F O R E W O R D

Publication of these Uniform Standard Specifications for Public Works Construction Off-Site Improvements, Clark County Area, Nevada, is the third edition of this important document and will supersede the 1986 edition.

This edition modified to fit local conditions and problems follows the format of the State of Nevada Department of Transportation Specifications for Road and Bridge Construction. It is felt this similarity of general makeup will be an aid to all those using both specifications.

Special provisions and drawings will be provided, when necessary, to supplement or modify these standard specifications.

The Uniform Standard Specifications for Public Works Construction may be revised by issuance of a revision or supplement to correct errors and omissions found in these specifications and to reflect advanced thinking and the changing technology of the construction industry. Each revision or supplement will supersede any previous supplement by inclusion of all pertinent portions. Upon approval by the RTC, revisions will become effective and be posted on the RTC web-site, www.rtcsouthernnevada.com, by the first day of the month of January and July.

To implement this end, a Specifications Subcommittee has been established as a permanent organization to continually study and recommend changes to the Uniform Standard Specifications. Interested parties may address suggested changed and questions to the Uniform Standard Specifications Subcommittee c/o Regional Transportation Commission of Southern Nevada, 600 Grand Central Parkway, Suite 350, Las Vegas, Nevada 89106-4512.

The following participating entities of the Clark County, Nevada area have adopted these specifications, as revised, by Resolution or Council or Board Action of the governing bodies as follows:

CLARK COUNTY
Adopted by Resolution ..... .July 20, 1993

CITY OF LAS VEGAS
Adopted by Resolution No. R32-93 .....June 16, 1993

CITY OF NORTH LAS VEGAS
Adopted by Resolution No. 1685 .....June 16, 1993

CITY OF HENDERSON
Adopted by Ordinance No. 549 ..... August 20, 1984
Revisions Adopted By Council Action (3rd Edition) .....June 15, 1993

CITY OF BOULDER CITY
Adopted by Resolution No. 2379 .....March 22, 1994

CITY OF MESQUITE
Adopted by Resolution No. 26 .....January 8, 1987
Revisions Adopted By Council Action (3rd Edition) .....June 10, 1993

REGIONAL TRANSPORTATION COMMISSION
Adopted by Resolution No. 7 .....June 14, 1984
Revisions Adopted By Commission Action ..... Various Dates

ACRONYMS

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:

AAN	American Association of Nurserymen
AAR	Association of American Railroads
AASHTO	American Association of State Highway & Transportation Officials
ACI	American Concrete Institute
AGC	Associated General Contractors of American
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 of Testing and Materials
AWG	American Wire Gage
AWPI	American Wood Preservers Institute
AWS	American Welding Society
AWWA	American Water Works Association
EIA	Electronic Industries Association
IEEE	Institute of Electrical and Electronics Engineers
IQAC	Interagency Quality Assurance Committee
MUTCD	Manual on Uniform Traffic Control Devices for Streets & Highways Published by the Federal Highway Administration
NEC	National Electrical Code
NEMA	Nation Electrical Manufactures Association
NOSHA	Nevada Occupational Safety and Hazard Act
QA	Quality Assurance
QC	Quality Control
SAE	Society of Automotive Engineers
UL	Underwriters Laboratories Incorporated
USASI	United States of America Standards Institute

SECTION 101

DEFINITIONS AND TERMS

101.01 BLANK

101.02 ADDENDUM

A. A supplemental addition or deletion to the contract documents prior to the advertised bid opening.

101.03 ADVERTISEMENT

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

101.04 ASSESSMENT ACT CONTRACT

A. A contract financed by special assessments authorized under, or implemented by, an act of the Legislature of the State or procedural ordinance of a City or the County.

101.05 AWARD

A. The acceptance by the Contracting Agency of a bid. Refer to Subsection 103.02.

101.06 BASE COURSE

A. The layer or layers of specified or selected material of designated thickness on a sub-base or a subgrade to support a surface course.

101.07 BIDDER

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

101.08 BOARD

A. The officer or body constituting the awarding authority for the Contracting Agency.

101.09 BRIDGE

A. 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 20 feet between under copings of abutments or extreme ends of openings for multiple boxes.

B. **Length:** The length of a bridge structure is the overall length measured along the line of survey stationing back to back of back walls 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.

C. **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.

101.10 CALENDAR DAY

A. Every day shown on the calendar.

101.11 CONTRACT CHANGE ORDER OR FIELD CHANGE ORDER

A. A written order issued by the Engineer or Contracting Agency as provided in the contract documents, 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.

101.12 CHANNEL

A. A natural or artificial water course.

101.13 CONTRACT

A. The written agreement between the Contracting Agency 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.

B. 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 addenda, 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.

101.14 CONTRACTING AGENCY

A. The party of the first part to a contract which may be any of the following entities: Boulder City, Nevada; City of Henderson, Nevada; City of Las Vegas, Nevada; City of North Las Vegas, Nevada; City of Mesquite, Nevada; Las Vegas Valley Water District, Las Vegas, Nevada; Clark County Water Reclamation District, Las Vegas, Nevada; Southern Nevada Water Authority, Las Vegas, Nevada; Clark County Regional Flood Control District, Las Vegas, Nevada; Regional Transportation Commission of Southern Nevada, Las Vegas, Nevada; and Clark County, Nevada.

101.15 CONTRACT ITEM (PAY ITEM)

A. 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 corresponds to the section of the same number. Thus, in Item No. 203.01, 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.

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

101.16 CONTRACTOR

A. The person, firm, partnership, corporation, permittee, subdivider, or other entity who has entered into a contract or agreement with the Contracting Agency. Where work is done under permit issued by the Contracting Agency, the permittee shall be construed to be the Contractor. Also, a subdivider who does land development and other work under contract with the Contracting Agency.

101.17 CONTRACT TIME

A. The number of days allowed for completion of the contract, including authorized time extensions.

101.18 CULVERT

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

101.19 DETOUR

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

101.20 DIVIDED HIGHWAY

A. A highway with separated roadways for traffic in opposite directions.

101.21 DRAWINGS

A. That part of the Contract Documents prepared or approved by the Contracting Agency which graphically shows the scope, intent, and character of the Work to be performed by the Contractor. Shop Drawings and other Contractor submittals are not Drawings as so defined.

101.22 EMPLOYEE

A. 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 received compensation from the Contractor or the Contractor's subcontractor.

101.23 ENGINEER

A. The Chief Engineer of the Contracting Agency or other person designated by the Board acting directly and through the Chief Engineer's duly authorized representative.

101.24 EQUIPMENT

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

101.25 EXTRA WORK

A. An item of work not provided for in the contract as awarded, but found essential by the Contracting Agency to the satisfactory completion of the contract within its intended scope.

101.26 FRONTAGE ROAD OR FRONTAGE STREET

A. 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.

101.27 GUARANTEE BOND

A. The approved form of security executed by the Contractor and the Contractor's surety or sureties guaranteeing the work against defect and failures.

101.28 HIGHWAY

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

101.29 HOLIDAYS

A. Any day established by law or agreed as a holiday for employees of the Contracting Agency.

101.30 HYDRAULIC CEMENT

A. An inorganic material or a mixture of inorganic materials that sets and hardens by chemical reaction with water by formation of hydrates, and is capable of doing so under water.

101.31 INSPECTOR

A. The Engineer's or Contracting Agency's authorized representative assigned to make detailed inspections of contract performance.

101.32 INTERAGENCY QUALITY ASSURANCE COMMITTEE (IQAC)

A. An ad hoc multi-jurisdictional and agency committee established for the purpose of simplifying the material approval process and promoting the consistent enforcement of the Uniform Standard Specifications and Drawings, Clark County Area, Nevada.

101.33 LABORATORY

A. The testing laboratory of the Contracting Agency or of any other testing laboratory which may be designated by the Engineer.

101.34 MAJOR CONTRACT ITEM

A. 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.

101.35 MATERIALS

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

101.36 MEDIAN

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

101.37 NOTICE TO BIDDERS

A. The official notice inviting bids for the proposed work or materials.

101.38 NOTICE TO PROCEED

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

101.39 PAVEMENT STRUCTURE

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

101.40 LABOR AND MATERIAL PAYMENT BOND

A. The approved form of security executed by the Contractor and the Contractor's surety or sureties to guarantee the payment of persons furnishing materials or persons performing labor under the contract.

101.41 PERFORMANCE BOND

A. The approved form of security executed by the Contractor and the Contractor's surety or sureties to guarantee the faithful performance of all work under said contract within the prescribed time limit and that materials and workmanship will be free from original or developed defects.

101.42 PLANS

A. The approved project plans and Standard Drawings, profiles, typical cross sections, 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.

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

1. Standard Drawings - The Standard Drawings of the Contracting Agency.
2. Project Drawings - The Project Drawings are specific details and dimensions peculiar to the work and are supplemented by the Standard Drawings insofar as the same may apply.

101.43 PROFILE GRADE

A. 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.

101.44 PROJECT

A. The specific improvement to be constructed together with all appurtenances and construction to be performed thereon at the prices quoted.

101.45 PROPOSAL

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

101.46 PROPOSAL FORM

A. The approved form on which the Contracting Agency requires bids to be prepared and submitted for the work.

101.47 PROPOSAL GUARANTEE

A. The security furnished with a bid to guarantee that the bidder will enter into the contract if bidder's bid is accepted.

101.48 QUALITY ASSURANCE (QA)

A. Planned and systematic operations conducted to ensure that the operations and/or product meets specifications. QA encompasses the Engineer's review and oversight of the Contractor's "Quality Control"; verifying the results of "Quality Control"; and inspecting for conformance to plans and specifications. QA is the responsibility of the "Engineer."

101.49 QUALITY CONTROL (QC)

A. Planned and specified operations necessary to construct items that will meet the requirements for quality and performance as specified. QC includes, but should not be limited to controlling the quality of raw materials, produced materials assemblies, components, finished product, and construction process. QC is the responsibility of the "Contractor."

101.50 RIGHT-OF-WAY OR EASEMENT

A. A general term denoting land, property, or interest therein, usually in a strip, acquired for or devoted to a highway or other improvements.

101.51 ROAD

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

101.52 ROADBED

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

101.53 ROADSIDE

A. 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.

101.54 ROADSIDE DEVELOPMENT

A. Those items necessary to the complete improvement which provides 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 improvements as may increase the effectiveness and enhance the appearance of the improvement.

101.55 ROADWAY

A. The portion of a highway within limits of construction.

101.56 SHOULDER

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

101.57 SIDEWALK

A. That portion of the roadway primarily constructed for the use of pedestrians.

101.58 SPECIAL PROVISIONS

A. Additions and revisions to the standard and supplemental specifications covering conditions peculiar to an individual project.

101.59 SPECIFICATIONS

A. 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.

101.60 STREET

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

101.61 SUBCONTRACTOR

A. Any individual, firm, or corporation to whom the Contractor, with the consent of the Contracting Agency, sublets any part of the contract.

101.62 SUBGRADE

A. The top of a roadbed upon which the base courses and/or the pavement structure and shoulders are constructed.

101.63 SUBSTRUCTURE

A. All of that part of the structure below the bearings of simple and continuous spans, skewbacks or arches, and tops of footings or rigid frames, together with backwall, wingwalls, and wing protection railings.

101.64 SUPERINTENDENT

A. 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.

101.65 SUPERSTRUCTURE

A. The entire structure except the substructure.

101.66 SUPPLEMENTAL AGREEMENT

A. A written agreement within the scope of the project made and entered into by and between the Contractor and the Contracting Agency 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.

101.67 SUPPLEMENTAL SPECIFICATIONS

A. Additions and revisions to the Standard Specifications that are approved subsequent to the issuance of the published specifications.

101.68 SURETY

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

101.69 SURFACE COURSE

A. The top layer of an improvement.

101.70 TRAFFIC LANE

A. The portion of a traveled way for the movement of a single line of vehicles.

101.71 TRAVELED WAY

A. That portion of roadway for the movement of vehicles, exclusive of shoulders and auxiliary lanes.

101.72 UTILITY

A. Tracks, overhead or underground wires, pipelines, conduits, ducts, or structures, sewers, or storm drains owned, operated, or maintained in or across a public right-of-way or private easement.

101.73 WORK

A. 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.

101.74 WORKING DAY

A. A 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 (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, 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.

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

101.75 WORKING DRAWINGS

A. 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. Working Drawings are not part of the Contract Documents.

B. 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 Contracting Agency."

SECTION 102

BIDDING REQUIREMENTS AND CONDITIONS

102.01 NOTICE TO CONTRACTORS

A. After the date is fixed for the bid opening for the work, the Contracting Agency will give notice 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 guarantee, and the reservation of the right of the Contracting Agency to reject any or all bids. A time, date, and place for a Pre-Bid Conference may be included in the Notice to Contractors.

102.02 PREQUALIFICATION OF BIDDERS

A. All prospective bidders for public works projects in Clark County are urged to prequalify with each local government at least on an annual basis. Applications for prequalification must be completed and submitted on forms and following instructions furnished by the respective local government. This will facilitate the awarding of contracts by giving local governments some basis to consider the financial responsibility, experience, adequacy of equipment and ability of each bidder to complete performance of public works contracts as required by Chapter 332 of the Nevada Revised Statutes (Local Government Purchasing Act). The director of public works or managing engineer of each local government considering such applications shall verify and evaluate the information contained therein and advise each applicant as to any prequalification or disqualification. Each prequalification shall indicate the type of work eligible to be bid and the maximum contract amount. Any applicant who is dissatisfied with such decision will have seven days from the receipt of such decision to submit a written request for a hearing thereon before the governing body of the respective local governmental entity and such entity must hold such hearing at their regularly scheduled meeting after the receipt of such written request.

B. This section shall not preclude any other licensed contractor from bidding on public works contracts in Clark County, however, the same forms and instructions for prequalification must, if required by the Contracting Agency, be completed and submitted with all such bids or such bids may be rejected at the sole discretion of the governing body of the respective local governmental entity. The governing body of the respective local governmental entity shall also have the discretion to determine whether sufficient time may be taken to verify and evaluate the bidder's qualifications before the contract must be awarded and if the bidder's qualifications can not be determined within such time to reject the respective bid.

C. Nothing contained in this section shall be construed as depriving any local government of its discretion in the matter of determining the lowest responsive and responsible bidder as set forth in NRS 332.065.

102.03 CONTENTS OF PROPOSAL FORMS

A. Upon request, the Contracting Agency shall 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 or lump sum bid prices are invited.

B. The proposal form will state the time in which the work must be completed, the amount of the proposal guarantee, 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.

C. All papers bound with or attached to the proposal form are considered a part thereof and must not be altered when the proposal is submitted.

D. 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.

E. The prospective bidder or interested non-bidder will be required to pay the Contracting Agency the sum stated in the advertisement and Notice to Contractors for each copy of proposal form and each set of plans.

F. Checks in payment for plans and specifications will be made payable to the Contracting Agency.

G. The Contracting Agency may invite the plan holders to a Pre-Bid Conference.

102.04 INTERPRETATION OF QUANTITIES IN THE PROPOSAL

A. 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 Contracting Agency does not, expressly or by implication, agree that the actual amount of work will correspond therewith, but reserves the right to make such alterations, deviations, additions to or omissions from the plans and specifications, including the right to increase or decrease the quantity of any item or portion of the work or to omit any item or portion of the work, as may be deemed by the Engineer to be necessary or advisable and to require such extra work as may be determined by the Engineer or Contracting Agency to be required for the proper completion or construction of the whole work contemplated.

B. Any such changes will be set forth in a contract change order which will specify, in addition to the work to be done in connection with the change made, adjustment of contract time, if any, and the basis of compensation for such work. A contract change order will not become effective until approved by the Contracting Agency.

102.05 EXAMINATION OF PLANS, SPECIFICATIONS, CONTRACT DOCUMENTS, AND SITE OF WORK

A. The Contracting Agency will prepare plans and specifications giving such directions as will enable a 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.

B. 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."

C. If the Contracting Agency acquires subsurface information for study and design, it may be obtained from the Contracting Agency upon written request as "Materials Information." While such data will have been collected with reasonable care, there is no expressed or implied guarantee that conditions so indicated are exact or entirely representative of those actually existing and the Contracting Agency will in no way be responsible for the accuracy therein contained. Information obtained as "Materials Information" is not a part of the contract.

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

E. When a log of test borings, showing a record of the data obtained by the Contracting Agency's investigation of subsurface conditions, is included with the contract plans, said record is the Contracting Agency's opinion of such borings and there is no expressed or implied guarantee that conditions so indicated are exact or entirely representative of those actually existing.

F. 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 design purposes only, and the Contracting Agency 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 guarantee of the same.

102.06 PREPARATION OF PROPOSAL

A. The bidder shall submit the proposal upon the forms furnished by the Contracting Agency. 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 and the bid total shall be computed from the prices given in words.

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

C. 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 Contracting Agency. If the proposal is made by an individual, the individual's 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 a 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

A. Proposals will be considered irregular and may be rejected for the following reasons:

1. If the proposal is on a form other than that furnished by the Contracting Agency, or if the form is altered or any part thereof is detached.
2. 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.
3. 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.
4. If the individual bid items or a prospective bidder's proposal are unbalanced in the sense that the listed price of any bid item departs by more than 20 percent from the Engineer's cost estimate for that item.
5. If the proposal does not contain a unit price for each pay item listed.

102.08 PROPOSAL GUARANTEE

A. No proposal will be considered unless accompanied by a proposal guarantee, in the amount equal to 5 percent of the Contractor's bid, made unconditionally payable to the Contracting Agency, which guarantee, 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 5 percent bid bond. No other guarantee will be acceptable. Such proposal guarantee is to be forfeited to the Contracting Agency should the bidder to whom the contract is awarded fail to enter into the contract within 15 days after notice of award.

102.09 DELIVERY OF PROPOSALS

A. Each proposal shall be submitted in an envelope. The envelope shall clearly indicate the contents and the name and address of the Contractor submitting the proposal. When sent by mail, the sealed proposal shall be addressed to the Contracting Agency 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. A bidder may withdraw or revise a proposal after it has been deposited with the Contracting Agency, provided the request for such withdrawal or revision is received by the Contracting Agency, 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

A. 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

A. Any of the following reasons may be considered as sufficient for the disqualification of a bidder and the rejection of bidder's proposal or proposals:

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

2. Evidence of collusion among bidders. Participants in such collusion will receive no recognition as bidders for any future work of the Contracting Agency until any such participants shall have been reinstated as a qualified bidder.
3. Unsatisfactory performance record as shown by past work for the Contracting Agency judged from the standpoint of workmanship and progress.
4. Uncompleted work which in the judgment of the Contracting Agency might hinder or prevent the prompt completion of additional work if awarded.
5. Failure to pay or satisfactorily settle all bills due for labor or material on former contracts in force at the time of letting.
6. 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.
7. Failure to comply with any qualification regulations of the Contracting Agency.
8. Any or all bids received in response to a request for bids may be rejected by the governing body or its authorized representative if such governing body or its authorized representative determines that any such bidder is not responsive or responsible or that the quality of the services, supplies, materials, equipment, or labor offered does not conform to requirements or if the public interest would be served by such a rejection.
9. Failure to list all subcontractors who will be employed by the bidder.
10. Omission of bid bond.

102.13 MATERIAL GUARANTEE

A. 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.

SECTION 103

AWARD AND EXECUTION OF CONTRACT

103.01 CONSIDERATION OF PROPOSALS

A. Proposals will be opened and read publicly at the time and place indicated in the Advertisement for Bids. Bidders, their authorized agents and other interested parties are invited to be present.

B. The total sum read shall be subject to the provisions of determination of the lowest proposal requirements.

C. No responsibility will attach to the Owner or any official or employee thereof for the pre-opening of, post-opening of, or the failure to open, a proposal not properly addressed and identified.

D. The lowest proposal shall be the lowest total sum for which the entire work will be performed, including all items as specified on the proposal form. The lowest proposal shall be determined on the basis of the exact lowest total sum for which the entire work will be performed, arrived at by a correct computation by the Contracting Agency of all items specified in the proposal based on the unit prices contained therein. In the event of a discrepancy between written prices and numerical unit prices, the written unit prices shall govern. The Contracting Agency reserves the right to reject any proposal that omits prices for any unit price bid item on the proposal form.

E. 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 interest of the Contracting Agency will be promoted thereby.

103.02 AWARD OF CONTRACT

A. The award of the contract, if awarded, will be to the lowest responsible bidder whose proposal complies with all the requirements prescribed. The award, if made, will be made within 45 calendar days after the opening of the proposals or as otherwise provided for. The successful bidder will be notified by letter, mailed to the address shown on the bidder's proposal, that the bidder's proposal has been accepted and that the bidder has been awarded the contract.

B. Bidders submitting a proposal to a public body for a public work shall bear the responsibility to ascertain the relevancy of the “preference for certain contractors and other matters relating thereto” as provided by Nevada Revised Statute 338.147, as amended by Chapter 713 of the 1991 Nevada Legislative Session, as it relates to a Nevada Public Body awarding a contract for a public work.

C. The date of the award of the contract shall be the date of the “Notice to Award.”

D. Five sets of the contract plans and drawings will be provided to the successful bidder without charge.

103.03 CANCELLATION OF AWARD

A. The Contracting Agency 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 Contracting Agency.

103.04 RETURN OF PROPOSAL GUARANTEE

A. All proposal guarantees, shall be retained until the award of the contract. The retained proposal guarantee of the unsuccessful bidders will be returned within 10 days following the award of the contract and that of the successful bidder will be returned after the required bonds have been furnished and the contract has been executed.

103.05 REQUIREMENTS OF CONTRACT BONDS

A. Prior to the execution of the contract by the Contracting Agency, the Contractor shall file with the Contracting Agency surety bonds in the amounts and for the purposes noted below, duly executed by a responsible corporate surety authorized to issue such bonds in the state of Nevada and secured through an authorized agent satisfactory to the Contracting Agency. The Contractor shall pay all premiums and costs thereof and incidental thereto.

B. Each bond must be signed by both the Contractor and surety and the Contractor shall give surety bonds with good and sufficient sureties; in the sum of not less than 100 percent of the contract price or as specified in the Special Provisions: First to ensure the claims of material men supplying materials to the Contractor, and of mechanics and laborers employed by the Contractor on the work required under these specifications; second to ensure the faithful performance of the contract; and third to guarantee the work.

1. The **"Labor and Material Bond"** shall be so conditioned as to ensure the benefit of persons furnishing materials to the Contractor and/or performing labor under the contract. This bond shall be maintained by the Contractor in full force and effect until the work is completed and accepted by the Contracting Agency and until all claims for materials and labor are paid.

2. The **"Performance Bond"** shall be so conditioned as to ensure the faithful performance by the Contractor of all work under said contract within the time limit prescribed in a manner that is satisfactory and acceptable to the Contracting Agency; and that all materials and workmanship supplied by the Contractor will be free from original or developed defects.

3. The **"Guarantee Bond"** shall be so conditioned that should original or developed defects or failures appear within a period of one year from the date of acceptance of the work by the Contracting Agency, the Contractor shall, at no additional cost to Contracting Agency, make good such defects and failures and make all replacements and adjustments required, within a reasonable time after being notified by the Contracting Agency to do so, and to the approval of the Engineer. This bond shall be maintained by the Contractor in full force and effect for a period as specified after the date of acceptance of the work by the Contracting Agency. This guarantee bond shall not limit the Contracting Agency's rights with respect to latent defects, gross mistakes, or fraud.

