mercaptan value, 3.6 meq./gram. Color, Gardner 1933, 1. Infrared curve shall match the curve on file in the Department of Highways.

[6]Color (APHA) 50 maximum; amine value 1250–1350 based on titration which reacts with the 3 nitrogens in the molecule; appearance clear and substantially free of suspended matter.

[7]Formula weight 265; specific gravity at 25°/25° Centigrade, 0.973; refractive index 1.514 at 25° Centigrade; distillation range 96 percent at 130° Centigrade to 160° Centigrade (0.5–1.5 mm.); flash point, Tag Open Cup, 300° Fahrenheit minimum; water content 0.06 percent maximum.

[8]Surface area, square meters/gram, 115–130; particle diameter, millimicrons, 18–30; pH, 7.5–8.5; fixed carbon (moisture free), percent, 96–98; volatile matter, percent, 2–4; oil absorption, stiff paste endpoint, CCS/gram, 0.80–0.90.

Tests

All tests shall be performed in accordance with Test Method No. Nev. T501.

Characteristics of Components

Viscosity, Poise—TA Spindle at 77° F.—	
Component A	15–35
Component B	15–35
Shear Ratio—	
Component A	1.3 min.
Component B	1.5 min.

Characteristics of Combined Components

Gel Time	10–15 minutes
On ⅛" cast sheet, cured 18 hours at 77° F. + 5 hours at 158° F.—	
Tensile Strength, p.s.i.	700 min.
Elongation, percent	70 min.
Shore D Hardness	50 min.
Tensile Bond to Concrete— Minimum 200 p.s.i. using a 4–1 Ottawa Sand-Binder Mortar, ¼ inch thick bonded to a concrete block and cured 7 days at 77° F. Strength measured according to Test Method No. Nev. T447.	

Directions for Use

The mixing ratio is one (1) part by volume of Component A to one (1) part by volume of Component B. Do not mix more material than can be used within ten (10) minutes from the time mixing operations are started.

When applying resinous seal, the aggregate shall be sprinkled in the epoxy film not later than five (5) minutes after epoxy is applied to the road surface.

728.03.09 Epoxy Sealant for Inductive Loops.

Classification

This specification covers a high viscosity liquid epoxy formulated primarily for use in sealing inductive wire loops and leads imbedded in asphalt concrete and Portland cement concrete for traffic signal controls and vehicle counters. This epoxy is to be used for repair work on existing spalls, cracks and other deformations in and around saw cuts housing inductor loops and leads. The rapid cure allows minimum traffic delay. This sealant is suitable for use in freeze-thaw areas and can be used on grades up to fifteen (15) percent without excessive flow of material.

Composition

COMPONENT A

	Parts by Weight
Epoxy Resin[1]	85.00
Orthocresol Glycidyl Ether[2]	15.00
Titanium Dioxide, ASTM Designation: D476, Type III or IV	2.00
Colloidal Silica[3]	1.50
Glycerine, ASTM Designation: D1257	0.50
Silicone Anti-Foam, Type Q	0.01

COMPONENT B

	Parts by Weight
High Functionality Polymercaptan Hardener[4]	40.00
N-Aminoethyl Piperazine[5]	10.00
2, 4, 6-Tri (Dimethylaminomethyl) Phenol[6]	4.00
Polysulfide Polymer[7]	48.94
Colloidal Silica[8]	1.00
Glycerine, ASTM Designation: D1257	0.50
Carbon Black[8]	0.10
Silicone Anti-Foam, Type Q	0.01

[1]Di glycidyl ether of bisphenol A, viscosity, 100–160 poise at 25° Centigrade, epoxide equivalent 180–200. Color, Gardner 1933, 3 max.

[2]Viscosity at 25° Centigrade, 5–10 Centipoise, Weight per gallon 9.00–9.10 pounds. Epoxide equivalent 180–200.

[3]SiO_2 (moisture-free basis), 99 percent minimum; refractive index, 1.46; surface area 175–225 square meters per gram; particle size 0.015 microns; pH (4 percent aqueous dispersion), 3.5–4.2; pour density, 2.3 lbs./cu. ft. maximum; free moisture at 105° Centigrade, 1.0 percent maximum.

[4]Liquid polymercaptan resin, viscosity 100–130 poise at 25° Centigrade; specific gravity 1.14–1.16; mercaptan value, 3.6 meq./gram. Color, Gardner 1933, 1. Infrared curve shall match the curve on file in the Department of Highways.

[5]Color (APHA) 50 maximum; amine value 1250–1350 based on titration which reacts with the 3 nitrogens in the molecule; appearance clear and substantially free of suspended matter.

[6]Formula weight 265; specific gravity at 25°/25° Centigrade, 0.973; refractive index 1.514 at 25° Centigrade; distillation range 96 percent at 130° Centigrade to 160° Centigrade (0.5–1.5 mm.); flash point, Tag Open Cup, 300° Fahrenheit minimum; water content 0.06 percent maximum.

[7]Specific gravity, 1.24–1.30 at 20°/20° Centigrade; viscosity, 700–1200 centipoise, Brookfield at 25° Centigrade; pH water extract, 6.0–8.0; moisture content, 0.1 percent maximum; pour point, —15° Fahrenheit; average molecular weight, 1000; flash point, degrees Fahrenheit, Cleveland Open Cup, 390 minimum; sulfur content, percent, 36–40; color, Hellige, 9–12. The product shall be a difunctional mercaptan made from 98 mole percent of bis (2-chloroethyl) formal and 2 mole percent of trichloropropane.

[8]Surface area, square meters/gram, 80–150; particle diameter, millimicrons, 18–30; pH, 7.0–8.5; fixed carbon (moisture free), percent, 96–98; volatile matter, percent, 1–4; oil absorption, stiff paste endpoint, CCS/gram, 0.75–0.90.

Tests

All tests shall be performed in accordance with Test Method No. Nev. T501.

Characteristics of Components

COMPONENT A

Viscosity, poise, Brookfield	100–250
Shear Ratio	2.0 min.

COMPONENT B

Viscosity, poise, Brookfield	100–250
Shear Ratio	1.8 min.

Infrared curves of the vehicle components shall match those on file in the Department of Highways.

Characteristics of Combined Components

Gel Time	13–18 minutes
On ⅛" cast sheet, cured 18 hours at 77° F. +5 hours at 158° F.—	
Tensile Strength, p.s.i.	400 min.
Elongation, percent	90 min.
Shore D Hardness	45 min.

Color to range from Color No. 26081 to Color No. 26173 of Federal Standard No. 595.

Directions for Use

Saw cuts shall be blown clean and dry with compressed air to remove all excess moisture and debris. For repairing damaged saw cuts, all loose spalled material shall be cleaned away from saw cut, chipping back to sound asphalt concrete or Portland cement concrete and all loose material cleaned from loop wires.

The mixing ratio is one (1) part by volume of Component A to one (1) part by volume of Component B. No more material shall be mixed than can be used within ten (10) minutes from the time mixing operations are started.

When automatic mixing equipment is used for mixing the sealant, the provisions in the sixth paragraph in subsection 633.03.01, "Installation," shall apply.

INDEX OF SUBJECTS

A

INDEX

B

C

D

E

F

G

H

I

J

L

M

N

O

P

Q

R

S

T

U

V

W