C. Should any surety become insufficient, the Contractor shall renew the bond or bonds within 10 days after receiving notice from the Contracting Agency that the surety is insufficient.

D. Should any surety be deemed unsatisfactory at any time by the Contracting Agency, notice will be given the Contractor to that effect, and the Contractor shall forthwith substitute a new surety satisfactory to the Contracting Agency. No further payment shall be deemed due or will be made under the contract until the new surety shall qualify and be accepted by the Contracting Agency.

103.06 EXECUTION AND APPROVAL OF CONTRACT

A. The contract shall be signed by the successful bidder and returned, together with the contract bonds, within 15 calendar days after the contract has been mailed to the bidder. If the contract is not executed by the Contracting Agency within 45 calendar days or as otherwise provided for following receipt from the bidder of the signed contract and bond, the bidder shall have the right to withdraw the bid without penalty. No contract shall be considered as effective until it has been fully executed by all parties thereto.

103.07 FAILURE TO EXECUTE CONTRACT

A. Failure to properly sign the contract and file acceptable bonds shall be just cause for the annulment of the award and the forfeiture of the proposal guarantee which shall become the property of the Contracting Agency, not as a penalty, but as liquidation of damages sustained. Award may then be made to the next lowest responsible bidder as provided in Subsection 103.02, “Award of Contract,” or the work may be readvertised and constructed under contract or otherwise, as the Contracting Agency may decide.

SECTION 104

SCOPE OF THE WORK

104.01 INTENT OF THE CONTRACT

A. 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, material, 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

A. The Contracting Agency reserves the right to make by written order and without notice to surety, such alterations in the plans and specifications 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.

B. Whenever an alteration in character of work on the project 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 plans and specifications and as directed, provided however, that before such work is started, a supplemental agreement acceptable to both parties to the contract shall be executed.

C. 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.

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

E. Whenever the termini of the project are changed or 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 25 percent, a supplemental agreement acceptable to both parties to the contract shall be executed in advance of performing the affected work.

F. Whenever an overrun or underrun of more than 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.

G. 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 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.

H. If a supplemental agreement satisfactory to both parties cannot be agreed upon, the Contracting Agency may order the work in dispute to be performed and the controversy shall be settled as provided in Subsection 105.17, "Claims for Adjustment and Disputes."

I. 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 Contractor's 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 and accepted by the Contractor.

J. In case the Contractor refuses to accept a change order, the Contracting Agency may order the work to proceed while proceeding as expeditiously as possible with settlement of the disputed points.

104.03 EXTRA WORK

A. 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

A. While undergoing improvements, all roads upon or within which any work is being done shall be kept open to all traffic by the Contractor unless otherwise provided for in the contract documents. If the useable 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 be as set forth in writing by the Engineer.

B. 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 Subsection 624.03.02, "Flaggers," 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. The Contractor shall bear all expense of maintaining all roads upon or within which any work is being done 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 1. below:

1. The Contractor shall be responsible for the maintenance of the roadway during suspension of the work when such suspension is due to the Contractor's negligence. Attention is directed to Subsection 108.06, "Temporary Suspension of 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 ordered by the Engineer for the temporary accommodation of traffic during the anticipated period of suspension. Thereafter, and until 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

Contracting Agency. Contractor's 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 from Maintenance and Responsibility." It is herewith expressed that the Contracting Agency 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.

C. 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 Contracting Agency. Consideration will be given to each such proposal and may be rejected, modified, or accepted as is deemed best by the Contracting Agency. The Contractor will not proceed with any such change in the staging until permission is granted by the Contracting Agency in writing.

D. When detours, temporary connections, crossovers, connection roads, and frontage roads are constructed by the item "Equipment Hours," such items 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, unless otherwise ordered by the Engineer. Attention is directed to Section 624, "Accommodations for Public Traffic."

E. When a detour is requested by the Contractor, the Contractor 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 Contracting Agency, and to the Contractor, the Engineer will designate that road as a detour, subject to the following conditions:

1. The Contractor shall provide and maintain the necessary route marking signs.
2. The Contractor shall construct and maintain in good condition such a detour. If the Contractor fails to maintain the detour in a condition satisfactory to the Engineer, the Contracting Agency will make such repairs as is deemed suitable and will deduct the cost thereof from money due or to become due to the Contractor.
3. Provisions for handling traffic will be subject to the conditions of Subsection 624.03.02, "Flaggers," and 624.03.03, "Pilot Cars."
4. 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 to the satisfaction of the Engineer.
5. 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

A. 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. At no additional cost to the Contracting Agency, the Contractor shall replace 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 project location which is not within the grading limits, as indicated by the slope and grade lines, without written authorization from the Engineer.

B. 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.

SECTION 105

CONTROL OF THE WORK

105.01 AUTHORITY OF THE ENGINEER

A. The Engineer will decide all questions that may arise as to the quality and acceptability of materials furnished and work performed and as to the rate of progress of the work; and all questions that may arise as to the interpretation of the plans and specifications.

B. 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 comply with the technical provisions of the contract; for failure to carry out orders; for such periods as the Engineer may deem necessary due to unsuitable weather; and for conditions considered unsuitable for the prosecution of the work.

C. Whenever the Contractor fails to carry out orders of the Engineer, the Engineer will have executive authority to enforce such orders and the Engineer's decision shall 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.

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

105.02 PLANS AND WORKING DRAWINGS

A. The contract plans and drawings do not purport to show all the details of the work. These documents are intended to illustrate the character and extent of the performance desired under the contract; therefore, they may be supplemented or revised from time to time, as the work progresses, by the Engineer or (subject to approval of the Engineer) by the Contractor. The Contractor will keep one set of plans available on the work at all times.

B. The plans may be supplemented by such working drawings as are necessary to adequately control the work. Working drawings for structures shall be furnished by the Contractor. Working Drawings 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 shall be submitted in triplicate 10 days prior to start of related work and approved by the Engineer. Such approval shall not relieve the Contractor of any of the Contractor's 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 the Contractor's working drawings with the approved plans and specifications.

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

105.03 CONFORMITY WITH PLANS AND SPECIFICATIONS

A. Work performed and materials furnished shall be in conformity with the lines, grades, cross sections, dimensions, and materials requirements, including tolerances, shown on the plans or indicated in the specifications.

B. In the event the Engineer finds the materials or the finished product in which the materials are used not in conformity with the plans and specifications, but that acceptable work has been produced, the Engineer 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 concurred in by the Contracting Agency which will provide for an appropriate adjustment in the contract price for such work or materials as the Engineer deems necessary to conform to the Engineer's determination based on engineering judgment.

C. 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 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 the Contractor at no additional cost to the Contracting Agency.

105.04 COORDINATION OF PLANS, SPECIFICATIONS, SUPPLEMENTAL SPECIFICATIONS, AND SPECIAL PROVISIONS

A. 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. These documents are intended to be complementary and to describe and provide for a complete work. In case of discrepancy, the following precedence will govern:

1. Permits from other agencies as may be required by law.
2. Special Provisions.
3. Plans.
4. Uniform Standard Drawings.
5. Uniform Standard Specifications.
6. Reference Specifications.

B. Change orders, supplemental agreements, and approved revisions to plans and specifications will take precedence over Items 2, 3, 4, 5, and 6 listed above. Detailed plans shall have precedence over general plans.

C. 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, the Contractor 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

A. The Contractor will be supplied with a minimum of 4 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 Contracting Agency.

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

C. The Contractor shall maintain a telephone for the duration of the contract, at no additional cost to the Contracting Agency, where the Contractor or the Contractor's authorized representative may be reached directly or by message at all times.

D. The prime Contractor shall have on the work at all times, as the Contractor's 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 the Engineer's 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 superintendent shall be furnished irrespective of the amount of work sublet.

E. Whenever the Contractor or the Contractor's 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 the Contractor's designated representative.

F. 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

A. The Permittee, in the case of private contract, and the Contracting Agency, in the case of cash contract or Special Improvement District contract, will search known substructure records which describe the location of utility substructures, and will indicate on the plans for the project those substructures, except for service connections, which may affect the work. Information regarding removal, relocation, abandonment, or installation of new utilities will be furnished to prospective bidders.

B. Where underground main distribution conduits such as water, gas, sewer, electric power, telephone, or cable television are shown on the plans, the Contractor, for the purpose of preparing the Contractor's bid, shall assume that every property parcel will be served by a service connection for each type of utility.

C. At least 2 working days before entering on the work, the Contractor shall notify all the utility owners to mark or otherwise indicate the approximate location of their subsurface facilities including, but not limited to, structures, main conduits, and service connections. This requirement will not apply to sewer and storm drain installations where their location and depth are shown on the plans for the project.

D. It shall be the Contractor's responsibility to determine the location and depth of all utilities, including service connections, for which approximate locations have been marked by the respective owners and which the Contractor believes may affect or be affected by the Contractor's operations. If no pay item is provided in the contract for this work, full compensation for such work shall be considered as included in the prices bid for other items of work.

E. The Contractor shall not interrupt the service function or disturb the supporting base of any utility without authority from the owner or an order from the Contracting Agency.

F. Where protection is required to ensure support of utilities, the Contractor shall, unless otherwise provided, furnish and place the necessary protection at no additional cost to the Contracting Agency.

G. Upon learning of the existence and location of any utility omitted from or shown incorrectly on the plans, or not properly marked, the Contractor shall immediately notify the Engineer in writing. When authorized by the Engineer, support or protection of the utility will be paid for as provided in Subsection 104.03, "Extra Work."

H. The Contractor shall immediately notify the Engineer and the utility owner if the Contractor disturbs or damages any utility. The Contractor shall bear the costs of repair or replacement of any utility damaged if properly located as provided.

I. When placing concrete around or contiguous to any utility installation, the Contractor, at no additional cost to the Contracting Agency, shall (1) furnish and install a 2-inch cushion of expansion joint material or other similar resilient material; or (2) provide a sleeve or other opening which will result in a 2-inch minimum clear annular space between the concrete and the utility; or (3) provide other acceptable means to prevent embedment in or bonding to the concrete. The standards of the affected utility company shall prevail. Where concrete is used for backfill or for structures which would result in embedment, or partial embedment, of a metallic utility installation, or where the coating, bedding, or other cathodic protection system is exposed or damaged by the Contractor's operations, or as may be required by the work, the Contractor shall notify the Engineer and arrange to secure the advice of the affected utility owner regarding the procedures required to maintain or restore the integrity of the system.

J. Unless otherwise specified, the Contractor shall remove all interfering portions of utilities shown on the plans or indicated in the bid documents as "abandoned" or "to be abandoned in place." Before starting removal operations, the Contractor shall ascertain from the Contracting Agency whether the abandonment is complete, and the costs involved in the removal and disposal shall be absorbed in the bid for the items of work necessitating such removals.

K. When feasible, the owners responsible for utilities within the area affected by the work shall complete their necessary installations, relocations, repairs or replacements before commencement of work by the Contractor. When the Special Provisions or plans indicate that a utility installation is to be relocated, altered, or constructed by others, the Contracting Agency will conduct all negotiations with the owners and the work will be done at no cost to the Contractor, except as provided in Subsection 107.17, "Contractor's Responsibility for Utility Property and Service." Utilities that are relocated in order to avoid interference with the proposed permanent work shall be protected in their relocated position and the cost of such protection shall be absorbed in the various items of the contract.

L. A utility company installing a new line is responsible for relocation of other utility company facilities if the new line conflicts with existing locations.

M. When the plans or specifications provide for the Contractor to alter, relocate, or reconstruct a utility, all costs for such work shall be included in the bid for the items of work necessitating such work. Temporary or permanent relocation or alteration of utilities requested by the Contractor for the Contractor's own convenience shall be the Contractor's responsibility, and the Contractor shall make all arrangements and bear all costs.

N. The utility owner will relocate service connections as necessary within the limits of the work or within temporary construction or slope easement unless otherwise specified. When directed by the Engineer, the Contractor shall arrange for the relocation of service connections as necessary between the meter and property line, or between a meter and the limits of temporary construction or slope easements. The relocation of such service connections will be paid for in accordance with provisions of Subsection 104.03, "Extra

Work." Payment will include the restoration of all existing improvements which may be affected thereby. The Contractor may, for the Contractor's own convenience or to expedite the work, agree with the owner of any utility to disconnect and reconnect interfering service connections. The Contracting Agency will not be involved in any such agreement.

O. The Contractor shall notify the Contracting Agency of the Contractor's construction schedule insofar as it affects the protection, removal, or relocation of utilities. This notification shall be in writing and shall be included as a part of the construction schedule required by Subsection 108.03, "Prosecution and Progress." The Contractor shall notify the Contracting Agency in writing of any subsequent changes in the Contractor's construction schedule which will affect the time available for protection, removal, or relocation of utilities.

P. The Contractor will not be entitled to damages or additional payment for delays attributable to utility relocations or alterations if correctly located, noted, and completed. The Contractor may be given an extension of time for unforeseen delays attributable to utility relocations or alterations not shown or incorrectly shown on the plans, or for unreasonably protracted interference by utilities in performing work correctly shown on the plans. If the Contractor sustains loss due to delays attributable to interferences, relocations, or alterations which could not have been avoided by the judicious handling of forces, equipment, or plant, there shall be paid to the Contractor such amount as the Contracting Agency may find to be fair and reasonable compensation for such part of the Contractor's actual loss as was unavoidable as provided in Subsection 108.12, "Right-of-Way Delays."

Q. When necessary, the Contractor shall so conduct the Contractor's operations as to permit access to the work site and provide time for utility work to be accomplished during the progress of the contract work.

105.07 COOPERATION BETWEEN CONTRACTORS

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

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

C. Each Contractor involved shall assume all liability, financial or otherwise, in connection with Contractor's contract and shall protect and save harmless the Contracting Agency from any and all damages or claims that may arise because of inconvenience, delay, or loss experienced by Contractor because of the presence and operations of other Contractors working within the limits of the same project.

D. The Contractor shall arrange Contractor's 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. Contractor shall join Contractor's work with that of the others in an acceptable manner and shall perform the work in proper sequence to that of the others.

105.08 CONSTRUCTION STAKES, LINES AND GRADES

A. The Contractor shall notify the Engineer at least 7 days before starting work in order that the Engineer may take necessary measures to ensure the preservation of survey monuments and bench marks. The Contractor shall not disturb permanent survey monuments or bench marks without the consent of the Engineer, and shall bear the

expense of replacing any that may be disturbed without permission. Replacement shall be done only by the Engineer.

B. When a change is made in the finished elevation of the pavement of any roadway in which a permanent survey monument is located, the Contractor shall adjust the monument cover to the new grade unless otherwise specified.

C. The Contractor shall preserve property line and corner survey markers except where their destruction is unavoidable, and the Contractor is proceeding in accordance with accepted practice. Markers that otherwise are lost or disturbed by Contractor's operations shall be replaced at the Contractor's expense by a Registered Land Surveyor.

D. Except for private contracts, the Engineer will perform and be responsible for the accuracy of surveying adequate for construction. The Contractor shall be responsible for preserving construction survey stakes and marks for the duration of their usefulness. If any construction survey stakes are lost or disturbed and need to be replaced, such replacement shall be by the Engineer at the expense of the Contractor.

E. The Contractor shall notify the Engineer at least 2 working days before Contractor will require survey services in connection with the laying out of any portion of the work. The Contractor shall dig all holes necessary for line and grade stakes.

F. The Engineer will furnish and set construction stakes establishing lines and grades for street excavation, finished base gravel, curb and gutter, walks, structures, and utilities, and will furnish the Contractor all the necessary information relating to the lines and grades. These stakes and marks shall constitute the field control by and in accordance with which the Contractor shall govern and execute the work.

G. The line and grade stakes will be offset from the construction area. The stakes will show the offset distance, stationing, and required cut or fill to the finished grade or flow line as indicated on the plans. Grade stakes shall be set by the Engineer to the finished grade of the subgrade and also of the base gravel and the tops of these stakes marked blue or red. All stakes and grade shall be set with a surveyor's level or transit.

H. The Contractor shall construct the work in accordance with the Engineer's stakes and marks, making use of them before they are disturbed, and shall be charged with full responsibility for conformity and agreement of the work with such stakes and marks. The Contractor shall be held responsible for the preservation of all stakes and marks, and if, in the opinion of the Engineer, any of the stakes or marks have been carelessly or willfully destroyed or disturbed by the Contractor, the cost of replacing them shall be charged against, and deducted from, the payment for the work.

I. Surveying by private engineers on work under the control of the Contracting Agency shall conform to the quality and practice required by the Engineer.

J. Work upon completion shall conform to the lines, elevations, and grades shown on the plans, or as ordered by the Engineer.

K. Three consecutive points set on the same slope shall be used together so that any variation from a straight grade can be detected. Any such variation shall be reported to the Engineer. In the absence of such report, the Contractor shall be responsible for any error in the grade of the finished work.

L. Grades for underground conduits will be set at the surface of the ground. The Contractor shall transfer them to the bottom of the trench.

105.09 BLANK

105.10 DUTIES OF THE INSPECTOR

A. Inspectors for the Contracting Agency 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 issue instructions contrary to the plans and specifications, or to act in any capacity for the Contractor.

105.11 INSPECTION

A. 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.

B. Any work done or materials used without inspection by an authorized Contracting Agency representative may be ordered removed unless the material meets the specifications and shall be replaced at no additional cost to the Contracting Agency unless the Contracting Agency representative failed to inspect after having been given notice in writing that the work was to be performed. If the noninspected work or material proves acceptable the work or material may remain, but any expenses entailed in a late inspection shall be the Contractor's.

C. 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 replacing 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 no additional cost to the Contracting Agency.

D. 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

A. 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."

B. 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.

C. 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 no additional cost to the Contracting Agency.

D. 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 Contracting Agency will have authority to cause unacceptable work to be remedied or removed or replaced and unauthorized work to be removed and to withhold the costs from any money due or to become due to the Contractor.

105.13 LOAD AND SPEED RESTRICTIONS

A. The Contractor shall be responsible for all damage to the work caused by Contractor's hauling equipment.

B. In hauling material for incorporation in portions of the project, loads which are in excess of the limits set by the Contracting Agency 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 Contracting Agency 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, "Traffic Laws," of the Nevada Revised Statutes and all acts amendatory thereto or supplementary thereto.

C. 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:

1. Concrete in any such structure shall have attained designed strength as shown on the structure plans.
2. The gross load of the vehicle shall not exceed 108,000 pounds.
3. Gross load on any individual axle shall not exceed 48,000 pounds.
4. The gross load on any individual set of tandem axles spaced not more than 6 feet apart shall not exceed 72,000 pounds.
5. The center to center spacing of individual axles or center to center spacing of pairs of tandem axles shall not be less than 14 feet.
6. No more than one lane of vehicles shall operate over any structure.
7. The speed of any vehicle approaching or traveling on any structure shall not exceed 10 mph.
8. The roadway surface approaching any structure shall be kept smooth and uniformly graded for 150 feet each side of the structure and shall be maintained to provide a uniform transition onto the structure.
9. A cover of 6 inches $\pm$ 1 inch shall be placed and maintained on the decks of all structures. Cover material shall not include rocks of diameter greater than 2 inches.

D. The limitations specified in items 2, 3, 4, 5, 6, 7, 8, and 9 above 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 center line of roadway. Fill may be placed not to exceed profile grade elevation.

E. Construction loads greater than legal loads may be carried over structures within the project which have spans of 10 feet to 20 feet only when the Contractor complies with the above Subparagraph C, numbers 3 through 9, inclusive; however, the limitations as set forth in Subparagraph C, numbers 3 through 5, inclusive, may be waived by the Engineer for reinforced concrete box structures which are adequately supported by shoring. The Contractor shall submit Contractor's 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.

F. The Engineer shall make sufficient checks to satisfy Engineer 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.

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

H. 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

A. 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.

B. 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.

C. 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

A. 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 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.

B. If a condition develops that is dangerous to public safety in the opinion of the Engineer, such condition may be immediately remedied with whatever means is available and the cost of this maintenance will be deducted from money due or to become due to the Contractor.

105.16 FINAL ACCEPTANCE

A. Upon due notice from the Contractor of 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 are found completed to Engineer's satisfaction, that inspection shall constitute the final inspection and the Engineer will so advise the governing body or commission, who will notify the Contractor in writing of the acceptance of the contract as of the date of the final inspection. Such notice will not be given to the board or commission until all work has been completed to the satisfaction of the Engineer.

105.17 CLAIMS FOR ADJUSTMENT AND DISPUTES

A. If, in any case, the Contractor deems that additional compensation is due Contractor 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 Contractor's intention to make claim for such additional compensation before Contractor begins the work on which Contractor 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."

B. For all claims, the Contractor shall certify in writing that the claim is made in good faith, that the supporting data are accurate and complete to the best of Contractor’s knowledge and belief, and that the amount requested accurately reflects the Contract adjustment for which the Contractor believes the Contracting Agency is liable. Subcontractor claims shall not be considered except as submitted by the Contractor as the Contractor’s claims.

C. Any controversy or claim arising out of or relating to this contract which cannot be resolved by mutual agreement shall be settled by arbitration in accordance with the Rules of the American Arbitration Association.

SECTION 106

CONTROL OF MATERIALS

106.01 SOURCE OF SUPPLY AND QUALITY REQUIREMENTS

A. 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 Contracting Agency as specified in Subsection 106.11, "Contracting Agency Furnished Materials."

B. No materials or supplies under this contract shall be purchased by the Contractor or by any subcontractor subject to any chattel mortgage, conditional sale contract or other security interest, or other agreement by which an interest is retained by the seller. The Contractor warrants that Contractor has good title to all materials and supplies used by the Contractor in the work, free from all liens, claims, or encumbrances.

C. Only materials conforming to the requirements of the specifications shall be incorporated in the work except as provided in Subsection 105.03, “Conformity With Plans and Specifications.”

D. 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.

E. The Contractor shall furnish the Engineer a list of the Contractor's sources of materials. The list shall be submitted to the Engineer prior to any official "Notice to Proceed" and in sufficient time to permit proper inspecting and testing of materials to be furnished from such listed sources in advance of their use.

F. The listings of materials that are posted on the Interagency Quality Assurance Committee (IQAC) web page are automatically considered a qualified source. However, this does not remove the responsibility of the Contractor to provide inspection and testing on the project as specified herein. The address for the IQAC webpage is:

http://www.accessclarkcounty.com/depts/public_works/pages/iqac.aspx

G. 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, which includes IQAC listed materials, the Contractor shall furnish satisfactory materials from other sources.

H. The Contractor shall furnish without charge such samples as may be required by the Engineer. The primary inspection and testing shall be made by the Contractor or the Contractor's designated representative, with Engineer oversight. However, 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 materials nor of continued acceptance of material presumed to be similar to that upon which inspections and tests have been made.

I. Manufacturer's 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 completed contract.

J. Contractor's reports and records of inspections made and tests performed shall be submitted to the Engineer as required in these specifications. The Engineer's inspection

and testing records, when available at the site of the work, may be examined by the Contractor.

106.02 LOCAL MATERIALS

A. Local material is defined as 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.

B. 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.

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

D. The furnishing of local materials from any source is subject to the provisions of Subsection 102.05, "Examination of Plans, Specifications, Contract Documents, and Site of Work," and Subsection 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 street or highway, unless such excavation is approved in writing by the Engineer.

E. Generally, local material deposits will not be approved if located within 1,000 feet of right-of-way line. In any case the Contractor's pit operations shall not encroach within 25 feet of the right-of-way. Payment will not be made on material obtained in violation of these provisions.

F. The Contractor shall, at no additional cost to the Contracting Agency, 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.

G. The Contractor or the Contractor's representative shall attest to the content of the submitted materials that have been reviewed against the Contract Documents, and that the materials are in compliance thereto. Submitted materials that are to be evaluated as “Or Equal” or “Substitution” shall include sufficient information to enable the Engineer to make the determination for approval.

106.03 POSSIBLE LOCAL MATERIAL SOURCES

A. If the Contractor desires to use materials from local sources other than those described in Subsection 102.05, "Examination of Plans, Specifications, Contract Documents, and Site of Work," the Contractor shall, at no additional cost to the Contracting Agency, 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, including inspection and testing, 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.

B. The Contractor's attention is especially directed to Title 43, "Code of Federal Regulations," Part 23, "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.

C. Where the Contracting Agency 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 Contracting Agency. The Contractor may, if the Contractor 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.

D. Such arrangements are not a part of the contract and the Contracting Agency assumes no responsibility to the bidder or Contractor whatsoever in respect to the Contracting Agency'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, 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.

E. In those instances in which the Contracting Agency has designated optional or mandatory local material sources in the Special Provisions, this may include the documents setting forth the arrangements 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.

F. The bidder or Contractor is cautioned to make such independent investigation and examination as the bidder or Contractor deems necessary to satisfy bidder or Contractor 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.

G. 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:

1. 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 agreed to conform to all other provisions set forth in the arrangement made between the Contracting Agency and the property owner. Said document will be prepared by the Engineer for execution by the Contractor, or

2. 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 Contracting Agency of any and all obligations under the Contracting Agency's arrangements with the owner.

H. If the Contractor elects to obtain material under G.1, the use of such site shall be subject to the terms, conditions, and limitations of the arrangement made between the property

owner and the Contracting Agency and the Contractor shall pay such charges as are provided for in the arrangement made by the Contracting Agency with the property owner.

I. If the Contractor elects to obtain material under G.2, the Contractor shall pay such charges as are provided for in the agreement between the owner and the Contractor.

J. Unless otherwise provided and before execution 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 Contracting Agency and the owner, or (b), the agreement between the owner and the Contractor as the case may be.

K. Where the Contracting Agency 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 as optional or mandatory local material sources in the Special Provisions, the Contractor 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 Contracting Agency from the U.S. Government which are not specifically designated for the project without prior written approval from the Contracting Agency.

L. Should the Contractor enter upon any of the areas withdrawn or otherwise obtained by the Contracting Agency from the U.S. Government, it shall be the Contractor's 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 the Contractor's entering said area. In addition, the Contractor shall be bound by the terms, conditions, and reservations contained in the approved application for withdrawal.

M. 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.

106.04 SAMPLES AND TESTS

A. Sampling for final acceptance of materials will be as required in the appropriate specifications sections and in general shall comply with the AASHTO requirements, where applicable, and with the following sampling criteria:

1. 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.

2. Aggregate for plantmix bituminous open-graded will be sampled from the laydown machine, or by “belt-cut” sample at the production plant at the Engineer’s discretion.

3. Aggregate for screenings will be sampled from the loaded truck just prior to placing, or by “belt-cut” sample at the production plant at the Engineer’s discretion.

4. 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.

5. 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.

   a. Two samples shall be taken from each railroad tank car or truck transport of material by the Contractor or the Contractor's designated representative under the observation of and complying with the requirements of AASHTO T 40 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 2 samples shall be taken to represent a maximum of 10,000 gallons. The Contractor shall take the samples during the established job working hours, unless arrangements are made for a representative of the Contracting Agency to witness the taking of the samples at another time.

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

   c. One of the 2 samples, taken from each load, shall be submitted to the Contractor's Material Source laboratory for testing and the other sample retained by the Engineer. If the first sample tested complies with requirements, the second may be discarded.

   d. Where less than 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 25 tons of asphalt delivered to the project.

6. 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 CERTIFICATE OF COMPLIANCE

A. 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 fabricator of assembled materials. A Certificate of Compliance shall be furnished with each lot of material delivered to the work and the lot so certified shall be clearly identified in the certificate with attached applicable test results for that lot in accordance with the specification section.

B. 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.

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

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

106.06 CITED SPECIFICATIONS

A. The Nevada Department of Transportation 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 Division, Nevada Department of Transportation, Carson City, Nevada.

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

C. Whenever a reference is made in the specifications to a specification or test designation either of ASTM International, AASHTO, 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 advertisement for bid.

D. 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, "Certificate 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

A. The Engineer may inspect the production of material or the manufacture of products at the source of supply. The Contractor and material producer shall assure the Engineer of their cooperation and assistance to perform plant inspection prior to production of materials for the project. The Engineer or the Engineer's 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.

B. It is understood that the Contracting Agency 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

A. Materials shall be so stored as to ensure the preservation of their quality and fitness for the work. When considered necessary by the Engineer, materials 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.

B. Stored materials, even though approved for use before storage, may be inspected prior to their use in the work, and materials 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.

C. Upon approval 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 shall be provided by the Contractor at no additional cost to the Contracting Agency. Private or public property shall not be used for storage purposes without written permission of the owner or lessee.

D. All storage sites shall be restored to their original condition by the Contractor at no additional cost to the Contracting Agency. 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. Construction materials may not be stored in streets, roads, or highways for more than 5 days after unloading. All materials or equipment not installed or used in the construction within 5 days after unloading shall be stored elsewhere by the Contractor at no additional cost to the Contracting Agency unless the Contractor is authorized additional storage time.

E. Construction equipment shall not be stored at the work site before its actual use on the work nor for more than 5 days after it is no longer needed on the work unless the Contractor is authorized additional storage time. Time necessary for repair or assembly of equipment may be authorized by the Engineer.

F. Excavated material, except that which is to be used as backfill in the adjacent trench, may not be stored in public streets, roads, or highways unless otherwise permitted. After placing backfill, all excess material shall be removed immediately from the site.

106.09 HANDLING MATERIALS

A. All materials shall be handled in such manner as to preserve their quality and fitness for the work.

B. 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 GUIDANCE ANALYSIS OF NONCOMPLYING MATERIALS

A. In the event of a non-compliance of a produced or placed material, the Contractor is responsible for submitting a recommendation report to the Engineer for the determination of the basis of acceptance of the material by the Engineer based on AASHTO R-9, this section, and/or other industry practices as approved by the Engineer. This report shall be performed by a Nevada Professional Engineer. The receiving of the report by the Engineer does not imply acceptance of the report recommendations.

B. The policy of the Engineer is that a project shall have been constructed "... in reasonably close conformity with the approved plans and specifications..." to be eligible for full payment of the material and installation. However, there will be instances when test results, as a result of the above noted variability may indicate apparent nonconformance to the specification limits, yet the construction product may be acceptable for the use intended at full or reduced pay. In these cases, an analysis of the materials and/or materials test results will be necessary by the Contractor through a professional engineer before payment is made.

C. As a general guidance and unless otherwise stipulated in other specification sections or contract Special Provisions, if more than 10 percent of the test values for any construction product are outside of the applicable specifications, there may be a question of "reasonably close conformity." In these cases, an analysis of the test values should be made to determine the magnitude and extent of the nonconforming materials.

106.11 CONTRACTING AGENCY FURNISHED MATERIAL

A. The Contractor shall furnish all materials required to complete the work, except those specified to be furnished by the Contracting Agency. Material furnished by the Contracting Agency will be delivered or made available to the Contractor at the points specified in the Special Provisions.

B. The cost of handling and placing all materials after they are furnished to the Contractor shall be considered as included in the contract price for the item in connection with which they are used.

C. The Contractor will be held responsible for all material furnished to the Contractor, and deductions will be made from any money due to the Contractor 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. The responsibility by the Contractor includes any project inspection and testing that is required in these specifications.

SECTION 107

LEGAL RELATIONS AND RESPONSIBILITY TO THE PUBLIC

107.01 LAWS TO BE OBSERVED

A. 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. The Contractor shall at all times observe and comply with all such laws, bylaws, ordinances, regulations, orders, and decrees, and shall protect and indemnify the Contracting Agency and its representative against any claim or liability arising from or based on the alleged violation of any such law, bylaw, ordinance, regulation, order, or decree, whether by the Contractor, the Contractor's employees, or agents.

107.02 PERMITS, LICENSES, AND TAXES

A. The Contractor shall obtain all permits and licenses, 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.

107.03 PATENTED DEVICES, MATERIALS, AND PROCESSES

A. If the Contractor employs any design, device, material, or process covered by letters of patent or copyright, the Contractor shall provide for such use by suitable legal agreement with the patentee or owner. The Contractor and the surety shall indemnify and save harmless the Contracting Agency, and 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 Contracting Agency for any costs, expenses, and damages which the Contracting Agency may be obliged to pay by reason of any alleged infringement, at any time during the prosecution or after the completion of the work.

107.04 RESTORATION OF SURFACES OPENED BY PERMIT

A. The right to construct or reconstruct any utility service in the public right-of-way, or to grant permits for same, at any time, is hereby expressly reserved by the Contracting Agency or 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.

B. Any individual, firm, or corporation wishing to make an opening in the highway or street must secure a permit from the proper authority. The Contractor shall allow parties bearing such permits, and only those parties, to make openings in the highways or streets. 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.

C. The Contracting Agency, the Contractor, and each of such workmen, contractors, and others shall coordinate their operations and cooperate to minimize interference.

D. The Contractor shall absorb in the Contractor's bid all costs involved on the Contractor's part as a result of coordinating the Contractor's work with others. The Contractor will not be entitled to additional compensation from the Contracting Agency for damages resulting from such simultaneous, collateral, and essential work. If necessary to avoid or minimize such damage or delay, the Contractor shall redeploy the Contractor's work force to other parts of the work.

E. Should the Contractor be delayed by the Contracting Agency, and such delay could not reasonably have been foreseen and prevented by the Contractor, the Engineer will determine the extent of the delay, the effect of the delay on the project as a whole, and recommend to the Board any time extension indicated.

107.05 BLANK

107.06 SANITARY PROVISIONS

A. The Contractor shall provide and maintain in a neat, sanitary condition, such accommodations for the use of the Contractor's employees as may be necessary to comply with the requirements and regulations of the Southern Nevada Health District and of other bodies or tribunals having jurisdiction thereover. The Contractor shall commit no public nuisance.

107.07 TRAFFIC AND ACCESS

A. The Contractor's operations shall cause no unnecessary inconvenience. The access right of the public shall be considered at all times. Unless otherwise authorized, traffic shall be permitted to pass through the work, or an approved detour shall be provided.

B. Safe and adequate pedestrian and vehicular access shall be provided and maintained to fire hydrants, commercial and industrial establishments, churches, schools, parking lots, service stations, motels, fire and police stations, hospitals, and establishments of similar nature. Access to these facilities shall be continuous and unobstructed unless otherwise approved by the Engineer.

C. Safe and adequate pedestrian zones and pedestrian crossings of the work at intervals not exceeding 300 feet shall be maintained unless otherwise approved by the Engineer.

D. Safe and adequate access shall be maintained to existing bus or transit stops throughout duration of road construction in accordance with the following minimum requirements:

1. Unless otherwise specified in the Special Provisions, no public bus or transit stop shall be temporarily closed without the written consent of the Regional Transportation Commission of Southern Nevada (RTC) General Manager or the RTC General Manager's designee. The RTC shall be notified at least 10 working days prior to the proposed temporary closure of any bus or transit stop, including those listed in the Special Provisions.

2. No bus stops at transfer points shall be closed during construction. Bus stops at transfer points can, however, be temporarily relocated with the approval of the RTC.

3. If bus or transit stop is temporarily relocated, the existing bus or transit stop sign panels shall be relocated to temporary bus or transit stops and shall remain until temporary stop is removed. Temporary relocation of sign panels shall conform to Subsection 627.03.05, “Relocation.”

4. The Contractor shall maintain access that is in conformance to the requirements of the Americans with Disabilities Act to and from bus or transit stops which remain open at all times during construction.

E. Vehicular access to residential driveways shall be maintained to the property line except when necessary construction precludes such access for reasonable periods of time. If backfill has been completed to such extent that safe access may be provided, and the street is opened to local traffic, the Contractor shall immediately clear the street and driveways and provide and maintain access.

F. The Contractor shall cooperate with the various parties involved in the delivery of mail and the collection and removal of trash and garbage to maintain existing schedules for these services.

G. Grading operations, roadway excavation, and fill construction shall be conducted by the Contractor in a manner to provide a satisfactory surface for traffic. When rough grading is completed, the roadbed surface shall be brought to a smooth, even condition satisfactory for traffic.

H. Unless otherwise authorized, work shall be performed in only one half the roadway at one time. One half shall be kept open and unobstructed until the opposite side is ready for use. If one half a street only is being improved, the other half shall be conditioned and maintained as a detour.

I. The Contractor shall absorb in the Contractor's bid all costs for the above requirements.

J. The Contractor shall comply with all applicable state, county, and city requirements for closure of streets. Traffic work zone technicians on the project shall be certified in the work zone traffic control at least at the “Technician” level by ATSSA, IMSA, or NICET. The Contractor shall provide barriers, guards, lights, signs, temporary bridges, flagmen, and watchmen, advising the public of detours and construction hazards. The Contractor shall also be responsible for compliance with additional public safety requirements that may arise during construction. The Contractor shall furnish and install, and upon completion of the work, promptly remove all temporary signs and warning devices.

K. At least 48 hours in advance of closing, partially closing, or reopening any street, alley, or other public thoroughfare, the Contractor shall notify the Police, Fire, Traffic and Engineering Departments having jurisdiction and comply with their requirements, and notify the Regional Transportation Commission of Southern Nevada. Deviations shall first be approved in writing by the Engineer.

L. All costs involved shall be absorbed in the Contractor's bid. All barricades, warning signs, lights, temporary signals, and other protective devices shall conform with the Traffic Control Plans for Highway Work Zones for the Clark County Area and the current edition of the Manual on Uniform Traffic Control Devices.

107.08 RELATIONS WITH RAILROADS

A. **Definitions:** The following definitions shall apply to the terms as herein used:

1. **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.

2. **Chief Engineer:** The Chief Engineer of the railroad or the Chief Engineer's authorized representatives.

3. **Railroad Crossing:** A crossing at grade of the tracks of a railroad and the highway.

4. **Grade Separation:** A permanent structure to effect the separation of grade 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 ensure 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 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 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 the Chief Engineer 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 regulation of the railroad with respect to the Contractor's work or operation 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 Contracting Agency 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, may be paid by the Contracting Agency directly to the railroad and the amount thereof shall be deducted by the Contracting Agency 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:**

1. The railroad may undertake certain work or operations incident to the project which are the subject of an agreement between the Contracting Agency 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.

2. 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 Subsection 624.03.02, "Flaggers," Subsection 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:**

1. The Contractor shall provide and maintain during the effective life of the awarded contract, regular Contractor's Public Liability and Property Damage Liability Insurance, the limits for which may be set by the Special Provisions to protect the Contractor and all of the Contractor's construction subcontractors from claims for personal injury, accidental death, and damage 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. The Successful Bidder shall furnish the Contracting Agency a policy or certificate of liability insurance in which the Contracting Agency shall be named insured or be named as an additional insured with the Contractor. The Successful Bidder shall

also furnish a Certificate of Workman's Compensation Insurance, Nevada Industrial Commission.

2. 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.

3. The Contractor shall furnish the Contracting Agency with 1 certified copy of all insurance required under this paragraph.

B. **Railroad's Protective Public Liability and Property Damage Insurance:**

1. 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 Contracting Agency 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.

2. Such insurance shall apply only to that portion of the project upon or adjacent to the railroad property.

3. 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.

4. 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 Contracting Agency and thereafter until all 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 non-cancelable and non-alterable for any cause whatsoever (including failure to pay premiums) either by the Contractor or by the insurance company without 30 days' written notice to the railroad and the Contracting Agency. 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 Contracting Agency at the time of execution of said contract, 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 copies of each of such policies shall be forwarded by the Contracting Agency to the Chief Engineer for the railroad's approval.

107.10 EXPLOSIVES

A. Explosives may be used only when authorized in writing by the Engineer, or as otherwise stated in the Special Provisions. Explosives shall be handled, used, and stored in accordance with all applicable regulations.

B. The Engineer's approval of the use of explosives shall not relieve the Contractor from the Contractor's liability for claims caused by the Contractor's blasting operations.

C. 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 1,000 feet from the road or from any building or camping area or place of human occupancy.

D. The Contractor shall notify each public utility company having structures or pipelines in proximity to the site of the work of the Contractor's intention to use explosives. Such notice shall be given in writing a week 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

A. The Contractor shall indemnify and save harmless the Contracting Agency, its officers, and its employees from all suits, actions, claims, losses, or expenses of any character brought because of any injuries or damages alleged to have been received or sustained by any person, persons, or property on account of the operations of the 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 "Nevada Industrial Insurance Act," or any other law, ordinance, order, or decree; and so much of the money due the Contractor under and by virtue of the contract as may be considered necessary by the Contracting Agency for such purpose, may be retained for the protection of the Contracting Agency; or in case no money is due, the Contractor's surety may be held until all such suits, actions, claims, losses, or expenses for the injuries or damages as aforesaid shall have been settled and suitable evidence to that effect furnished to the Contracting Agency; except that money due the Contractor will not be withheld when the Contractor produces satisfactory evidence that the Contractor is adequately protected by public liability and property damage insurance.

B. Reimbursement to the Contractor by the Contracting Agency in whole or in part for costs of protecting traffic shall not serve to relieve the Contractor of the Contractor's responsibility as set forth in these specifications.

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

107.12 PROTECTION AND RESTORATION OF PROPERTY AND LANDSCAPE

A. The Contractor shall be responsible for the preservation from injury or damage resulting directly or indirectly from the work under the contract of all public and private property, crops, trees, vegetation, monuments, fences, highway signs and markers, etc., along and adjacent to the project, and shall use every precaution necessary to prevent damage to waterlines, sewers, 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 the Contractor shall not remove or cut trees or shrubs without proper authority.

B. The Contractor 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 the Contractor's 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.

C. 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."

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

E. 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 the part of the Contractor or the Contractor's agents, suppliers, or subcontractors, the Contractor shall restore at no additional cost to the Contracting Agency 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 the Contractor 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 within 10 days, the Contracting Agency may, upon 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 become due the Contractor under the contract.

F. The Contractor shall restrict the movement of the Contractor's 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 staked area 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 no additional cost to the Contracting Agency, shall eradicate such marks to the satisfaction of the Engineer.

G. All roads used for construction operations shall be spaced at least 1,000 feet apart from flat bottom ditches and material deposits, 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 occupied by said ditch or dike, except as provided for in Subsection 203.03.13, "Channels." The crossing of median areas shall be at structures or areas approved by the Engineer.

H. 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.

I. 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 FIRE PROTECTION

A. There shall be no open burning unless approval has been given in writing by the Clark County Air Pollution Control Officer and the Engineer has concurred. Before setting any fires whatsoever, the Contractor shall notify the responsible agency having jurisdiction for the area concerned. The Engineer shall have authority to enforce correction of any condition which is, in the Engineer's opinion, unsafe.

107.14 DISPOSAL OF MATERIAL OUTSIDE PROJECT RIGHT-OF-WAY

A. The Contractor shall make the Contractor's own arrangements for disposal of materials outside the project right-of-way at no additional cost to the Contracting Agency.

B. When any material is to be disposed of outside the project 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 the Contractor shall file in writing with the Engineer said permit or the certified copy thereof together with a written release from the property owner absolving the agency of any and all responsibility in connection with the disposal of material on said property.

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

D. 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 therefore.

107.15 RELIEF FROM MAINTENANCE AND RESPONSIBILITY

A. 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 the Engineer's 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 the 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 the Contractor's negligence.

B. 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:

1. A bridge or other structure of major importance.
2. A complete unit of a traffic control signal system or of a highway or street lighting system.
3. Non-project facilities constructed for other agencies.

C. 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 project by the Contracting Agency.

107.16 CONTRACTOR'S RESPONSIBILITY FOR THE WORK AND MATERIALS

A. 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 the Contractor has received partial payment as provided in Subsection 109.06, "Partial Payments," or materials which have been furnished by the agency) 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."

B. 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 203.03.11, "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 proximately caused by acts of the federal government or the public enemy. The Contractor shall, at no additional cost to the Contracting Agency, provide suitable drainage for the project and erect such temporary structures as are necessary to protect the work or materials from damage.

C. The suspension of the work from any cause whatever shall not relieve the Contractor of the Contractor's responsibility for the work and materials as herein specified. If ordered by the Engineer, the Contractor shall, at no additional cost to the Contracting Agency, properly store materials which have been fully or partially paid for and furnished by the Contracting Agency. Such storage by the Contractor shall be on behalf of the Contracting Agency and the Contracting Agency 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

A. At points where the Contractor's operations are adjacent to properties of railroad, telegraph, telephone, and power companies, or are adjacent to or in conflict with other property or utilities, 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.

B. The Contractor shall not begin any operations which may interfere with or impair the normal service being rendered by public or private utility operations, until such operators have been notified, and shall cooperate with the owners of any underground or overhead utilities in their removal and rearrangements operations in order that these operations may progress in a reasonable manner, and that duplication of rearrangements 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.

C. In general, the repair and adjustment of street structures such as waterlines, sewers, telephone, telegraph, gas, and electric lines, above or below the ground, will be made by the owners thereof as specified in Subsection 105.06, "Cooperation with Utilities." 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.

D. 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.

E. 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 15 feet of the fire hydrant in the absence of such ordinances, rules, or regulations.

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

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

H. Attention is directed to Subsection 105.06, "Cooperation with Utilities."

107.18 FURNISHING RIGHT-OF-WAY

A. The Contracting Agency will be responsible for the securing of all right-of-ways shown in the plans. Any exceptions will be indicated in the contract.

107.19 PERSONAL LIABILITY OF PUBLIC OFFICIALS

A. 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 officers or employees of the Contracting Agency, either personally or as officials of the County or Municipality, it being understood that in all such matters they act solely as agents and representatives of the Political Subdivision.

107.20 NO WAIVER OF LEGAL RIGHTS

A. The Contracting Agency 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 measurement, estimate, or certificate is untrue or is incorrectly made, nor that the work or materials do not in fact conform to the contract. The Contracting Agency shall not be precluded or estopped, notwithstanding any such measurement, estimate, or certificate, and payment in accordance therewith, from recovering from the Contractor or the Contractor's sureties, or both, such damages as it may sustain by reason of the Contractor's failure to comply with the terms of the contract. Neither the acceptance by the Contracting Agency, or any representative of the Contracting Agency, 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 Contracting Agency, 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

A. Dust that originates from the Contractor's 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.

B. A permit from the Clark County Air Pollution Officer shall be obtained by the Contractor prior to the start of construction operations.

C. Reference is made to Section 637, "Pollution Control."

107.22 VIBRATORY EQUIPMENT OPERATIONS

A. All construction activities involving vibratory equipment shall be conducted by the Contractor on a performance basis. The Contractor may be required to conduct impact assessment tests of the Contractor's vibratory equipment prior to initiation or during construction. The frequency and amplitude of the vibratory equipment shall be calibrated and used to measure ground velocity for conformance to the current regulatory limit of 0.5 inch per second peak ground velocity at the nearest affected structure. The measurements shall comply with the recommendations of the *Blasting Guidance Manual*, published in 1987 by the Office of Surface Mining and Enforcement.

SECTION 108

PROSECUTION AND PROGRESS

108.01 SUBLETTING OF CONTRACT

A. If the bidder intends to sublet any portion of the work, the bidder shall furnish a list of the subcontractors as a material part of the bidder's sealed proposal on the form provided, listing a description of the work to be performed by each subcontractor. If the bidder does not intend to sublet any part of the work, the bidder shall insert the word "NONE" on the form provided. In the event that the prospective bidder fails to complete the subcontractor's list, either with the insertion of the bidder's intended subcontractors, or with the word "NONE," the bidder's proposal shall be rejected without consideration. The Contractor shall not sublet, sell, transfer, assign, or otherwise dispose of the contract or contracts or any portion thereof, or of the Contractor's right, title, or interest therein, without prior written consent of the Contracting Agency and of the surety.

B. 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.

C. Consent to sublet, assign, or otherwise dispose of any portion of the contract shall not be construed to relieve the Contractor of the Contractor's liability under the contract and bonds.

D. All subcontractors and assignees of the prime or general Contractor shall be required to comply with the provisions of NRS 408.373, NRS Chapter 338, and all other applicable federal, state, and local laws or regulations in the same manner as the prime or general Contractor.

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

F. The Contractor shall perform with the Contractor's own organization, unless otherwise authorized by the Special Provisions, work amounting to not less than 25 percent of the combined value of all items of the work covered by the contract except as follows:

   1. 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 these materials into the project, the cost of the 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.

G. 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 a single subcontract.

H. Roadside production of materials is construed to be the production of crushed stone, gravel, or other material with portable or semi-portable 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.

I. The Contracting Agency 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 Contracting Agency. The Contractor will be held responsible for the progress of the work in accordance with the contract progress required.

108.02 NOTICE TO PROCEED

A. The successful bidder agrees to conform to the following which shall govern the Physical Notice to Proceed for this project:

1. Authorization to commence actual physical work shall be issued by the Contracting Agency.
2. The authorization to proceed shall be given verbally to the successful bidder. The Contracting Agency shall confirm this authorization in writing.
3. The verbal authorization to proceed shall have an actual start date for physical work to commence and a scheduled completion date.
4. After the verbal Notice to Proceed has been issued by the Contracting Agency, failure of the successful bidder to commence work by the actual start date shall be grounds for breach of contract.

B. A Material Notice to Proceed may be issued by the Contracting Agency subject to the same conditions as items 1, 2, and 3 of the Physical Notice to Proceed requirements. The maximum time allowed for acquisition of materials shall be the number of calendar days specified in the contract after verbal authorization has been given by the Contracting Agency.

C. At the successful bidder's option, the successful bidder may elect to start work during the Material Notice to Proceed time. If the successful bidder elects to commence physical work prior to the calendar days of the Material Notice to Proceed expiration, the following shall apply:

1. Once the actual date the successful bidder elects to enter the project and commence physical work, the time allotted for Physical Work shall commence.
2. No stop orders shall be issued due to lack of materials that have not arrived.
3. Any time remaining under the calendar day Material Notice to Proceed shall expire automatically at the end of the last calendar day for physical work to be completed.

108.03 PROSECUTION AND PROGRESS

A. When required by the Engineer, the Contractor shall furnish the Engineer with a "Progress Schedule" for the Engineer's 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 24 hours in advance of resuming operations.

108.04 LIMITATION OF OPERATIONS

A. The Contractor shall conduct the work in such a manner and in such sequence as will ensure the least interference with traffic. The Contractor shall have due regard to the

location of detours and to the provisions for handling traffic. The Contractor 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.

B. No productive work will be required on Saturdays, Sundays, or holidays unless otherwise provided for in the Special Provisions. 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 the Contractor's intention to work on the aforementioned days at least 48 hours in advance of such work. Holidays are defined in Subsection 101.29, "Holidays."

C. 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, or the traffic is of such volume that it is deemed expedient to do so.

108.05 CHARACTER OF WORKMEN; METHODS AND EQUIPMENT

A. 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.

B. 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 the work satisfactorily.

C. Any person employed by the Contractor or by a subcontractor who, in the opinion of the Engineer, does not perform the Contractor's or subcontractor's work in a proper 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.

D. 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 Contracting Agency may suspend the work by written notice until such orders are complied with.

E. 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 improvement will result from its use.

F. 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 the Contractor demonstrates to the satisfaction of the Engineer will accomplish the contract work in conformity with the requirements of the contract.

G. 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, the Contractor 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 and with the concurrence of the Contracting Agency. 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 substituted 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 in contract time as a result of authorizing a change in methods or equipment under these provisions.

108.06 TEMPORARY SUSPENSION OF WORK

A. The Engineer shall have the authority to suspend the work wholly or in part, for such period as the Engineer may deem necessary due to unsuitable weather, or to such other conditions as are considered unfavorable for the suitable prosecution of the work. The Contracting Agency shall have the authority to suspend the work wholly or in part for such time as it 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 or Contracting Agency 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.

B. 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 no additional cost to the Contracting Agency, 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, "Traffic and Access," and as specified in the Special Provisions for the work. In the event that the Contractor fails to perform the work above specified, the Contracting Agency will perform such work and the cost thereof will be deducted from money due or to become due the Contractor.

C. In the event that a suspension of work is ordered by the Contracting Agency 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 Contracting Agency such work will be performed by the Contracting Agency at no cost to the Contractor.

D. If the Engineer orders a suspension of all the work or a portion of the work which is the current controlling operation or operations, due to unsuitable weather or to such 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 101.74, "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.

E. If a suspension of work is ordered by the Contracting Agency, due to the failure on the part of the Contractor to carry out orders given 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 101.74, "Working Day."

F. 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 the Contractor's responsibilities as set forth in Section 107, "Legal Relations and Responsibility to the Public."

108.07 PRECONSTRUCTION CONFERENCE

A. After the contract has been awarded and prior to commencing work, the Contracting Agency 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

A. The contract time for completion will be fixed by the Contracting Agency, and will be stated in the Special Provisions, either as a calendar date, or based on a number of working days, or on a specified number of calendar days. Attention is directed to Subsection 101.74, "Working Day."

B. 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:

1. 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.

2. If delays beyond the Contractor's control are caused solely by action or inaction by the Contracting Agency, such delays will entitle the Contractor to an extension of time which will be based upon the effect of delays to the project as a whole and will not be granted for noncontrolling delays to minor included portions of work, unless it can be shown that such delays did, in fact, delay the progress of the product as a whole.

3. 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 Contracting Agency to be equivalent to the delays; provided,

however, written request for such extension of time is made by the Contractor within 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.

C. 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 Contracting Agency 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 the Contractor had taken adequate steps for a guaranteed delivery date from the Contractor's supplier.
3. The evidence shall contain certification of adequate steps for a guaranteed delivery by not less than 3 suppliers of the material or if 3 suppliers are not available, the Contractor shall so certify and supply certification from such suppliers as there are.
4. That the Contracting Agency 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.

D. 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.

108.09 FAILURE TO COMPLETE THE WORK ON TIME

A. Time is an essential element of the contract and it is important that the work be pressed vigorously to completion. The cost to the Contracting Agency 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 a project.

B. 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 Contracting Agency, 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 day the work shall remain uncompleted. This sum shall be considered and treated not as a penalty but as liquidated damages due the Contracting Agency 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 the Contractor's failure to complete the work within the time specified in the contract.

C. 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 Contracting Agency of any of its rights under the contract.

D. The Contracting Agency may waive such portions of the liquidated damages as may accrue after all work is completed, except "Final Cleanup" and seeding gravel pit and borrow areas and haul roads.

108.10 DEFAULT AND TERMINATION OF CONTRACT

A. If for any cause whatsoever, the Contractor fails to carry on the work in an acceptable manner, the Contracting Agency will give notice in writing to the Contractor and the Contractor's surety of such delay, neglect, or default. The Contractor shall be considered in default and the contract may be terminated if any of the following shall occur:

1. Fails to begin the work under the contract within the time specified in the Notice to Proceed, or
2. Fails to perform the work with sufficient workmen and equipment or with sufficient materials to ensure the prompt completion of the work, or
3. 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
4. Discontinues the prosecution of the work, or
5. Fails to resume work which has been discontinued after notice to do so, or
6. Becomes insolvent or is declared bankrupt or commits any act of bankruptcy or insolvency, or
7. Allows any final judgment to stand against the Contractor unsatisfied for a period of 5 days, or
8. Makes an assignment for the benefit of creditors, or
9. 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 the Contractor's surety of such delay, neglect, or default.

B. If the Contractor or surety, within a period of 10 days after such notice, does not proceed in accordance therewith, then the Contracting Agency 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 Contracting Agency may, at the Contracting Agency's option, call upon the surety to complete the work in accordance with the terms of the contract; or the Contracting Agency 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 the contract according to the terms and provisions thereof, or use such other methods as, in the Contracting Agency's opinion, will be required for the completion of the contract in an acceptable manner.

C. All costs and charges incurred by the Contracting Agency, together with the cost of completing the work under the contract, shall be deducted from any money due or which may become due the Contractor. In case the expense so incurred by the Contracting Agency shall be less than the sum which would have been payable under the contract if it had been completed by the Contractor, then the 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 the Contractor's surety shall be liable and shall pay to the Contracting Agency the amount of said excess.

108.11 TERMINATION OF THE CONTRACTOR'S RESPONSIBILITY

A. 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 Contracting Agency according to the contract, and the final estimate paid, the Contractor's obligations shall then be considered fulfilled, except as set forth in the Contractor's contract bond and as provided in Subsection 107.11, "Responsibility for Damage Claims."

108.12 RIGHT-OF-WAY DELAYS

A. The Contractor may be compensated for delays caused solely by the failure of the Contracting Agency to furnish necessary rights-of-way, failure to deliver materials shown on the contract documents to be furnished by the Contracting Agency, or for the suspension of the work by the Contracting Agency for its own convenience or benefit. If the Contractor sustains loss which could not have been avoided by the judicious handling of forces, equipment, or plant, there shall be paid to the Contractor such amount as the Engineer may find to be fair and reasonable compensation for such part of the Contractor's actual loss as was unavoidable.

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

108.13 TERMINATION OF CONTRACT

A. The Contracting Agency may, upon 30 days' written notice, terminate the contract or a portion thereof.

B. 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.

C. 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.

D. Acceptable materials, obtained by the Contractor for the work, that have been inspected, tested, and accepted by the Contracting Agency 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 Contracting Agency.

E. Termination of the contract or a portion thereof shall not relieve the Contractor's surety of its obligation for any just claims arising out of the work performed.

SECTION 109

MEASUREMENT AND PAYMENT

109.01 MEASUREMENT OF QUANTITIES

A. The measurements 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.

B. 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.

C. 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 engineering 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. The planimeter shall be considered an instrument of precision adapted to the measurement of areas, but other acceptable methods may be used.

D. 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 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.

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

F. All items that 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.

G. Items may be measured by surface area, either square foot or square yard. The term "gage" when used in connection with the measurement of plates, shall mean the U.S. Standard Gage. 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 the material as described in the "Materials" section of these specifications.

H. When the term "gage" refers to the measurement of wire, it shall mean the wire gage specified in the AASHTO M 32 for cold drawn steel wire for concrete reinforcement.

I. Unless otherwise specified, water meters shall be accurate to within 2 percent of the indicated amount. The frequency of checking water meters will be determined by the Engineer.

J. The term ton shall mean the short ton consisting of 2,000 pounds avoirdupois. All materials that 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 that will print the weights of the material delivered, provided the system is used in conjunction with an approved automatic batching control system. Such a system shall issue a weigh ticket for each load. The Contractor shall have on hand not less than ten 50-pound standard weights for testing the scales.

K. Scales:

1. 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 ensure the accuracy of the scales. The cost of inspecting the scales shall be borne by the Contracting Agency.

2. 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 shall be level with the scale platform for a minimum distance of 50 feet from each end of the scale platform.

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

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

5. Support members for platform scales shall consist of 12-inch by 12-inch or 6-inch by 16-inch (minimum) timbers placed on a firm gravel foundation. Scales consisting of more than one section shall be supported with 12-inch by 12-inch or 6-inch by 16-inch (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.

6. 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 6 feet wide, 8 feet long, and 7 feet high; shall have 2 windows, adjustable for ventilation with one 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.

7. Conveyor scales of an approved type may be used. The conveyor scales shall be furnished with 1 master counter to run continuously and 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 2 windows. One window shall face the point of loading and the conveyor scales. This window shall also be equipped with a shelf 2 feet wide and 6 feet long. A controlled method of heating shall be supplied for cold weather operations.

8. A locked door shall be provided on the access to the conveyor balances (where fine adjustment must be made). The key shall be in the hands of the Engineer and the

door shall 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 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 shall have a certificate of inspection.

b. At the beginning and middle of each shift, or as requested by the Engineer, 2 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 2 loads shall check with the platform scale weight within 0.5 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 shall be used with conveyor scale weights stamped by the remote counter.

L. Unless otherwise specified, materials shipped by rail shall be weighed over the authorized project scales before incorporation into the work.

M. Cement will be measured by the barrel or ton. The term "barrel" will mean 376 pounds of cement.

N. 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.

O. 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.

P. 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 shall bear a plainly legible identification mark, indicating its specified approved capacity. All vehicles shall be loaded to at least waterlevel capacity. Loads not hauled in approved vehicles or of a quantity less than the specified approved quantity for the hauling vehicle will be subject to rejection and no compensation will be allowed for the hauling of the material.

Q. Liquid Asphalts, Asphalt Cement, and Asphaltic Emulsions:

1. The unit of measurement for liquid asphalts, asphaltic emulsions, and paving asphalts shall be a ton or gallon at 60 degrees F.

2. 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.

3. 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 weight and measures, and pay quantities shall be determined in accordance with the following procedure.

4. Volumetric measurements at any temperature shall be reduced to the volume the material would occupy at 60 degrees F, before converting the volumetric measurements to weight.

5. 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 AT 60 DEGREES FAHRENHEIT

Grade of Liquid Asphalt	Gallons Per Ton	Pounds Per Gallon
70	253	7.90
250	249	8.03
800	245	8.16
3000	241	8.30

AVERAGE WEIGHTS AND VOLUMES OF ASPHALT CEMENT AT 60 DEGREES FAHRENHEIT

Grade	Gallon Per Ton	Pounds Per Gallon
AC-40	233	8.59
AC-30	235	8.51
AC-20	235	8.51
AC-10	237	8.43

AVERAGE WEIGHTS AND VOLUMES OF ASPHALTIC EMULSION AT 60 DEGREES FAHRENHEIT

Type of Emulsion	Gallon Per Ton	Pounds Per Gallon
All Grades	240	8.33

6. When converting the volume of liquid asphalt, asphalt cement, or asphaltic emulsion at any temperature to the volume of 60 degrees F, a conversion factor for correlation shall be used. Said conversion factors shall be those prescribed in The Asphalt Institute (Pacific Coast Division) publication "Asphalts -- Paving Liquids and Emulsions" (PCD-7).

R. Rental of equipment will be measured by time within 1/2 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.

S. When 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 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:

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

2. The Contracting Agency will pay the costs of loading and unloading such equipment.

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

4. 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 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

   a. When hourly rates are listed, less than 30 minutes of operation shall be considered to be 1/2 hour of operation.

   b. When daily rates are listed, payment for 1/2 day will be made if the equipment is not used. If the equipment is used, payment will be made for 1 day.

5. Should the Contractor desire the return of the equipment to a location other than its original location, the Contracting Agency 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.

6. 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.

7. 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

A. 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 Subsection 104.02, "Increased or Decreased Quantities and Change in Character of Work." Except as provided in Subsection 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:

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

2. Any loss or damage to the nature of the work, the action of the elements, strikes or lockouts;

3. Accidents to employees or the public, or both;

4. Unforeseen difficulties or obstructions that may arise or be encountered during the prosecution of the work;

5. All risks whatsoever connected with the work under contract until it is accepted by the Contracting Agency.

6. 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.

B. If the "Basis of Payment" clause in the specifications relating to any unit price in the bid schedule required 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 on the Work."

C. 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.

D. In case of a lump sum contract, when required by the Special Provisions or requested by the Contracting Agency, the Contractor shall submit to the Contracting Agency within 15 days after award of contract, a detailed schedule in triplicate, to be used only as a basis for determining progress payments on a lump sum contract or any designated lump sum bid item. This schedule should equal in total the lump sum bid and shall be in such

form and sufficiently detailed as to satisfy the Contracting Agency that it correctly represents a reasonable apportionment of the lump sum.

109.03 EXTRA AND FORCE ACCOUNT WORK

A. 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.

B. 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 by the Contracting Agency for such work.

C. **Specialized Work:**

1. Whenever the Contractor is required to perform originally unanticipated work of a specialized nature (electrical, plumbing, landscaping, etc.,) for which the Contractor is not properly equipped, the Contractor may upon approval of the Contracting Agency have the work performed by a local firm or specialist who is proficient in the type of work to be performed.

2. 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 10 percent for the Contractor's profit and overhead with no further compensation therefor.

D. **Owner-Operators:** Whenever the Contractor is authorized by the Contracting Agency 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 include wages and equipment rental. To this lump sum rate shall be added the sum of 10 percent for the Contractor's profit and overhead with no further compensation therefor.

E. Work specified and performed on a force account basis should be paid for as follows:

1. **Labor:**

a. 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:** 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.

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

2. **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 15 percent of the sum thereof.

3. **Equipment:**

a. For any machinery or special equipment, the use of which has been authorized by the Engineer, the Contractor will be paid for the use of equipment at rental rates for such equipment which shall be determined as follows:

1) The base rates shall be those established in publications and revisions thereto entitled *Rental Rate Blue Book for Construction Equipment*, Volumes 1-3, published by EquipmentWatch, a division of PRIMEDIA Business Magazines and Media, a PRIMEDIA company, which is a part of the contract.

2) The hourly rate to be paid shall be the sum of the weekly Blue Book rate divided by 40 plus the estimated operating cost per hour shown therein.

3) Attachments (e.g., tractor with ripper and dozer or tractor with loader and backhoe) will be included in the hourly rate only when deemed essential to the work as determined by the Engineer. When multiple attachments are approved for use and are being used interchangeably, the attachment having the higher rental rate shall be the only one included for payment.

4) The total established rental rate per hour shall be rounded to the nearest 10 cents.

5) Rental rates shall not be adjusted for regional differences.

6) No compensation shall be allowed for shop tools having a daily rental rate of less than 10 dollars as set forth in Section 18 of the Rental Rate Blue Book.

b. If it is deemed necessary by the Engineer to use equipment not listed in the Rental Rate Blue Book, a suitable rental rate for such equipment will be established by the Engineer based on the rate of a comparable model or unit. The Contractor may furnish any cost data that might assist the Engineer in the establishment of such rental rate including an adequate description, trade or manufacturer's name, model, capacity, horsepower, years of manufacture, and purchase price.

c. Payment will be made for actual time, to which rental sum of 15 percent shall be added.

d. 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, but not labor costs for the operation of the equipment.

4. **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.

5. **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.

6. **Documentation:**

   a. **Labor:** No payment will be made for labor performed on force account work until the Contractor shall furnish to the Contracting Agency 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 employed on the force account work.

   b. **Materials:** Copies of the suppliers' invoices, including transportation charges, shall be furnished the Contracting Agency. 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 invoices, the Contractor shall furnish an affidavit certifying that such materials were taken from the Contractor's stock, that the quantity claimed was actually used, and that the price and transportation claimed represent the actual cost to the Contractor. The Contracting Agency may request additional documents to substantiate the Contractor's claims.

109.04 ELIMINATED ITEMS

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

109.05 BLANK

109.06 PARTIAL PAYMENT

A. The Engineer will, after award of contract, establish a monthly progress bill submittal date. Each month, the Contractor will make an approximate measurement of the work performed to that date, estimate its value based on the contract unit prices and/or approved schedule of values, and submit a progress bill on that date. The quantities and value estimates shall have the concurrence of the Engineer and the billing shall include supporting documentation such as material receipts and storage verifications. In accordance with NRS 338.525, the Engineer may withhold from a progress payment, with timely notice and a detailed explanation, a sufficient amount to compensate for failure(s) by the Contractor to comply with a contract requirement or applicable building code, law, or regulation.

B. Monthly certified payroll records shall be submitted as required by NRS 338.070. If the record submittals scheduled for the previous month have not been received, the Contracting Agency may withhold funds in accordance with NRS 338.060 and NRS 338.515.

C. From each progress bill submittal, 10 percent will be deducted and retained by the Contracting Agency, and the remainder less the amount of all previous payment(s) will be paid to the Contractor. After 50 percent of the work has been completed and if progress on the work is and remains satisfactory, the deduction to be made from the remaining

progress billing submittals and from the final payment may be reduced or eliminated by the Contracting Agency.

D. The Contracting Agency shall pay to the Contractor at the end of each quarter the interest earned on the amount retained under the contract during the quarter as provided in NRS 338.515.

E. The Contracting Agency's payment to the Contractor shall be made no later than 30 days after the receipt of an approved progress bill or retainage bill. Interest shall be paid on late payments as provided in NRS 338.530.

F. Partial payments may be made to the extent of the delivered cost of materials to be incorporated in the work, provided that such materials meet the requirements of the Contract, plans, and specifications, and are delivered to acceptable sites on the project or at other sites in the vicinity that are acceptable to the Engineer. Such delivered costs of stored or stockpiled material may be included in the next progress bill submittal after the following conditions are met:

1. The material shall have been stored or stockpiled in a manner acceptable to the Engineer, at the project site or a site approved by the Engineer.
2. The Contractor shall have furnished the Engineer with acceptable evidence of the quantity and quality of such stored or stockpiled materials.
3. The Contractor shall have furnished the Contracting Agency legal title (free of liens or encumbrances of any kind) to the material so stored or stockpiled.
4. The Contractor shall have furnished the Contracting Agency evidence that the material so stored or stockpiled is insured against loss, due to damage or to disappearance of such materials, at any time prior to use in the work.

G. Public Works Projects requiring a performance bond and a labor and material payment bond shall be exempt from the provisions of F.3 and F.4 immediately preceding. 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 the Contractor's stock and the price and transportation claimed represent the actual cost to the Contractor.

H. It is understood and agreed that the transfer of title to, and the Contracting Agency's payment for such stored or stockpiled materials shall in no way relieve the Contractor of the Contractor's responsibility for furnishing and placing such materials in accordance with the requirements of the Contract, plans, and specifications.

I. In no case shall the amount of a progress billing submittal for material on hand exceed the Contract price for such material nor the Contract price for the Contract item in which the material is intended to be used.

J. The Contractor shall bear all costs associated with the progress payment of stored or stockpiled materials in accordance with the provisions of this subsection.

109.07 ACCEPTANCE AND FINAL PAYMENT

A. 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 Contractor shall prepare the final estimate of the quantities of the various classes of work performed under the

contract. The Engineer shall examine such estimate and notify the Contractor in writing of the Engineer's agreement or disagreement, including any amounts to be withheld in accordance with NRS 338.525.

B. Final acceptance of the work by the Contracting Agency shall be withheld until the Contractor furnishes all certificates, guaranties, releases, certified payroll records, affidavits, etc., required by these specifications or the Special Provisions.

C. The acceptance by the Contractor of final payment shall be and shall operate as a release to the Contracting Agency of all claims and all liability by the Contractor for all things done or furnished in connection with this work and for every act and neglect of the Contracting Agency and others relating to or arising out of this work. No payment, however, final or otherwise shall operate to release the Contractor or the Contractor's sureties from any obligations under this contract or the performance and labor and material payment bond.

109.08 BLANK

SECTION 110

WAGES, HOURS AND CONDITIONS OF EMPLOYMENT

110.01 WAGES, HOURS AND EMPLOYMENT PRACTICES

A. The Contractor and the Contractor's subcontractors shall conform in all respects to the Federal Fair Labor Standards Act, as amended, and to Chapter 338 of Nevada Revised Statutes pertaining to wages, hours, and employment on public works projects and shall forfeit amounts and be subject to fines set forth therein for noncompliance with the provisions of the statute.

B. The Contractor shall pay for the overtime of all employees of the Contracting Agency who, as a result of the Contractor's operation, are required to perform inspections or testing beyond the normal hours of the established working day hours, and in accordance with Subsection 105.11, "Inspection."

C. The Contractor will be billed at the base overtime rate, including fringe benefits, equipment costs, and administrative costs.

D. Failure on the part of the Contractor to reimburse the Contracting Agency for these overtime costs, as described in this section, will result in retention monies being held until such time as full reimbursement is made.

E. In no way shall the reimbursement of overtime costs of the Contracting Agency, as a result of the Contractor's operation, be intended to give authorization to the Contractor to perform normal work beyond the normal hours of the established working day hours as stated herein.

110.02 SAFETY REQUIREMENTS

A. The Contractor's construction materials, equipment, methods, and workmanship shall be in accordance with applicable local ordinances, state laws including the Industrial Safety, Nevada Occupational Safety and Hazard Act, Nevada Industrial Commission, and federal requirements.

110.03 STATE MUSEUMS

A. The Contractor shall comply with all provisions of Nevada Revised Statutes, Chapter 381, "State Museums," Section 17, as follows:

1. All departments, commissions, boards, and other agencies of the State and its political subdivisions shall cooperate with the survey in order to salvage or preserve historic, prehistoric, or paleoenvironmental evidence located on property owned or controlled by the United States, the State of Nevada, or its political subdivisions.

2. When any agency of the State or its political subdivisions is preparing or has contracted to excavate or perform work of any kind on property owned or controlled by the United States, the State of Nevada, or its political subdivisions which may endanger historic, prehistoric, or paleoenvironmental evidence found by the survey to be on the property or when any artifact, site, or other historic or prehistoric evidence is discovered in the course of such excavation or work, the agency or the contractor hired by the agency shall notify the survey and cooperate with the survey to the fullest extent practicable to preserve or permit study of such evidence before its destruction, displacement, or removal.

3. The provisions of this section shall be made known to all private contractors performing such excavation or work for any agency of the state or its political subdivisions.

4. The Contractor shall also, immediately, report any historic, prehistoric, or paleoenvironmental evidence found on the site to the Contracting Agency or the Engineer.

SECTION 111

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SECTION 201

CLEARING AND GRUBBING

DESCRIPTION

201.01.01 GENERAL

A. 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.

MATERIALS

201.02.01 BLANK

CONSTRUCTION

201.03.01 GENERAL

A. 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. Subsection 107.21, "Dust Control" shall be complied with.

201.03.02 AREAS TO BE CLEARED

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

1. The entire area upon which the project construction is to be performed to the width of the excavation and embankment slope lines.
2. Ditch and dike areas to the width of the slope lines.
3. Areas on which service roads 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.
4. Designated material sites and designated borrow pits.
5. Areas designated in the plans or Special Provisions.

201.03.03 CLEARING AND GRUBBING

A. Surface objects and 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 6 inches above the ground line or low water level, and are a minimum of 3 feet below subgrade or embankment slope.

B. The Engineer may permit sound stumps to be cut off not more than 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.

C. 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, the trees shall be cut in sections from the top down.

D. There shall be no burning unless approval has been given in writing by the Clark County Air Pollution Control Officer and this approval concurred with 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.

E. 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 Project Right-of-Way."

F. Except in areas to be excavated, stump holes and other holes from which obstructions are removed shall be backfilled with suitable materials and compacted in accordance with Subsection 203.03.18, "Compaction, Dirt Embankment" or Subsection 203.03.19, "Compaction, Rock Embankment" if within the staked prism. Payment for backfilling and compacting will be considered subsidiary to other items of the work and no further compensation will be made therefor.

G. 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 shall be removed prior to final acceptance of the project.

H. 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 road shall be trimmed to give a clear height of 20 feet above the road surface. All trimming shall be done by skilled workmen and in accordance with good tree surgery practices.

I. 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.

J. 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 4 feet or more in height to subgrade elevation.

METHOD OF MEASUREMENT

201.04.01 MEASUREMENT

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

1. **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.

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

3. **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.

4. **Individual Unit Basis:**

   a. The diameter of trees will be measured at a height of 24 inches above the ground. Trees less than 6 inches in diameter will be classed as brush.

   b. Stumps of over 6 inches in diameter will be measured by individual count.

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

BASIS OF PAYMENT

201.05.01 PAYMENT

A. 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:

1. **Area Basis:** The quantities determined will be paid for at the contract unit price bid per acre.

2. **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.

3. **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.

4. **Individual Unit Basis:**

   a. 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.

   b. 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."

5. **Exclusion:** When the bid schedule does not contain an estimated quantity or 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.

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

C. Payment will be made under:

PAY ITEM	PAY UNIT
Clearing and Grubbing	Acre, Station, Miles, Lump Sum
Remove Trees	Each
Remove Stumps	Each

SECTION 202

REMOVAL OF STRUCTURES AND OBSTRUCTIONS

DESCRIPTION

202.01.01 GENERAL

A. This work shall consist of the removal, wholly or in part, and satisfactory disposal of all buildings, fences, guardrails, structures, old pavement, abandoned pipelines, 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.

MATERIALS

202.02.01 BLANK

CONSTRUCTION

202.03.01 GENERAL

A. The Contractor shall raze, remove, and dispose of all buildings and foundations, structures, guardrail, culvert 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 material shall be disposed of in accordance with Subsection 107.14, "Disposal of Material Outside Project 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 Subsection 203.03.18, "Compaction, Dirt Embankment" or Subsection 203.03.19, "Compaction, Rock Embankment."

202.03.02 REMOVAL

A. Bridges, culverts, and other drainage structures in use by traffic shall not be removed until satisfactory arrangements have been made to accommodate traffic.

B. 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.

C. 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 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.

D. 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.

E. Bituminous pavement shall be removed to clean straight lines. Saw cutting of edges to be joined is required. Where only the surface of existing bituminous pavement is to be removed by heater-planing, or by other approved methods, a minimum laying depth of 1 inch of new pavement material shall be provided at the joint line. Where bituminous pavement adjoins a trench, the edges adjacent to the trench shall be saw cut to neat straight lines before resurfacing.

F. Concrete pavement shall be removed to neatly sawed edges. Saw cuts shall be made to a minimum depth of 1-1/2 inches. If a saw cut in concrete pavement falls within 3 feet of a construction joint, cold joint, expansion joint, or edge, the concrete shall be removed to the joint or edge. The edges of existing concrete pavement adjacent to trenches, where damaged subsequent to saw cutting of the pavement, shall again be saw cut to neat straight lines for the purpose of removing the damaged pavement areas. Such saw cuts shall be either parallel to the original saw cuts or shall be cut on an angle which departs from the original saw cut not more than 1 inch in each 6 inches.

G. Concrete curb, walk, gutters, cross gutters, driveways, and alley intersections shall be removed to nearest score line or joint.

H. In removing manholes, catch basins, and inlets, any live sewers connected to item 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 and any necessary backfill shall be placed and compacted to specifications.

202.03.03 EXTENSIONS

A. 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

A. Existing culverts within construction limits, the top of which are 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 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 2 feet, plus the height of the opening of the structure.

202.03.05 SALVAGE

A. 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."

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

C. Guardrail, culvert markers, and guide posts designated for reuse shall be removed in such a manner that 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 ensure the maximum salvage value for the entire operation. Attention is directed to Section 618, "Guardrail," and Section 619, "Object Markers and Guide Posts."

D. 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.

E. When re-lay 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 re-lay, the Contractor shall salvage and clean sufficient amount of the best available pipe to satisfy the re-lay pipe item.

F. 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

A. 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.

B. When the placement 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 accordance with Subsection 107.14, "Disposal of Material Outside Project Right-of-Way." The material shall not be placed where it will obstruct any drainage course.

C. When concrete or masonry is placed in embankments, it shall be placed in accordance with Subsection 203.03.16, "Embankment Materials."

METHOD OF MEASUREMENT

202.04.01 MEASUREMENT

A. 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.

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

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

BASIS OF PAYMENT

202.05.01 PAYMENT

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

B. 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 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.

C. 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.

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

E. Payment will be made under:

PAY ITEM	PAY UNIT
Removal of Structures and Obstructions	Lump Sum
Removal of (Item)	Each, Linear Feet, Stations, Miles, Square Yards

SECTION 203

EXCAVATION AND EMBANKMENT

DESCRIPTION

203.01.01 GENERAL

A. 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 slope rounding, structure excavation, or other separately designated pay items of work, which are made a part of the contract. All work shall be in conformity with the alignment, grades, and cross sections shown on the plans or established by the Engineer.

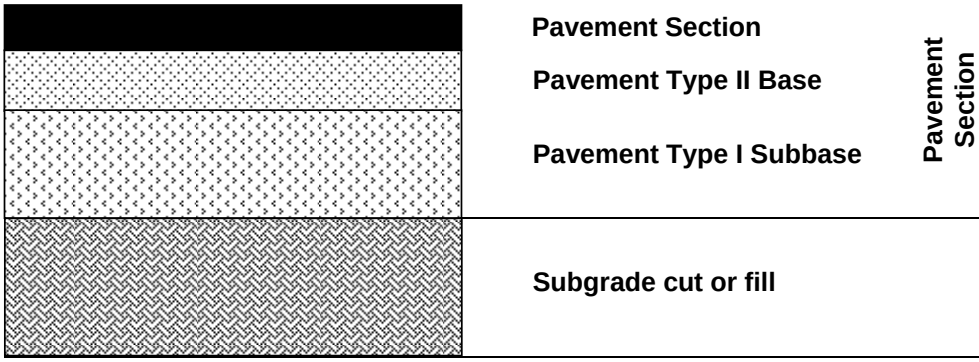

Figure 1- Definition of Terms

MATERIALS

203.02.01 ROADWAY EXCAVATION

A. 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 excavation, 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 classifications.

203.02.02 DRAINAGE EXCAVATION

A. Drainage excavation shall include all excavation in the construction of open ditches less than 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

A. Channel excavation shall include all excavation in the construction of open ditches or stream channels with a bottom width of 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

A. Borrow shall consist of approved material excavated and used in the construction of fills, or for other construction purposes. Borrow shall be material that is excavated from sources specified in the Special Provisions or designated by the Engineer. The source of material to be excavated shall be approved in advance by the Engineer. Borrow shall be excavated to the lines and grades established by the Engineer.

B. The Contractor shall notify the Engineer, sufficiently in advance, of opening any borrow site so that adequate time will be allowed for testing the material and establishing cross section elevations and measurements of the ground surface. 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

A. 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.

B. Selected borrow shall conform to the requirements set forth in the Special Provisions.

CONSTRUCTION

203.03.01 ROADWAY

A. All excavation shall be made true to lines and grades staked by parties under the supervision of a Nevada licensed professional land surveyor working for the Engineer or Contractor 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.

B. The work done under this section shall begin at some definite point or points on the project subject to the approval of the Engineer, and the work shall progress toward completion in an orderly manner. The roadway shall be graded to full cross section width before placing base or surfacing of any type, unless otherwise specified.

C. Intersecting roads, service highways, ramps, approaches, and driveways shall be graded as shown on the plans or established by the Engineer.

D. 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 specifications herein or disposed of in a manner satisfactory to the Engineer. Excavated material shall not be wasted without permission.

203.03.02 GRADE TOLERANCE

A. Immediately prior to placing subsequent layers of material thereon, the grading layer shall conform to one of the following:

1. The subgrade shall not vary more than 0.10 foot above or below the grade established by the Engineer or Contractor.
2. The final subgrade layer prior to application of the structural base shall not vary more than zero foot above or 0.10 foot below the grade.

203.03.03 UNSUITABLE MATERIAL

A. Unsuitable material shall be defined as soil 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.

B. 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 specified below under embankment.

C. Disposal of material outside the right-of-way shall be in accordance with Subsection 107.14, "Disposal of Material Outside Project Right-of-Way."

203.03.04 BLASTING

A. 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 no additional cost to the Contracting Agency. 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.

B. The use of coyote holes in blasting is prohibited. Attention is directed to Subsection 107.10, "Explosives."

203.03.05 ROCK CUTS

A. 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 damage to the roadbed resulting from Contractor's operations.

B. 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.

C. 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 12 inches from the true slope.

203.03.06 OVERBREAK

A. Overbreak is that portion of material excavated, displaced or loosened outside and beyond the slopes or grade as staked or re-established, 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 203.03.11, "Slides and Slipouts," and that portion of rock subgrade as set forth below shall not be considered overbreak. All side slope overbreak as so defined shall be removed by the Contractor and shall be disposed of in the same manner as provided for the surplus under the heading of "Surplus Material," but at no additional cost to the Contracting Agency and without any allowance for overhaul.

B. Rock removed to a maximum depth of 6 inches below subgrade will be measured for payment as described in Subsection 203.04.01.C.2, "Overbreak."

203.03.07 SLOPES

A. 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 or blade grader operations.

203.03.08 WIDENING CUTS

A. 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.3, "Widening Cuts."

203.03.09 SURPLUS MATERIAL

A. 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.

B. If the quantity of surplus material is specified in the contract documents, such quantity shall be considered approximate only. The Contractor shall verify 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 the Contractor and no compensation will be allowed the Contractor for such replacement.

203.03.10 SELECTED MATERIAL

A. 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 right-of-way, or in the excavation or borrow, shall be used for finishing the top portion of the subgrade. The top portion of the subgrade shall be 2 feet in depth, or as determined by the Engineer.

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

C. When practical, selected material shall be hauled directly from excavation to its final position and compacted in place and such work shall be paid for at the contract unit price for the excavation item involved. Attention is directed to Subsection 104.05, "Rights In and Use of Materials Found on the Work."

D. When the transporting of selected material directly from excavation to its final position 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 and stockpiling locations shall be designated by the Engineer. The selected material shall be removed from the stockpile and placed in final position when approved by the Engineer.

E. Measurement for payment of selected material will be in accordance with Subsection 203.04.01.C.4, "Selected Material."

203.03.11 SLIDES AND SLIPOUTS

A. Material outside the planned roadway or ditch slopes that is unstable and constitutes potential slides in the opinion of the Engineer, material from slides that has come into the roadway or ditch, and material that 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 a manner approved by the Engineer. Such material shall be used in the construction of the embankments or disposed of as approved by the Engineer.

B. 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.C.6, "Slides and Slipouts."

203.03.12 DRAINAGE

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

B. 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. The bottom of the finished ditches shall not be less than 2 feet 6 inches below the crest of the loose material piled on the downhill side.

C. In going from cut-to-fill, the roadway ditches shall be so cut as to avoid damage to embankments by erosion.

D. 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.

203.03.13 CHANNELS

A. To avoid destruction of natural growth during construction of ditches, channels, or dikes, travel of equipment shall be confined to the construction limits. Where ditches, channels, and dikes are nearly parallel to the roadway, turn-around shall not be located closer than 200 feet apart. Attention is directed to Subsection 107.12, "Protection and Restoration of Property and Landscape."

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

203.03.14 BORROW

A. 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, the Contractor shall, at no additional cost to the Contracting Agency, 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.

B. The Contractor 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.

C. 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 the Engineer's investigation shows that there is not sufficient quantity of acceptable material, the Engineer shall designate an alternate deposit from which to obtain the deficit.

D. 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 material.

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

F. The Contractor shall notify the Engineer 30 days 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 of the borrow material shall be allowed.

G. 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 Section 626, "Final Cleanup." Unless otherwise permitted, borrow pits shall be excavated so that the pits will drain to the nearest natural outlet.

H. All materials that 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.

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

J. All work and materials required to build and maintain borrow haul roads and obliteration of haul roads in accordance with Section 626, "Final Cleanup" shall be considered subsidiary to the "borrow" item and no further compensation will be allowed.

203.03.15 FOUNDATION

A. 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 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 no additional cost to the Contracting Agency, unless the width of excavation required by the Engineer exceeds 6 feet, in which case the excavated material in excess of 6 feet will be measured and paid for as roadway excavation.

B. All foundations for embankment shall be cleared and grubbed in accordance with Section 201, "Clearing and Grubbing."

C. In designated areas, unsuitable material shall be removed and disposed of as prescribed in Subsection 203.03.03, "Unsuitable Material."

D. Where 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 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 measured and paid for as roadway excavation unless the contract documents specifically call for payment under Section 202, "Removal of Structures and Obstructions."

203.03.16 EMBANKMENT MATERIALS

A. 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.

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

C. When there is a choice of material, the excavation shall be made so the best material will be placed on top of the embankment for at least 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 203.03.10, "Selected Material."

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

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

203.03.17 PLACING EMBANKMENT

A. 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."

B. Where structure abutments are placed on embankment, the embankment shall be constructed to subgrade elevation prior to excavating for the construction of the abutment. Where the abutment is supported on piles, the embankment shall be constructed to the elevation of the bottom of the footing.

C. Where a structure is to be covered by a rockfill, it shall be covered with not less than 2 feet of satisfactory soil or granular materials before the rock embankment is placed over the structure.

D. Embankments shall, except as specified herein, be constructed in layers. The construction of embankments shall begin at the lowest point of the fill below the grade or 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 12 inch maximum thickness after compaction. Excepted provisions for placing in marsh and placement of rock are outlined below. Hauling equipment shall be routed to obtain uniform compaction and channelization of haul routes and rutting of the fill shall be avoided.

E. When embankments are constructed across wet or swampy ground that 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. This shall be 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.

F. It is not the policy of the Contracting Agency 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 the Contractor had originally contemplated in order to comply with the foregoing, such shall not be the basis for a claim for extra compensation against the Contracting Agency. 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.

G. Embankment which, in the opinion of the Engineer, contains enough rock larger than 4 inches to make it impractical to place and compact in 1-inch lifts 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 1-1/3 times the vertical dimension of maximum size material larger than 8 inches. The largest size rock allowed in the embankment will be 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 3 feet and be disposed of in an inconspicuous manner approved by the Engineer.

H. 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 to work the fines and smaller rock into the spaces between the larger rock. Compaction will be required as provided in Subsection 203.03.19, "Compaction, Rock Embankment."

I. To the extent of project requirements for embankments, all rock from excavation shall be used for embankment. The Contractor shall plan the grading operation to use rock that may be encountered in excavation in accordance with the following provisions:

J. Rock, in general, shall be placed to form the base of embankment for the full width of the cross section under the following condition*:*

1. on the side slope or slopes of a new embankment being placed; or
2. on the side slope or slopes of an embankment already in place requiring widening; or where excess rock may be wasted; or
3. on the side slopes and top of rolled embankment made of embankment materials other than rock.

K. 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.

L. 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.

M. 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.

N. 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 time has been reached.

203.03.18 COMPACTION, DIRT EMBANKMENT

A. Optimum moisture content and material density of the various soils will be determined by a Geotechnical Engineer and acceptable ranges for optimum moisture and material density shall be approved by the Engineer. At the time of compaction, the moisture content of the various soils shall be within the approved ranges.

B. The compacted subgrade shall be maintained at a minimum of optimum moisture content until placement of an aggregate base course or cement treated base.

C. 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 of 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.

D. Hauling and leveling equipment shall be routed over each layer of the fill in such a manner as to uniformly distribute the compaction afforded by the wheel load. In addition to hauling and leveling equipment, the Contractor shall provide compaction equipment that is specifically designed and manufactured for compacting dirt embankments. The compaction equipment shall work continuously with the grading equipment.

E. The top 8 inches of the base of cuts and natural ground having less than 5 feet of embankment, measured from the subgrade, and all embankment material, shall be

compacted to not less than 90 percent relative compaction unless otherwise specified. When natural ground material is encountered that cannot be compacted to the required density, compaction requirements shall be determined by the Engineer.

F. All selected borrow and structure backfill placed within the limits of embankment shown on the plans for approaches to bridges shall be compacted to not less than 95 percent relative compaction unless otherwise specified.

G. 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.

203.03.19 COMPACTION, ROCK EMBANKMENT

A. Field density tests will not be required on rock embankments. In lieu thereof, the required compaction shall be tested by proof rolling. Unless otherwise specified, compaction shall be attained and tested by using construction methods and equipment as follows:

1. Methods:

   a. The material for the embankment shall be deposited, spread, and leveled the full width of the embankment, and the layer of thickness may be 1-1/3 times the vertical dimension of maximum size material. The maximum size rock shall not exceed 3 feet.

   b. 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. Rollers, vibrators, or compactors shall compact the embankment full width with a minimum of 3 complete passes for each layer of embankment. The compacting equipment shall not exceed a speed of 5 miles per hour and shall work continuously with the grading equipment.

   c. Rolling shall be done in a longitudinal direction along the embankment and shall 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 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.

   d. Water shall be applied to the embankment in the amount necessary to obtain the required compaction.

2. Equipment:

   a. Compaction equipment shall be adequately designed to obtain compaction requirements without adverse shoving, rutting, displacement, or loosening and shall meet the requirements specified herein. Rollers shall have displayed thereon in permanent legible characters, the manufacturer's guaranteed net operating weights as distributed on each axle.

   b. The proof roller shall be a pneumatic-tired roller or pneumatic-tired compactor weighing not less than 50 tons , and capable of applying to the ground loads of not less than 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

90 psi. The tires shall be kept uniformly inflated so that the difference in pressure in any 2 tires shall never exceed 5 psi and means shall be provided by the Contractor for checking the tire pressure on the job at any time.

3. Tests:

   a. 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 Contractor with approval of the Engineer.

   b. Rolling and proof rolling may be deleted on any layer or portion thereof when, in the judgment of the Engineer, accomplishment is physically impractical.

   c. 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.

4. The Contractor shall submit an inspection report to the Engineer that has been reviewed and stamped by a Nevada professional engineer.

203.03.20 MAINTENANCE

A. Embankment material that 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 material used.

B. The Contractor shall, at no additional cost to the Contracting Agency, 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 the Contractor's part.

203.03.21 SUBGRADE TOLERANCE

A. Subgrade shall comply with Subsection 203.03.02, “Grade Tolerance.”

METHOD OF MEASUREMENT

203.04.01 MEASUREMENT

A. 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 the Engineer's opinion, is best suited to obtain an accurate determination.

B. The quantity of excavation to be measured for payment shall be the number of cubic yards excavated and placed as shown on the plans and as directed by the Engineer. The estimated quantities shown on the plans, plus or minus authorized changes will be the quantity used for payment. Additional measurement of excavation quantities will not be made for methods or equipment chosen by the Contractor for the Contractor's convenience. The Contracting Agency or the Contractor may 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 Contracting Agency for the Agency's expenses incurred by such final measurement and calculation.

C. 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 outlined below:

1. **Unsuitable Material:**

   a. 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." However, if removal and disposal of unsuitable material not shown on the plans required special equipment or unusual operations, it may be paid for as extra work according to the provisions of Subsection 104.03, "Extra Work."

   b. No measurement will be made of suitable material temporarily removed and replaced to facilitate compaction of material.

2. **Overbreak:**

   a. All sideslope overbreaks as defined in Subsection 203.03.06, "Overbreak," shall not be paid for. Rock removed to a maximum depth of 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 and approved by the Engineer and will be measured and paid for at the contract unit price for the material used.

   b. Rock loosened or removed in excess of 6 inches below subgrade will not be measured nor 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.

3. **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."

4. **Selected Material:** Selected material stockpiled as provided in Subsection 203.03.10, "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.

5. **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.

6. **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."

D. 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."

E. 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."

F. Only those quantities of slide or slipout material that are authorized and actually removed will be measured for payment.

G. Excavation in excess of the staked or authorized cross section will not be measured for payment, except as outlined above.

H. 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 when removed from the surcharge position.

I. Earthwork quantities within the limits of "Slope Rounding" will not be measured for payment.

J. V-type ditches will be measured parallel to the ground and each 100 linear feet shall constitute a unit of measure. The volume of excavation for such ditches will not be measured for payment.

K. 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.

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

BASIS OF PAYMENT

203.05.01 PAYMENT

A. 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. Compensation for roadway excavation shall include excavating, loading, hauling, depositing, spreading, compacting, and maintaining the material complete and in place which includes all labor, tools, equipment for removal of existing asphalt paving, saw cutting of existing paving, scarifying the existing subgrade or subbase, all miscellaneous grading of shoulders, ditches, and transitions, and incidentals as necessary, as shown on the drawings, as specified herein, and as required by the Engineer.

B. All costs for disposal of surplus materials is considered to be included in the contract price paid per cubic yard of roadway excavation and no additional payment will be made therefor.

C. 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 shall be full compensation for furnishing all materials, loading, hauling, depositing, spreading, watering, compacting, and maintaining the material complete and in place.

D. The contract unit price bid per cubic yard for roadway excavation, borrow excavation, and channel excavation shall be considered as including payment for all haul.

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

F. 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, Ton
Selected Borrow Excavation	Cubic Yard, Ton

TESTING

203.05.02 TESTING

SECTION	DESCRIPTION	TEST	REFERENCE SPECIFICATION AND/OR TEST PROCEDURE	RECOMMENDED FREQUENCY
203.02.01	Roadway Excavation (Subgrade)	Field Density	AASHTO T 310	1/5000 SF
203.02.02	Drainage Excavation (Subgrade)	Field Density	AASHTO T 310	1/5000 SF
203.02.03	Channel Excavation (Subgrade)	Field Density	AASHTO T 310	1/5000 SF
203.02.04	Borrow	Sieve Analysis	AASHTO T 11 & T 27	1/Type
		Plasticity Index	AASHTO T 89 & T 90	1/Type[1]
203.02.05	Selected Borrow	R-Value	AASHTO T 190	1/Type
		Proctor	AASHTO T 180	1/Project or Change
203.03.01	Roadway At Grade or Fill (Subgrade)	Field Density	AASHTO T 310	Residential = 1/5000 SF/Lift/Day
				Arterial and Collector = 1/5000 SF/Lift/Day
203.03.10	Selected Material	Sieve Analysis	AASHTO T 11 & T 27	1/1000 LF
		Plasticity Index	AASHTO T 89 & T 90	1/1000 LF
		R-Value	AASHTO T 190	1/Type
		Field Density	AASHTO T 310	1/5000 SF/Lift/Day
		Proctor	AASHTO T 180	1/Project or Change
203.03.15	Foundation[2] (Subgrade)	Field Density	AASHTO T 310	1/500 SF/Lift/Day
		Proctor	AASHTO T 180	1/Project or Change
203.03.18	Embankment	Field Density Fill	AASHTO T 310	1/5000 SF/Lift/Day
		Field Density Native Below Embankment Fill Operations	AASHTO T 310	1/5000 SF/Lift/Day
		Proctor	AASHTO T 180	1/Project or Change
203.03.19	Rock Embankment	Visual	Issue Inspection Report	Full Time

[1] A maximum testable lift is defined as a 12-inch layer of compacted material.
[2] This is in reference to benched slope construction of embankment only.

SECTION 204

ROUNDED AND TRANSITION SLOPES

DESCRIPTION

204.01.01 GENERAL

A. This work shall consist of rounding and shaping slopes in accordance with the plans and where designated by the Engineer.

MATERIALS

204.02.01 BLANK

CONSTRUCTION

204.03.01 GENERAL

A. The top of cut slopes shall be rounded by excavating to blend the cut slopes with the adjacent natural terrain. At the intersections of cuts and fills, slopes shall be adjusted and warped to blend into each other or into the natural ground surface without noticeable break.

B. 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 the 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.

C. Slopes rounding and warping shall also apply to all drainage ditches when such rounding will improve the appearance of the roadside.

D. 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.

E. The degree of smoothness required in rounding and warping slopes shall be as specified in Subsection 203.03.07, “Slopes.”

METHOD OF MEASUREMENT

204.04.01 MEASUREMENT

A. The quantity of rounded cut 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 100 feet shall constitute the unit of one station. Earthwork quantities with in the limits of “Slope Rounding” will not be measured for payment.

B. All measurements will be made in accordance with Subsection 109.01, “Measurement of Quantities.”

BASIS OF PAYMENT

204.05.01 PAYMENT

A. 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.

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

C. Payment will be made under:

PAY ITEM	PAY UNIT
Slope Rounding	Stations

SECTION 205

BLANK

This section reserved for future use.

SECTION 206

STRUCTURE EXCAVATION

DESCRIPTION

206.01.01 GENERAL

A. This work shall consist of the removal of all material of whatever nature encountered in the construction of foundations for bridges, retaining walls, headwalls for culverts and other structures; the excavation of trenches for pipe culverts, box culverts, cut-off 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, which shall include 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.

B. For separate 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

A. 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.

MATERIALS

206.02.01 BLANK

CONSTRUCTION

206.03.01 GENERAL

A. The Contractor shall notify the Engineer in 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.

B. 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.

C. Unless otherwise permitted by the Engineer, foundations shall be compacted to not less than 90 percent relative compaction for culvert pipe and not less than 95 percent relative compaction for structures. For fine-grained soils, which are classified by having 50 percent or more passing the No. 200 sieve, the relative compaction may not be less than 90 percent for structures if approved by the Engineer.

D. 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.

E. Where masonry is to rest on material other than rock or boulders, special care shall be given not to destroy its bearing value.

F. Should the Contractor remove structure excavation below grade, the Contractor shall backfill to the required elevation at no additional cost to the Contracting Agency with backfill in a manner satisfactory to the Engineer.

G. Wet pits shall be dewatered for inspection and for construction of foundations unless otherwise provided.

H. 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 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 a 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.

I. 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.

206.03.02 SAFETY REQUIREMENTS AND REGULATIONS

A. The Contractor shall follow OSHA safety regulations (29 CFR, Part 1926, Subpart P, Excavations) for sloping the sides of excavations, using shoring and bracing, and for using other safety features. When the sides of excavations are sloped for safety considerations, the Contractor shall provide, for informational purposes, one copy of the design that demonstrates conformity with OSHA regulations to the Engineer. Where support systems, shield systems, or other protective systems are to be used, the Contractor shall be responsible for their design and shall submit design calculations along with detailed drawings that demonstrate conformity with OSHA regulations to the Engineer. These calculations and detailed drawings shall be stamped and signed by a professional engineer licensed to practice in the state of Nevada. The design calculations and detailed drawings are considered working drawings and shall be submitted in accordance with Subsection 105.02, “Plans and Working Drawings.”

METHOD OF MEASUREMENT

206.04.01 BLANK

BASIS OF PAYMENT

206.05.01 PAYMENT

A. Unless otherwise provided in the Special Provisions, no payment will be made for structure excavation or backfill as such. The cost thereof under normal circumstances being considered as included in the price bid for the construction or installation of the items to which such excavation or backfill is incidental or appurtenant. Payment for such excavation or backfill will be made only when the Special Provisions so provides.

SECTION 207

STRUCTURE BACKFILL

DESCRIPTION

207.01.01 GENERAL

A. This work shall consist of placing and compacting, to the lines designated on the plans or as established by the Engineer, backfill material in excavations for bridges, retaining walls, headwalls for culverts, and other structures; placing and compacting backfill material for box culverts and other non-pipe culverts; and other backfill specifically designated in the contract documents as structure backfill. This item does not include backfilling pipes within a trench or minor miscellaneous structure excavations outside the limits of the roadway.

MATERIALS

207.02.01 SELECTED BACKFILL

A. Selected backfill shall be of a quality acceptable to the Engineer and shall consist of suitable material from the excavation complying to Table 1. It shall be free from sod, frozen earth, organic materials, rubbish, or debris. If the material does not comply with Table 1, it may be used only if approved by the Engineer.

Table 1 – Select Backfill Gradation

Sieve Sizes	Percentage of Weight Passing
6-inch	100
3-inch	80-100
No. 4	35-100

Table 2 – Select Backfill Maximum Plastic Index Requirement

Percentage by Weight Passing No. 200 Sieve	Plasticity Index Maximum
10-10.0	15
10.1-20.0	12
20.1-50.0	10
50.1-80.0	8
80.1-100.0	6

B. When the completed select backfill test results from the sample indicate a Plasticity Index of 12 or greater, a swell potential test may be required. Contact the Contracting Agency for further procedure requirements or comply with the contract Special Provisions.

C. The liquid limit of the material shall not exceed 50 percent maximum.

D. Stones or lumps exceeding 3 inches shall not be used within the zones 12 inches or less from the structure, 12 inches or less from the finish subgrade in unpaved areas, or 16 inches or less below the finish subgrade in paved areas.

E. Acceptable material from excavation "Selected Backfill" may be used for structure backfilling unless "Granular Backfill" is specified.

207.02.02 GRANULAR BACKFILL

A. Granular backfill shall consist of natural sand or a mixture of sand with gravel. Broken Portland cement concrete and bituminous type pavement will be permitted, subject to the gradation limits specified herein. The granular backfill material shall have a sufficient amount of fine material to fill the voids between the coarser aggregate.

B. In addition, the material shall conform to the following requirements:

Table 3 – Granular Gradation

Sieve Sizes	Percentage of Weight Passing
3-inch	100
No. 4	35-100
No. 16	25-100
No. 200	5-15

C. The plasticity index of the material shall be as specified in Subsection 704.03.01, "Plastic Limits."

D. The total available water soluble sulfate content of the material shall not exceed 0.3 percent by dry soil weight.

CONSTRUCTION

207.03.01 GENERAL

A. Compaction of backfill or embankment around all structures shall be in accordance with the requirements of AASHTO LFRD Bridge Construction Specifications with exceptions as described in this section. The compaction shall be performed with mechanical tamping units and the material shall be placed in layers of thickness compatible with the characteristics of the backfill and the type of equipment being used subject to approval by the Engineer.

B. Unless otherwise specified or approved by the Engineer, the compaction requirement shall be a minimum of 90 percent.

C. Mechanically compacted backfill shall be placed in layers of thickness compatible with the characteristics of the backfill and the type of equipment being used. Backfill material shall be placed in uniform horizontal layers with a maximum compaction depth of 12 inches and a maximum loose lift of 16 inches and shall be brought up uniformly on all sides of the structure or improvement.

D. Backfill material to be used around buried structures where water is present or anticipated to be present shall be carefully selected so that it will protect the surrounding soil from infiltrating into the backfill as determined by the Engineer. This select material shall serve as a filter material. If the drain material is to remove an appreciable quantity of water, graded filter drains using separate fine-grained layers for filters and coarse-grained layers to conduct the water may be required. As an alternate to using a filter material, a filter fabric may be placed between the backfill material and surrounding soil.

E. Material resulting from structure excavation and not used, shall be deposited in roadway embankments in accordance with the requirements specified elsewhere or otherwise disposed of in a manner approved by the Engineer and no additional compensation will be allowed for such work.

F. 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 80 percent of the required compressive strength and approved by the Engineer.

G. Backfill operations placed against concrete walls that will support any deck shall not be performed until after the deck has been placed.

H. 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

A. 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."

B. Where backfill is to be placed on one side of an abutment, wingwall, pier, or headwall, care shall be exercised to prevent displacement of line, or batter, or both.

C. Existing slopes that are shaped to cause wedge action in the backfill shall be step-cut or benched before backfilling.

207.03.03 PLACING AND COMPACTING AT CULVERTS

A. After the bedding has been prepared and the culverts installed or constructed as required by the pertinent specifications, "Selected Backfill" or "Granular Backfill" shall be placed along both sides of the culvert equally in uniform layers such that the elevation of the top of the backfill on either side of the culvert does not exceed the elevation of the top of the backfill on the other side of the culvert by more than 6 inches. The thickness of each layer shall be compatible with the characteristics of the backfill and the type of equipment being used, but shall not exceed 12 inches in depth after compaction nor a loose lift of 16 inches. Each layer shall be wetted as required and thoroughly compacted to the density requirements as set forth in Subsection 207.03.01, "General."

B. Special care shall be taken in placing and thoroughly compacting the material under the haunches of all pipe culverts.

C. Unless otherwise directed, the backfilling shall continue as directed to the level of the ground or to an elevation 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 reinforced concrete box culvert in projection.

D. No construction equipment or other traffic shall be permitted to cross any culvert until a safe minimum depth of fill above the culvert has been placed and compacted in accordance with these specifications. The Contractor shall be solely responsible for protecting the structure from superimposed loading by construction equipment and shall repair any damage to the structure or replace the structure as ordered without extra compensation.

E. 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

A. 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 displacing them from established line and batter.

METHOD OF MEASUREMENT

207.04.01 BLANK

BASIS OF PAYMENT

207.05.01 PAYMENT

A. Unless otherwise provided in the Special Provisions or Proposal, no payment will be made for structure excavation or backfill as such; the cost thereof under normal circumstances being considered as included in the price bid for the construction or installation of the items to which such excavation or backfill is incidental or appurtenant. Payment for such excavation or backfill will be made when the Special Provisions or Proposal provides.

TESTING

207.06.01 TESTING

Table 4 - Testing

Spec. Section	Description	Test	Reference Specification and/or Test Procedure	Recommended Frequency[1]
207.02.01	Selected Backfill	Sieve Analysis	AASHTO T11 & T27 USS 301 & Special Provisions	1/1000 CY
		Plasticity Index	AASHTO T89 & T90 USS 301 & Special Provisions	1/1000 CY
207.02.02	Granular Backfill	Sieve Analysis	AASHTO T11 & T27 USS 301 & Special Provisions	1/1000 CY
		Soluble Sulfates	AWWA 4500E	1/Type
207.03.01	General	Field Density	AASHTO T310	If Riding Equipment Used: 1/5000 SF/Lift
				If Walk Behind Equipment Used: 1/1000 SF/Lift Per Structure Per Day

[1] A maximum testable lift is defined as a 12-inch layer of compacted material.

SECTION 208

TRENCH EXCAVATION AND BACKFILL

DESCRIPTION

208.01.01 GENERAL

A. This work shall consist of the excavation and backfill of trenches for the accommodation of substructures including, but not limited to electrical conduits, telephone conduits, television cable, traffic signal conduits, gas lines, sewer lines, water lines, and storm drains except where governed by utility agency specifications. These other agencies are responsible for the trench to the top of subgrade (bottom of the pavement section).

B. When the terms "Backfill" or "Trench Backfill" are used herein, they shall be construed to mean one or more of the types of backfill specified below under "Materials."

C. The designing engineer shall comply with the intent of the pipe material as defined as either rigid or flexible in conformance with the AASHTO LRFD Bridge Design and Construction Specifications and this Section. Special attention shall be given to the sidewall material properties as this section assumes a minimum AASHTO A1 or A3 material. Other sidewall material type shall be given special consideration for minimum trench widths, the use of Controlled Low Strength Materials (CLSM), or other critical processes that would affect the pipe ability to withstand the load and shall also be noted on the plans and specifications for the project.

D. The type of pipe and applicable installation requirement (trench and embankment) to be used as demonstrated by the design and approved by the Agency Engineer shall be clearly noted on the drawings and specifications along with installation procedures that may differ from this section.

E. Quality control field inspection and testing requirements including frequency shall be in accordance with Contracting Agency requirements.

208.01.02 DEFINITIONS

A. **Foundation:** Over-excavation and backfill of the foundation is required only when the native trench bottom does not provide a firm-working platform for placement of the pipe bedding material.

B. **Bedding:** In addition to bringing the trench bottom to required grade, the bedding levels out any irregularities and ensures uniform support along the length of the pipe.

C. **Haunch Zone:** The backfill under the lower half of the pipe (haunches) distributes the superimposed loadings.

D. **Initial Zone:** The backfill from the springline to the top of the pipe zone provides the primary support against lateral pipe deformation for flexible pipe.

E. **Final Zone:** Backfill above the pipe zone to the top of subgrade.

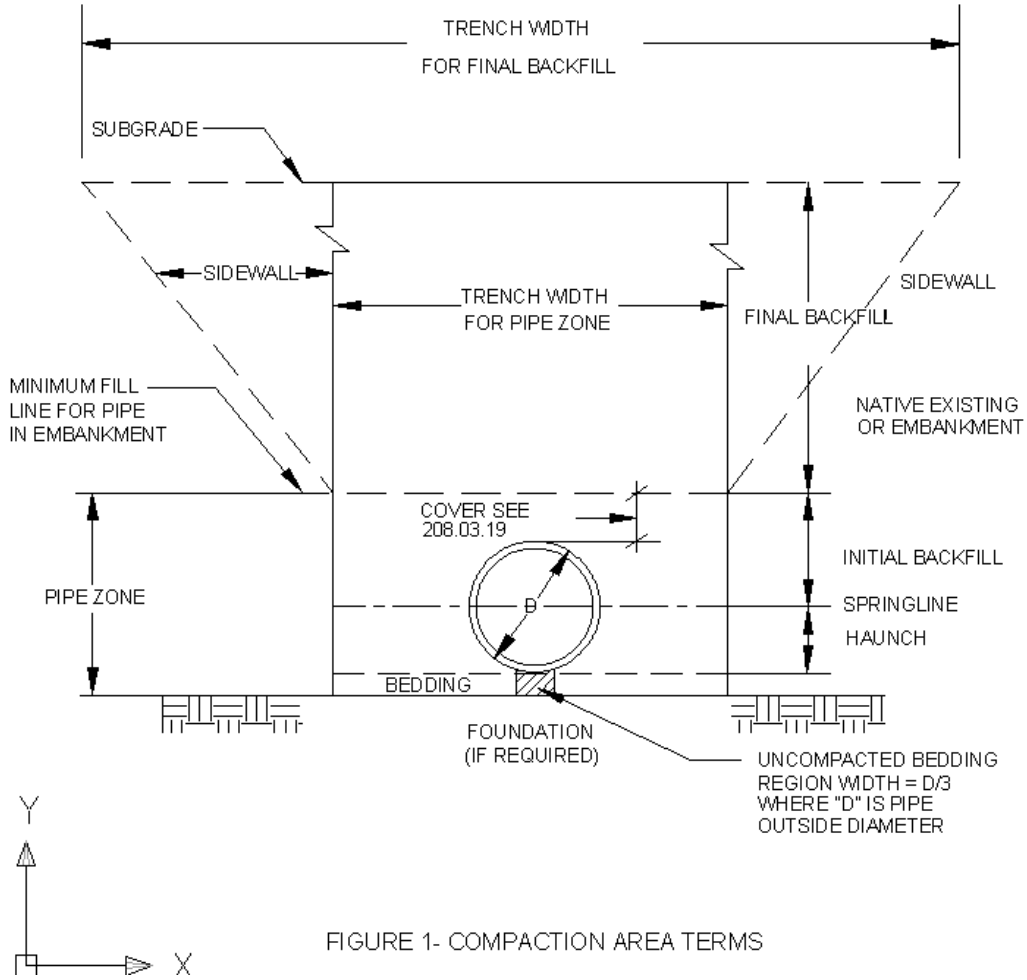

FIGURE 1- COMPACTION AREA TERMS

MATERIALS

208.02.01 GENERAL

A. The material placement in the pipe zone area shall first comply with Table 1, when applicable.

Table 1 - Pipe Zone Maximum Particle Size for Backfill

Nominal Pipe Size (inches)	Maximum Particle Size (inches)
2 to 4	1/2
6 to 8	3/4
10 to 16	1
18 and larger	1-1/2

B. One of two methods of compaction of the trench pipe zone shall be used and shall be specified in the Construction Documents and approved by the Engineer prior to construction:

1. **Method A:** The use of CLSM as defined in this section.

2. **Method B:** The use of aggregate materials as described in this section as associated with either Rigid or Flexible designed pipe shall be as specified in this subsection below.

C. Prior to construction, the materials and method type shall be submitted and approved by the Engineer.

208.02.02 SELECTED BACKFILL

A. This material shall be similar to that removed from the trench excavation or may be imported material as specified in Subsection 207.02.01, "Selected Backfill," or as otherwise shown on the Drawings.

208.02.03 GRANULAR BACKFILL

A. Granular backfill shall be as specified in Subsection 207.02.02, "Granular Backfill."

208.02.04 SAND BACKFILL (DRY UTILITIES ONLY)

A. Sand backfill shall consist of natural sand or a mixture of sand with gravel or stone. In addition thereto, the material shall conform to the following gradation requirements:

Table 2 - Sand Backfill Gradation

Sieve Sizes	Percentage of Weight Passing
3/8 inch	100
No. 4	80-100
No. 200	5-20

B. The plasticity index of the material shall be as specified in Subsection 704.03.01, "Plastic Limits." The soluble sulfate content shall not exceed 0.3 percent by dry weight of soil.

208.02.05 TYPE II AGGREGATE BASE BACKFILL

A. Type II aggregate base backfill shall be as specified in Subsection 704.03.04, "Type II Aggregate Base." The total available water soluble sulfate content shall not exceed 0.3 percent by dry weight of soil.

208.02.06 DRAIN BACKFILL

A. Drain backfill shall be as specified in Subsection 704.03.02, "Drain Backfill." The type shall be as shown on the plans or approved by the Engineer.

208.02.07 CONTROLLED LOW STRENGTH MATERIAL (CLSM)

A. Backfill shall be as specified in Subsection 704.03.07, "Controlled Low Strength Material."

208.02.08 CRUSHED ROCK

A. The materials properties shall conform to Subsection 704.03.06, "Crushed Rock."

208.02.09 TYPE III AGGREGATE

A. Aggregate properties and gradation shall conform to Type III as specified in Subsection 704.03.05, "Type III Aggregate," or as approved by the Engineer.

CONSTRUCTION

208.03.01 TRENCH EXCAVATION, GENERAL

A. Excavation including the manner of supporting excavation and provisions for access to trenches, shall comply with the current regulations as determined by NOSHA. Excavation shall include, without classifications, the removal of all materials of whatever nature encountered, including all obstructions of any nature that would interfere with the proper execution and completion of the work. The removal of said materials shall conform to the lines and grade shown. Excavation for pipe, wire, or conduits shall be by open trench unless otherwise specified or shown on the plans. However, should the Contractor elect to tunnel or jack any portion not so specified, he shall first submit a design by a Nevada Professional Engineer to and obtain an approval from the Engineer. The Contractor shall furnish, place, and maintain all supports and shoring that may be required for the sides of the excavation, and all pumping, ditching, or other approved measures for the removal or exclusion of water, including storm water and wastewater reaching the site of the work from any source so as to prevent damage to the work or adjoining property. The Contractor shall be responsible for any damage to persons or property due to interruption or diversion of storm or wastewater because of his operations. If due to delays in delivery of materials or for other reasons, and the Contractor is not expected to fully complete the work within any excavated area in a reasonable length of time as determined by the Engineer, the Engineer may require the Contractor to backfill the excavation and re-excavate when the work can be completed expeditiously, with no additional payment therefor.

B. Except as otherwise shown or provided herein, excavation shall be open cut trenches with vertical sides up to the top of the pipe zone.

208.03.02 MINIMUM TRENCH WIDTH

A. Excavation of pipe trench for flexible and rigid pipe is as required in Table 3 and this width is only applicable for trenches that have trench sidewall of native material"" which meets the classification class A1 or A3 installation as defined in AASHTO M145 table. In all cases, the trench width shall be wide enough to allow for the compaction equipment.

Table 3 - Minimum Trench Widths

Flexible Pipe	Minimum shall be not less than 1.5 times the pipe outside diameter plus 12 inches
Rigid Pipe	Minimum shall be not less than the outside diameter plus the outside diameter times 0.33

B. For pipe backfill using CLSM, the minimum trench width may be reduced to the pipe diameter plus 12 inches and enough room needed to allow for the proper placement of the CLSM using tools to "spade" the material under the pipe haunches. This condition applies only for trench sidewalls meeting the minimum AASHTO material class A1 or A3.

C. If the sidewall trench soil is classified other than AASHTO Class A1 or A3, a recommendation by a Nevada Professional Engineer shall be submitted and approved by the Engineer prior to construction. However, minimum trench width shall not be less than the minimum stated in this section.

208.03.03 MAXIMUM TRENCH WIDTH

A. The maximum width of the trench shall be determined by the Contractor based on the method and means for the installation. However, trench width shall not exceed the width of a ride-along compactor plus 2 feet when working along side the pipe or culvert. If for

any reason this maximum trench width is exceeded, a higher strength of pipe may be required as determined by the Engineer with no additional cost to the Contracting Agency.

B. Except when otherwise specified or ordered by the Engineer, the bottom of the trench shall be excavated uniformly to the grade or depth indicated on the drawings. The maximum amount of open trench permitted in any one location shall be 500 feet, or the length necessary to accommodate the amount of pipe installed in a single day, whichever is greater, unless otherwise approved by the Engineer. Trench shall be considered open until backfilled to the top of subgrade. Trenches crossing streets shall be completely backfilled immediately after pipe, wire, or conduit installation.

C. Substantial bridging, properly anchored, capable of carrying the design loading, in addition to adequate trench bracing, shall be used to bridge across trenches at street crossings where trench backfill and temporary patches have not been completed during regular working hours. Safe and convenient passage for pedestrians and access to all properties shall be provided.

208.03.04 TRENCH OVER-EXCAVATION

A. Wherever the excavation is made below the grade shown on the drawings, or below the grade ordered by the Engineer, it shall be refilled to the required grade with suitable backfill and bedding material ""at no additional cost to the Contracting Agency.

B. Trench over-excavation below the specified level of bedding material, and additional backfill material, ordered by the Engineer where unsuitable materials are encountered, shall be paid by the appropriate contract item.

C. Trench over-excavation and backfill to control groundwater shall be at the option and expense of the Contractor; however, the backfill material shall comply with this specification and the approved design of the pipe.

208.03.05 DISPOSAL OF UNSUITABLE AND EXCESS EXCAVATED MATERIALS

A. Excess material and excavated material unsuitable for backfill shall be removed from the site of the work by the end of each working day unless otherwise approved by the Engineer and disposed of by the Contractor as specified in Subsection 107.14, "Disposal of Material Outside Project Right-of-Way."

208.03.06 CHANGES IN ALIGNMENT OR GRADE

A. In the event that changes in elevation of the trench of less than 6 inches are ordered by the Engineer, no changes in the contract amount will be allowed. When such changes in elevation are more than 6 inches or changes in alignment are made that change the character of the work required, the work shall be performed as specified in Subsection 104.02, "Increased or Decreased Quantities and Change in Character of Work."

208.03.07 PORTABLE TRENCH SHIELD

A. Portable trench shields or boxes that provide a moveable safe working area for installing pipe may be used for the installation of pipe. After placing the pipe in the trench, backfill material shall be placed in lifts and the shield shall be lifted to allow for the backfill material to be placed for each lift, trench wall to trench wall.

208.03.08 MINIMUM PIPE SPACING

A. If the pipe space between parallel pipes in a single trench is not conducive to mechanical backfill, then CLSM shall be used.

208.03.09 TRENCH BACKFILL

A. The backfilling of the trench differs in each zone due to the complexity of providing a secure support for the pipe as well as ensuring that all voids are filled to prevent nuisance water flow under the pipe. The zones are foundation, bedding, haunch, initial, and final as illustrated in Figure 1.

208.03.10 USE OF CLSM

A. CLSM may be placed in all installations. However, for flexible pipe, in the pipe zone region, either full CLSM or full aggregate backfill is required. There can not be applied a mixing of CLSM and aggregate fill layers due to the different stresses that can occur on the pipe at the interface of both types of products.

B. CLSM shall be placed directly into the space to be filled. The placement of CLSM shall include "spading" under the pipe haunches and into the corrugations or other difficult areas around a structure. Care shall be taken to prevent flotation or misalignment of the pipe by means of straps, soil anchors or other designed and approved means of restraint as per the manufacturer's recommendation. Material may be placed in stages equally on both sides of the pipe to prevent movement or flotation of pipe.

C. If Bonded Aggregate Fill (BAF) is to be used, it shall be as specified in Subsection 704.03.07, "Controlled Low Strength Material (CLSM)."

208.03.11 FOUNDATION

A. Trench foundation shall be stable prior to placing bedding material. If the Engineer determines that unsuitable materials exist at the trench foundation, the Contractor shall remove and replace the material as directed by the Engineer and as specified in Subsection 208.03.04, "Trench Over-Excavation."

208.03.12 PIPE BEDDING

A. **Dry Utilities:** Dry utilities shall be defined as facilities for fiber optics, electrical, telephone, television cable, traffic signals, and natural gas lines. Pipe bedding for dry utilities only may consist of sand in compliance with applicable utility agency's specifications. In all cases, when sand is used as a bedding material, the sand shall be moisture conditioned and mechanically compacted.

B. **Wet Utilities:** Wet utilities shall be defined as facilities for sewer lines, water lines, and storm drains. Except as otherwise provided herein, or in the Special Provisions, or as otherwise shown on the plans, the trench shall be excavated to a depth of at least 4 inches to 6 inches below the bottom of the pipe barrel and to a depth that will be sufficient to provide at least 2 inches of clearance under the pipe bell (where applicable).

C. Uniform and stable bedding shall be provided for the pipe and any protruding features of its joints and/or fittings with the exception that the middle of the bedding equal to 1/3 the pipe outside diameter shall be loosely placed (see Figure 1). The compaction shall be:

1. Compaction density minimum = 90 percent of the maximum density as determined by test method AASHTO T180 with exception of the middle uncompacted area.

D. The material for use as bedding shall be Type II/III Aggregate Base or CLSM complying with this section. Crushed Rock may be used to stabilize the trench foundation and shall be specifically approved by the governing agency.

E. Bedding shall be backfilled to the required grade of the bottom of the pipe. When Crushed Rock is used for foundation stabilization, the Contractor shall follow the same procedures described below in Subsection 208.03.16, "Drain Backfill."

F. All pipes shall be placed directly on the bedding material unless otherwise required or approved by the Engineer. If groundwater is present or anticipated to be present, the need for a filter material as specified in Subsection 207.03.01, "General," shall be reviewed and approval may be required by the Engineer.

208.03.13 HAUNCH ZONE BACKFILL

A. **Dry Utilities:** After pipe or conduit is laid, the haunch areas shall be backfilled with sand in compliance with applicable utility agency's specifications. In all cases, when sand is used as a backfill material, the sand shall be moisture conditioned and mechanically compacted.

B. **Wet Utilities:** After the pipe or conduit is laid, the haunch areas shall be backfilled with Type II, Type III, Aggregate Base Backfill, or CLSM. Crushed Rock or drain backfill may be used for the haunch zone only if material use has been specifically approved by the governing agency. If crushed rock or drain backfill is used, comply with Subsection 208.03.16, "Drain Backfill."

C. Compaction of the haunching material can best be accomplished by hand with tampers or suitable power compactors for maximum compacted lift thickness of 6 inches. The Contractor shall take care to not disturb the pipe from its line and grade and shall compact to:

1. Compaction minimum = 90 percent of the maximum density as determined by test method AASHTO T180.

D. While compacting the embedment near the pipe with impact-type tampers, caution shall be taken to not allow direct contact of the equipment with the pipe.

208.03.14 INITIAL ZONE BACKFILL

A. **Dry Utilities:** Initial zone backfill for dry utilities may consist of sand in compliance with applicable utility agency's specifications. In all cases, when sand is used as a backfill material, the sand shall be moisture conditioned and mechanically compacted.

B. **Wet Utilities:** After the pipe or conduit is laid, the initial backfill areas shall use Type II, Type III, Aggregate Base, or CLSM. Avoid usage of impact tampers directly above the pipe until the full loose layer backfill depth above the pipe is obtained. Crushed Rock or drain backfill may be used for the initial zone only if material use has been specifically approved by the governing agency. If crushed rock or drain backfill is used, comply with Subsection 208.03.16, "Drain Backfill." The depth of initial backfill above the pipe shall comply with Table 4:

Table 4 - Initial Zone Material Depths

Pipe or Conduit	Initial Zone
2-inch or less diameter	6 inches above the top of pipe
Greater than 2-inch diameter	12 inches above top of the pipe

208.03.15 FINAL ZONE BACKFILL

A. The remaining backfill shall consist of one of the following types as determined by the Engineer.

B. Granular, Selected, or CLSM Backfill. Backfill material from the initial backfill zone to a plane, which is below the bottom of the pavement section, shall be "Granular Backfill," "Selected Backfill," or CLSM.

1. The material shall be compacted to:

   a. Compaction minimum = 90 percent of the maximum density as determined by test method AASHTO T180.

   b. If "Selected Backfill" is used in trenches 2 feet or less in width, no stones or lumps greater than 3 inches will be permitted.

2. **CLSM:** When used, CLSM backfill shall be placed from the top of the initial backfill zone to the bottom of the bituminous pavement (top of aggregate base).

C. CLSM Cap: Unless otherwise specified by the Contracting Agency, a CLSM Cap shall be required in the upper portion of the Final Zone for all non-residential roadways with a minimum thickness of 12 inches for all minor collectors and 24 inches for all major collectors and arterials.

208.03.16 DRAIN BACKFILL

A. In the event that Drain Backfill is used to control groundwater, the Contractor shall, at no additional cost to the Contracting Agency, construct dams conforming to the requirements of Section 501, "Portland Cement Concrete," Class II CLSM, or compacted Type II Aggregate Base. Construct the dams within the drain rock bedding material at each manhole or at intervals of 600 feet, whichever is less. Dams shall extend the width of the trench, a minimum of 18 inches in length, for the height of the drain backfill, and where Type II is used, the compaction shall be:

1. Compaction minimum = 95 percent of the maximum density as determined by test method AASHTO T180.

B. The Contractor shall install nonwoven geotextile filter fabric between the bedding and backfill material in such a manner to prevent migration of the backfill material into the bedding whenever Drain Rock or Crushed Rock is used as bedding.

C. Geotextile filter fabric shall conform to the requirements specified in AASHTO M288, "Subsurface Drainage Geotextile."

208.03.17 COMPACTION

A. Compaction shall be performed by mechanical means. Mechanically compacted backfill shall be placed in layers of thickness compatible with the characteristics of the backfill and the type of equipment being used and shall have a maximum lift thickness as indicated in Table 5 - Compaction Lift Thickness. The lifts shall be placed on both sides of the pipe at the same time to reduce pipe movement.

Table 5 - Compaction Lift Thickness

Location	Maximum Compacted Lift Thickness (inches)	Maximum Loose Lift Thickness (inches)
Bedding, Haunch, and Initial Zones	6	8
Final Zone Backfill	12	16

B. Each layer shall be evenly spread, moistened, and tamped or rolled until the specified relative compaction has been attained.

C. Compaction minimum = 90 percent of the maximum density as determined by test method AASHTO T180.

208.03.18 TRANSITION INSTALLATIONS

A. When differential conditions of pipe support might occur, such as in transitions from manholes to trench, a transition support region shall be provided to ensure uniform pipe support and preclude the development of shear, or other concentrated loading on the pipe.

208.03.19 MINIMUM DEPTH OF COVER

A. The minimum cover shall be as stated on the plans and/or contract Special Provisions. For flexible pipe, the minimum cover for compaction process using wheel or hydro hammer loads is 24 inches. Equipment used for the initial zone shall allow compaction to the lift requirements of this specification without damage to the pipe.

208.03.20 TESTING

A. Where tests reveal non-compliance with the requirements of the Contract, the Contractor shall bear the costs of subsequent rework and retesting until the required specification compliance is obtained to the satisfaction of the Engineer.

208.03.21 CUTTING AND RESTORING STREET SURFACING

A. Prior to beginning work within any public right-of-way, or cutting any street surfacing therein, an encroachment permit and barricade plan approval shall be obtained from the governmental entity or agency having jurisdiction over that right-of-way.

B. Permit fees and construction restrictions shall be in accordance with the rules, regulations, and ordinances of the entity or agency having jurisdiction.

C. While undergoing improvements, all streets upon or within which any work is being done shall be kept open to all traffic by the Contractor, as specified in Subsection 104.04, "Maintenance of Traffic," unless otherwise approved by the Engineer, or as provided in the Special Provisions.

D. Prior to beginning the work, barricading and traffic control devices conforming to the latest editions of the Traffic Control Plans for Highway Work Zones for the Clark County Area and the *Manual on Uniform Traffic Control Devices* shall be in place, and shall be in compliance with the governmental agency approved traffic control and barricade plan.

E. Pavement in the area of the trench excavation may be wheel cut or spade cut.

F. Temporary Steel Plate Bridging: When approved by the Engineer or Contracting Agency, the Contractor may use steel plates to bridge excavated trenches in areas where the

roadway surface is to be opened to traffic. Steel plates shall have non-skid surfaces and shall extend at least 12 inches beyond the edges of the trench. Trenches shall be adequately reinforced to support the bridging and traffic loads. Trench plate thickness shall be at least 3/4 inches for a 1 foot wide trench and shall increase 1/8 inch for every foot of trench width up to a thickness of 1-1/4 inch for a 5 foot wide trench. Steel plates for trench widths greater than 5 feet shall require a special structural design. The placement and installation method for temporary steel plate bridging shall be as follows:

1. Method 1: Roadways with posted speeds of 45 mph and greater – The pavement shall be cold-planed to a depth equal to the thickness of the plate and to a width and length equal to the dimensions of the plate(s). The approach and ending plates shall be attached to the roadway by a minimum of 2 dowels pre-drilled into the corners of the plate and drilled 2 inches into the pavement, subsequent plates shall be butted to each other.

2. Method 2: Roadways with posted speeds less than 45 mph – Approach and ending plates shall be attached to the roadway by a minimum of 2 dowels pre-drilled into the corners of the plate and drilled 2 inches into the pavement. Subsequent plates shall be butted to each other. Fine graded asphalt concrete shall be compacted to form ramps with a maximum slope of 8.5% and a minimum 12 inch taper to cover all edges of the steel plates. When steel plates are removed, the dowel holes in the pavement shall be backfilled with either graded fines of asphalt concrete mix, concrete slurry, or an equivalent slurry approved by the Engineer.

G. Whenever permanent pavement patches are not constructed immediately following trench backfilling operations, temporary pavement patches consisting of a minimum of 2 inches of hot or cold plantmix or plates shall be utilized to provide the required number of paved travel lanes. Plates may be left in place for a maximum of 14 days or unless otherwise approved by the Engineer. Temporary pavement patches may be left in place for a maximum of 30 working days following completion of backfilling operations unless otherwise approved by the Engineer.

H. The following surface tolerance for temporary patches shall be observed. When a 12-foot straight edge is laid across the temporary patch parallel to the centerline of the street and in a direction transverse to the centerline, a rut, hump, or depression of more than 1/2 inch shall not be evident. Deteriorated temporary patches exhibiting ruts, humps, or depressions shall be repaired or replaced immediately upon notification of the Engineer. If the existing street exceeds the above tolerances, then the temporary patch shall be equal to or better than the condition of the surrounding pavements.

I. Unless otherwise specified and approved, prior to placing the permanent patch, the existing pavement shall be saw cut to a neat line and to a minimum width as shown on the Standard Drawings for Pavement Restoration.

J. Existing aggregate base, shall be scarified and recompacted to meet the requirements of Section 302, "Aggregate Base Courses." Compaction by rolling with vehicle tires will not be permitted. Aggregate base courses that were constructed with geosynthetics shall be repaired in conformance with the manufacturer's recommendations.

K. Existing asphalt concrete shall be replaced with the same depth on major streets (greater than 60 feet of planned right-of-way) except that the minimum depth shall be 4) inches and shall be placed in multiple lifts of equal thickness. Existing asphalt concrete shall be replaced with the same depth in local streets (60 feet or less of planned right-of-way) except that the minimum depth shall be 3 inches; for existing depth of 4 inches or more, pavement shall be replaced in multiple lifts of equal thickness within the parameters

established in Section 401, "Plantmix Bituminous Pavements - General." The pavement material shall be similar to the original. If not known, request from the Engineer the current mix type used on Contracting Agency Capital Improvement Projects (CIP).

L. Completion of the permanent patch in areas where an open graded surface course exists, which is less than 10 years in age, shall include placement of a surface course to match the existing surface texture and material mix design, including original bituminous cement type.

M. In areas where lime treated sub-base, cement modified sub-base, soil cement, or similar materials have been used, the Contractor may substitute a lean concrete mix or asphalt concrete equivalent, subject to approval of the Engineer.

N. Upon completion of the permanent patch, including the surface treatment, the surface shall be thoroughly compacted, smooth, and free from ruts, humps, depressions, or irregularities. The Contractor shall inspect with a straightedge 12 feet long that is laid across the permanent patch parallel to the centerline of the street and in a direction transverse to the centerline. The surface shall not vary more than 1/4 inch from the lower edge of the straightedge. Patches exhibiting deviations greater than 1/4) inch shall be replaced or use mechanical grinding prior to acceptance of the patch. If the existing street exceeds the above tolerances, then the patch shall be equal to or better than the condition of the surrounding pavement. The Contractor shall submit a report of the tolerance testing to the Engineer for approval prior to the acceptance of the patch.

O. Any concrete improvements disturbed or damaged during construction shall be replaced prior to placement of the permanent pavement patch.

P. All traffic control devices removed or disturbed during construction shall be replaced upon completion of the permanent patch including but not limited to delineation, paint, thermoplastic pavement markings, and traffic signal detector loops. Temporary lane lines and other markings used during construction shall be permanently removed, to the satisfaction of the Engineer, prior to placing the new traffic stripes or markings.

METHOD OF MEASUREMENT

208.04.01 MEASUREMENT

A. Unless otherwise provided in the Special Provisions, trench excavation and backfill will not be measured for payment.

B. The quantity of Permanent Patch to be measured for payment will be the number of square yards complete, in place, and conforming to all requirements herein.

BASIS OF PAYMENT

208.05.01 PAYMENT

A. Unless otherwise provided in the Special Provisions, no payment will be made for trench excavation or backfill as such; the cost thereof under normal circumstances being considered as included in the price bid for the construction or installation of the items to which such excavation or backfill is incidental or appurtenant.

B. No payment will be made for temporary cold plantmix patching as such; the cost thereof is considered as included in the price bid for the construction or installation of the items to which such patching is incidental or appurtenant.

C. The contract unit price paid for Permanent Patch as measured in Subsection 208.04.01, "Measurement," shall be full compensation for saw cutting, removal of asphalt, Type II aggregate base, prime coat, tack coat, and seal coat if required, asphaltic pavement (excluding open-grade or gap-grade UTACS), pavement markings, compaction, and for all labor, tools, equipment and incidentals necessary to complete the work as specified herein, as shown on the plans, and as directed by the Engineer. Compensation for trenching, backfilling, and compaction of pipe zone and other items of work, which are considered as part of underground piping or conduit work, shall be included with the contract bid item for such piping or conduit work.

D. Payment for such excavation or backfill will be made only when the Special Provisions provide.

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

F. Payment will be made under:

PAY ITEM	PAY UNIT
Permanent Patch	Square Yard

SECTION 209

DRAIN BACKFILL

DESCRIPTION

209.01.01 GENERAL

A. This work shall consist of furnishing, hauling, placing, and compacting drain backfill material around structures, pipes or perforated underdrains to the lines designated on the plans or established by the Engineer.

MATERIALS

209.02.01 GENERAL

A. Material shall conform to the requirements of Subsection 704.03.02, "Drain Backfill."

CONSTRUCTION

209.03.01 GENERAL

A. The trench shall be excavated and drain backfill placed in accordance with provisions of Section 607, "Underdrains."

B. Where drain backfill is part of the structural section, it shall be compacted to not less than 90 percent maximum density. Test method to be determined by the Engineer.

C. Compacting by ponding or jetting will not be permitted.

METHOD OF MEASUREMENT

209.04.01 MEASUREMENT

A. 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.

B. All measurement will be made in accordance with Subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

209.05.01 PAYMENT

A. Payment for drain backfill will be made only when provided for in the Special Provisions or Proposal.

B. 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.

C. Full compensation for furnishing, hauling, placing, and compacting drain backfill shall be considered as included in the contract price paid for drain backfill.

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

E. Payment will be made under:

209 DRAIN BACKFILL

PAY ITEM	PAY UNIT
Drain Backfill	Cubic Yard

SECTION 210

WATERING

DESCRIPTION

210.01.01 GENERAL

A. 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 lime treated base or subgrade material, or cement treated base, and for controlling dust caused by grading operations, traffic, and natural conditions.

MATERIALS

210.02.01 GENERAL

A. All materials shall conform to the requirements set forth in Section 722, "Water."

CONSTRUCTION

210.03.01 EQUIPMENT

A. Equipment used for applying water required for compacting embankment materials, subgrade, base and surfacing materials, and for controlling 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 enough pressure, the pump requirement may be eliminated.

B. The Contracting Agency does not require that watering equipment be provided with measuring or metering devices.

210.03.02 GENERAL

A. Water for dust control shall be applied in the amounts and on the areas designated by the Engineer.

B. The Contractor shall apply water in the amount necessary to attain the compaction in those materials requiring a specified density. In certain areas of the base courses, water may 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.

C. Excavation areas and borrow pits may be watered prior to excavating the material.

D. 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.

E. The Contractor shall make all arrangements for providing an adequate water supply. The Contractor 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 to the Engineer.

The Contractor shall pay all royalties occurring under such agreements and shall also obtain any necessary right-of-way.

METHOD OF MEASUREMENT

210.04.01 MEASUREMENT

A. 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

A. 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

A. This work shall consist of preparing slopes, placing and compacting top soil, seeding, fertilizing, jute matting, and mulching graded and disturbed areas in accordance with these specifications and the details shown in the contract documents.

MATERIALS

211.02.01 GENERAL

A. 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 PLANTING SOIL

A. Unless designated in the contract documents, the Contractor shall make the Contractor's own arrangements for obtaining soil at no additional cost to the Contracting Agency. Soil shall be transported directly from the source to final position unless otherwise permitted. Soil shall not be obtained from an area known to have noxious weeds growing in it.

B. Prior to removal of planting soil 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. Soil that has been treated with herbicides or sterilizers shall be tested by the Nevada State Department of Agriculture to determine the residual in the soil.

211.02.03 SEED

A. 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 AND AGRICULTURAL MINERALS

A. All fertilizer and agricultural minerals shall conform with all "Rules and regulations governing the registration, and collection of license tonnage 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 and subject to sampling for verification of analysis.

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 free of noxious weeds as defined by 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, seeds, water, and other approved

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 seed. Rate of application shall be as specified in the contract documents.

C. **Wood Chips:** Wood chips shall be as specified in Subsection 726.03.04.D, "Wood Chips and Shavings."

D. **Bark:** Bark shall be as specified in Subsection 726.03.04.E, "Bark."

211.02.06 ASPHALT EMULSION

A. Asphalt emulsion used as a tie-down for mulch shall be as described in the contract documents.

CONSTRUCTION

211.03.01 PREPARATION

A. Excavation slopes shall be thoroughly cultivated to the depth shown in the contract documents, after which planting soil, if required by the contract, shall be uniformly spread to an approximate thickness of 4 inches, the exact thickness will be determined by the Engineer.

B. Cultivation of embankment slopes shall be required before placing planting soil unless otherwise specified in the contract documents or ordered by the Engineer. Such cultivation shall be considered subsidiary to other portions of the work and no direct payment will be made for such work.

C. Cultivation shall not be performed until all equipment is through working in the area, except equipment required to cultivate the area and spread planting soil.

D. After cultivation and prior to seeding, all rocks 1 inch in smallest dimension and larger shall be removed from all slopes to be seeded and shall be disposed of as approved by the Engineer.

211.03.02 PLACEMENT OF PLANTING SOIL

A. Planting soil shall be evenly spread over the specified areas to the depth shown on the plans unless otherwise approved by the Engineer. After the planting soil has been spread, all large clods, hard lumps, rocks, and litter shall be raked up, removed, and disposed of by the Contractor.

B. Planting soil shall not be placed when the ground is frozen, excessively wet, or, in the opinion of the Engineer, in a condition detrimental to the work.

C. 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 planting soil shall be repaired by the Contractor at no additional cost to the Contracting Agency.

211.03.03 FIRMING OF PLANTING SOIL

A. Planting soil shall be made firm by use of a heavy or weighted disk set at an acute angle. The entire planting area shall be firmed by a minimum of three passes of the disk. The planting soil surface shall be brought to finished grade by one pass of a toothed harrow with teeth set at a 45-degree angle or by one pass of a steel-wire mat. Soil firming operations shall be performed by traveling at right angle to the slope, except slopes

greater than 30 percent shall be firmed by equipment conveyed up and down the slope by means devised by the Contractor. After firming operations, the planting soil shall be 2 inches below the top of all structures.

211.03.04 SEEDING AND FERTILIZING

A. The Contractor shall notify the Engineer not less than 24 hours in advance of any seeding operation and the Contractor 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.

B. 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:

1. 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.

2. 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 rate herein specified.

3. Helicopters properly equipped for aerial seeding and fertilizing. Helicopters so equipped shall have the following:

   a. Two hoppers or seed compartments each capable of containing a minimum of 100 pounds of grass seed or granular fertilizer.

   b. Power driven, readily adjustable disseminating mechanisms capable of maintaining a constant, measured rate of distribution of grass seed or granular fertilizer.

   c. 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 15 gallons each. Distribution shall be a spray boom of sufficient size and length, fitted with proper nozzles to distribute uniformly, liquid fertilizer as herein specified.

4. 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 3/4 inch for consistent furrow bottom placement.

   a. 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.

   b. 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.

   c. The Contractor shall provide qualified personnel experienced in all phases of the seeding and fertilizing operation, 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.

1. Unless otherwise specified, straw or hay shall be anchored into the soil by use of a heavy disc with flat serrated discs approximately 1/4 inch thick, having dull edges and spaced no more than 9 inches apart.

2. Anchoring shall be to a depth of 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.

C. **Wood Chips:** Wood chips utilized as a mulch may be applied by available mechanical chip spreaders or by approved hand methods. The wood chips shall be spread to an average depth of 3 inches.

D. **Bark:** Bark utilized as a mulch may be applied by available mechanical spreaders or by approved hand methods. The bark shall be spread on open slope areas to an average depth of 3 inches. Bark applied as a mulch for tree and shrub rings shall be spread to an average depth of 4 inches.

211.03.06 APPLYING ASPHALT EMULSION

A. 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 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

A. Jute matting shall be unrolled and placed parallel to the flow of water immediately following the bringing to finished grade the area specified in the plans or the placing of seed and fertilizer. Where more than one strip is required to cover the given areas, the strips shall overlap a minimum of 4 inches. Ends shall overlap at least 6 inches with the up-grade section on top. The up-slope end of each strip of matting shall be buried in 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 6 inches vertically into the soil. These shall be tamped and stapled the same as up-slope ends. Check slots shall be spaced so that one check slot or one end occurs within each 50 feet of slope.

B. Edges of matting shall be buried around the edges of catch basins and other structures as herein described. Matting shall be spread evenly and smoothly and in contact with the soil at all points.

C. 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 3 feet apart in 3 rows for each strip of matting, with 1 row along each edge and 1 row alternately spaced in the middle. All ends of the matting and checks slots shall be fastened at 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

A. The quantity of planting soil measured for payment will be the number of cubic yards placed in the work. The quantity of seeding, 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.

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

BASIS OF PAYMENT

211.05.01 PAYMENT

A. The accepted quantity of planting soil measured as provided in Subsection 211.04.01, "Measurement," will be paid for at the contract unit price bid per cubic yard of planting soil which price shall include hauling and placing.

B. 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.

C. The contract unit price bid for seeding shall also be considered due compensation for removing and disposing of rocks, 1 inch in smallest dimension and larger, from slopes as specified in Subsection 211.03.01, "Preparation."

D. Water will be considered subsidiary to the major items of work and no further compensation will be allowed therefor.

E. Asphalt emulsion will be considered subsidiary to the item "Mulching" and no further compensation will be allowed therefor.

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

G. Payment will be made under:

PAY ITEM	PAY UNIT
Planting Soil	Cubic Yard
Seeding (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

A. This work shall consist of furnishing and planting trees, shrubs, and ground covers where shown on the plans or as established by the Engineer, all in accordance with specifications and accepted horticultural practices.

MATERIALS

212.02.01 GENERAL

A. 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

A. 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.

B. All plant material in these specifications will be classified by group as follows:

1. Plants, Group A: Denotes container plant material
2. Plants, Group B: Denotes balled and burlapped plant material
3. Plants, Group C: Denotes ground cover
4. Plants, Group D: Denotes grass (turf)

212.02.03 QUALITY OF PLANT MATERIALS

A. It is the intent that all plant materials 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.

B. All plants shall conform to the applicable requirements as specified in Subsection 726.03.06, "Plants."

C. In determining the quality of plant material, the following elements shall be evaluated:

1. Root condition.
2. Plant size (above ground).
3. Insect and disease free condition.
4. General appearance (color, shape, prior pruning).

D. All container grown plants specified in the plans shall be established in the container in which the plants are sold, and grown in that container sufficiently long for the new fibrous roots to have developed so that the root mass will retain its shape and hold together when removed from the container.

E. Balled and burlapped plants shall be plants dug with the ball of earth in which the plants are growing. Ball sizes shall be of the diameter and depth specified in the plans and contain enough fibrous root system for the full recovery of the plant. Balled plants shall have the ball firm and unbroken.

F. Pruning of plants shall not be done prior to delivery to the planting site except by approval of the Engineer. Plant pruning when found necessary to remove damaged branches and to improve the plant shape and form when approved by the Engineer shall be accomplished after completion of individual planting operations.

G. A deficiency in any one or more of these areas shall be sufficient reason to reject selectively or by lot.

H. Grass or legume seeds shall conform to the requirements of Subsection 211.02.03, "Seed."

212.02.04 HANDLING AND SHIPPING

A. Plants shall be packed for shipment according to standard practice for the type of plant being shipped. The root system of plants shall not be permitted to dry out at any time. Plants shall be protected against heat and freezing temperatures, sun, wind, climatic, or seasonal conditions during transit. Plant material shall be furnished in containers unless otherwise specified. Plants specified balled and burlapped (B & B) shall be handled by the ball of earth and not the plant. Broken or "made" balls will not be acceptable. 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.

212.02.05 INSPECTION OF PLANT MATERIAL

A. The Contractor shall inform the Engineer as soon as possible 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 Contracting Agency, the Contractor and the nursery. However, there will be no acceptance of any plant material during this inspection. All plant material shall meet the requirement specified in Subsection 726.02.01, "Certificates and Samples."

B. All plant material will be inspected by the Engineer on arrival at the site or storage area for quality. These inspections 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 acceptable plants at no additional cost to the Contracting Agency.

C. 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 no additional cost to the Contracting Agency.

212.02.06 SUBSTITUTION OF PLANTS

A. 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

A. Plant material delivered and accepted at the project site shall be planted immediately. Plants that cannot be planted within 1 day after arrival shall be "held" in accordance with accepted horticultural practice, and as follows:

1. Balled and burlapped plants shall have the root ball protected by moist earth, sawdust, or other acceptable material.
2. Container grown plants shall be placed 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 PLANTING SOIL

A. Planting soil shall conform to the applicable requirements of Section 726, "Roadside Materials."

212.02.09 LUMBER

A. Lumber for header boards and planter boxes, as may be called for on the plans, shall conform to the requirements of Section 718, "Timber."

212.02.10 MULCH

A. Hay or straw, wood cellulose fiber, wood chips and bark shall conform to the applicable requirements of Subsection 726.03.04, "Mulch."

CONSTRUCTION

212.03.01 SITE PREPARATION

A. 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

A. The Contractor will designate, by means of stakes or other approved markings, the ground location of each randomly 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.

B. In mixed planting areas, trees shall be planted first, followed by the larger shrubs, low shrubs, and the final planting or ground covers.

212.03.03 PREPARATION OF PLANTING AREAS

A. During the preparation of planting areas, all clods, rocks, or other debris over 1 inch in 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:

1. **Planter Boxes:** Backfill material shall consist of 1 part organic matter to 3 parts soil 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 2 inches below the top of the box.

2. **Planting Beds:** The soil preparation shall not be initiated until 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 6 inches. When required, organic matter, commercial fertilizer, or agricultural minerals 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 6 inches. The area shall then be brought to a plane in conformance to the elevations shown on the plans.

3. **Seed Beds:** The soil preparation shall be the same as specified for planting beds.

4. **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 relocated under the direction of the Engineer.

   a. 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.

   b. When required, organic matter, commercial fertilizer, or agricultural minerals 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.

5. **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, organic matter, commercial fertilizer, or agricultural minerals 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

A. No planting shall be done in any area until the Contractor has received the Engineer's approval that the area concerned has been satisfactorily prepared as provided in Subsection 212.03.03, "Preparation of Planting Areas."

B. No more plants shall be distributed within the project area on any 1 day than can be planted and watered on that day.

C. Any planting done in soil that is too wet or 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.

1. **Plants (Group A):** Nursery stakes supporting plants in containers shall be removed and the plants pruned, if necessary, as specified herein, after planting.

   a. Containers shall be cut 3 times from top to bottom.

   b. Plants shall be removed from the containers in such a manner that the ball of earth surrounding the roots is not broken, and the plants shall be planted and watered as hereinafter specified immediately after removal from the containers.

   c. Containers shall not be cut prior to delivery of the plants to the planting areas.

2. **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.

3. **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 and watered around it to eliminate air pockets.

   a. 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. No plants brought to the jobsite in pony pacs or bare root will be accepted.

   b. Plants shall be watered as hereinafter specified immediately after planting.

   c. 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.

   d. 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 2 inches below finished grade.

   e. Plants shall be planted in such a manner that the roots will not be restricted or distorted. Soil shall be firmed around the roots or ball of the plant during planting operations by foot tamping or saturation with water. 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.

4. **Plants (Group D):** The seed bed 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.

a. 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 embedded by light rolling. The Contractor shall exercise care to avoid leaving footprints or other depressions in the compacted seed bed.

b. Organic mulch shall be evenly applied immediately after the seed bed has been firmed, with manure spreaders, mulch blowers or other approved equipment. The mulch shall be spread at the rate of 1 cubic yard per 1,000 square feet. As soon as mulch is in place, the surface of the seed bed shall be dampened with a fine spray from a nozzle until the mulch is thoroughly moist.

212.03.05 STAKING AND GUYING

A. All staking and guying shall be done concurrently with the planting operation.

1. **Staking:** Plants that are to be staked will be specified in the contract documents.

   a. 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.

   b. The stakes shall be placed against but not through the plant ball in the case of plants (Groups A and B).

2. **Tree Ties:** The method of attaching the ties to stakes and trees shall provide firm connection, but the trunk loop shall be sufficiently loose to prevent damage to the bark. It may, on occasion, as determined by the Engineer, be considered necessary to use number 10 gage galvanized wire encased in at least 1/2-inch rubber hose as tree ties, in which case all connections shall be twisted.

3. **Guying:** Plants that are to be guyed will be specified in the contract documents.

   a. All guying shall be done as specified in the contract documents or as approved by the Engineer.

212.03.06 PRUNING

A. Pruning shall be done as determined by the Engineer after plant materials are planted.

B. Pruning of evergreen coniferous plants will not be permitted except under the direction of the Engineer.

212.03.07 WATERING

A. The Contractor shall make arrangements for furnishing and applying water at no additional cost to the Contracting Agency.

B. Valves at meters shall be kept closed at all times, except while the irrigation system is actually in use.

C. 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 no additional cost to the Contracting Agency.

D. Compliance with the provisions in this section shall not relieve the Contractor of responsibility for the replacement of plants as provided hereinafter.

1. **Plants (Groups A and B):**

   a. 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.

   b. 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 moist, 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.

   c. 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 no additional cost to the Contracting Agency.

2. **Plants (Group C):**

   a. 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.

   b. 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.

3. **Plants (Group D):**

   a. The seed bed shall be kept in 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.

   b. 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 1 inch. After a uniform stand of grass which has attained a height of 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

1. **Plants (Groups A, B, and C):**

   a. 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 the plants 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 and 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 2 weeks to complete the replacement.

b. Replacement plants shall be furnished and planted by the Contractor at no additional cost to the Contracting Agency.

2. **Plants (Group D):** The Engineer will inspect the turf at the time of the first cutting 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, AGRICULTURAL MINERALS AND ADDITIVES

A. When fertilizers or other agricultural minerals or additives are called for, the fertilizers, minerals, and additives 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

A. 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 no additional cost to the Contracting Agency as directed by the Engineer.

212.03.11 PLANT ESTABLISHMENT WORK

A. 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.

B. 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.

C. The length of the plant establishment period shall be as specified in the contract documents.

D. 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.

E. 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 the Contractor performs plant establishment work.

F. 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.

G. All plants shall be kept watered as provided in Section 210, "Watering."

H. 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 Project 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 no additional cost to the Contracting Agency, when and as directed by the Engineer.

I. 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

A. 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 in the units as follows:

1. Site preparation will be measured by the acre or square foot.
2. Planting soil will be measured by the cubic yard.
3. Preparing soil (plant boxes) will be measured by the cubic foot.
4. Preparing soil (plant bed) will be measured by the square foot.
5. Fertilizer or agricultural minerals 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.
6. Organic matter will be measured by the cubic yard, or determined by marked quantities and sack count.
7. Mulch will be measured by the cubic yard or determined by marked quantities and sack count.
8. Hole preparation will be measured by the actual number of holes prepared.
9. Trench preparation will be measured by the linear foot and the depth and width of the trench will be designated in the contract documents.
10. Tree rings will be considered incidental to "Hole Preparation" and there will be no measurement or payment therefor.
11. Mowing strips will be measured by the number of linear feet along the top of the strip.
12. Planter boxes will be measured by the number of boxes placed on the project that conform to the sizes specified in the contract documents.
13. Header boards will be measured by the thousand foot board measure (Mfbm).
14. Plants in Groups A through C will be measured by the number of plants in each group.
15. Plants in Group D will be measured by the square foot in place.
16. The unit of measure for Plant Establishment Work will be lump sum.

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

BASIS OF PAYMENT

212.05.01 PAYMENT

A. 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.

B. Water will be considered subsidiary to the major items of work and no further compensation will be allowed therefor.

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

D. Payment will be made under:

PAY ITEM	PAY UNIT
Site Preparation including removal of excess soil	Acre, Square Foot
Planting Soil	Cubic Yard
Preparing Soil (plant boxes)	Cubic Foot
Preparing Soil (planting bed)	Square Foot
Fertilizer (type and class)	Pounds, Ton, Each, Gallons
Organic Matter (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 (Group A - C)	Each
Plants (Group D)	Square Foot
Plant Establishment Work	Lump Sum

SECTION 213

IRRIGATION SYSTEMS

DESCRIPTION

213.01.01 GENERAL

A. 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.

B. This work may also consist of furnishing and installing pipe conduit for future irrigation systems as shown on the plans and as specified herein.

MATERIALS

213.02.01 GENERAL

A. 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 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."

B. The Contractor shall submit 3 sets of brochures or shop drawings for each accessory or fixture, and each item of hardware or equipment the Contractor 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. 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

A. Pipe and fittings shall conform to the requirements of Subsection 726.03.09, "Pipe and Fittings."

B. Pipe conduit shall be bedded and backfilled with sandy material as shown on the plans. Material used for bedding and backfilling of 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 Inch	100
No. 200	0-15

213.02.03 CONTROL TUBING

A. Tubing and fittings shall be capable of withstanding a 300 psi operating pressure, shall be of the size indicated on the plans, and shall conform to the requirements of Subsection 726.03.10, "Control Tubing."

213.02.04 AUTOMATIC CONTROLLERS

A. When called for on the plans, the Contractor shall furnish and install, on a concrete base, automatic controllers as herein specified. There 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 3 sets of keys provided. Operating features shall include the following:

1. Each valve in the circuit shall be adjustable for setting to remain open for any desired period of time from 1 minute or less to at least 60 minutes.
2. The controller shall operate on 110-117 volts and shall be equipped with a circuit breaker or fusible connection to protect the controller from overloads.
3. The controller shall have a master on off switch to turn all stations off without disturbing the clock settings or automatic timing sequences.
4. Controllers shall allow any station to be operated manually both on or off whenever desired.
5. 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

A. Sprinkler heads shall be of the type, pattern and coverage shown on the plans.

B. 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 the soaker valves 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 1 to 3 gallons per hour at 10 to 20 psi; final adjustment shall be as determined by the Engineer. Adjustment shall be accomplished with a 7/16-inch socket wrench.

213.02.06 BLANK

213.02.07 GATE VALVES

A. Valves 2-1/2 inches and smaller shall be of the same size as the pipes on which the valves are placed unless otherwise indicated on the plans. Service rating for non-shock cold water shall be 200 psi. 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 2-1/2 inches and smaller shall be the threaded type and installed with a union on either side of the valve.

B. Gate valves 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. Gate valves shall

have a working pressure of 200 psi and a test pressure of 400 psi. A shut-off rod, 6 feet in length that will fit a 2-inch wrench nut, shall be furnished by the Contractor.

213.02.08 CONTROL VALVES

A. 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 the valves 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 150 psi except for valves of 1-1/2-inch and larger where 200 psi valves will be required.

B. 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. Solenoids shall be completely encapsulated for positive waterproofing. The valve body and bonnet shall be of cast brass or bronze, flanged 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 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 non-shock cold water working pressure of 150 psi.

213.02.09 QUICK-COUPLER VALVES

A. The quick-coupler valve shall be of brass or bronze construction with 1-inch F.I.P. bottom connection. The valve shall be of 2-piece construction with removable upper body. The valve body shall be designed with a single slot to receive a single slot coupler. The 1-inch male and 3/4-inch female I.P.S. coupler for the quick coupler valve shall be single slot of bronze construction.

213.02.10 VALVE BOXES

A. Valve boxes shall be reinforced precast Portland cement concrete boxes of the general dimensions shown on the plans with a steel lid. Concrete made of Type V Portland cement shall be used. Valve boxes shall have extensions as necessary to reach the depth indicated.

213.02.11 BACKFLOW PREVENTERS

A. 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. Valves 3-inch and larger shall be flanged type, iron body, brass trimmed, wedge gate valves with non-rising stem, and shall be capable of withstanding a cold water working pressure of 200 psi. Valves 2-1/2-inch and smaller shall be as specified above, except that the valves shall be screw 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.

B. The Contractor shall determine the requirements of the governing agency in regard to the type and detail of backflow prevention required.

C. 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

A. Automatic ball check drain valves 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 2 to 4 psi. Valves shall be installed with a gravel sump as shown on the plans.

B. 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, "Coarse Aggregate."

213.02.13 HOSE BIBBS

A. The hose bibb shall be a no-freeze burial type hydrant with a self-closing handle and shall have 3/4-inch male I.P.S. threads at the supply line end.

213.02.14 VACUUM BREAKERS

A. 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.

B. 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 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 6 inches above the finished grade, such as sprinkler lines irrigating shrub beds. Atmospheric vacuum breakers shall have a service rating of 150 psi for non-shock cold water and shall be designed for operation up to temperatures of 140 degrees F.

C. 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 ensure 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 300 psi for non-shock cold water.

D. All vacuum breaker installations shall meet local ordinances and plumbing requirements.

213.02.15 AIR RELIEF VALVE

A. 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 1-inch size with screwed inlet, and shall be capable of withstanding pressures up to 300 psi. The valve shall be fitted with a galvanized steel return elbow as indicated on the plans.

CONSTRUCTION

213.03.01 GENERAL

A. 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

A. 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 6 inches of planting soil, 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 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

A. Care shall be exercised by the Contractor when excavating trenches near existing trees. Where roots are 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, the roots shall be wrapped with heavy burlap for protection and to prevent excessive drying. Trenches dug by machines adjacent to trees having roots 2 inches and less in diameter shall have the sides hand trimmed making a clean cut of the roots. All roots 1/2-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 24 hours unless adequately protected by moist burlap or canvas.

213.03.04 PIPING

A. Live main lines shall have a minimum cover of 24 inches. Other lines shall have a minimum cover of 18 inches below finish grade except flexible soaker lines which shall be 4 inches below finish grade.

B. All water lines, except soaker lines, with less than 18 inches of cover depth shall be provided a means for drainage to prevent freezing. Pipe 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

A. All galvanized steel pipe shall have sound, clean-cut, well-fitted standard pipe threads. 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

A. Control tubing shall be joined as specified in Subsection 213.03.07, "Installation," for PVC pipe.

213.03.07 INSTALLATION

A. Conduit shall be installed not less than 18 inches below the curb grade in sidewalk areas and not less than 24 inches 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 2 feet from pavement edge wherever possible. Excessive use of water that will soften subgrade or undermine the pavement will not be permitted.

B. Where conduit is installed in an open trench, excavation and backfill shall conform to the provisions of Section 208, "Trench Excavation and 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.

C. After the conduit is installed, if shown on the plans or specified in the special provisions, galvanized steel pipe shall be placed therein.

D. 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.

E. Where connection is made to existing supply lines, compression type fittings may be used.

F. A backflow preventer shall be installed at each meter if called for on the plans.

G. Where supply lines or conduits are to be installed through existing paved areas, the sub base, base, and paving removed shall be replaced with material of equal quality.

H. All pipe shall be cut straight and true. After cutting, the ends shall be reamed out to the full inside diameter of the pipe.

I. Foreign material shall be prevented from entering the irrigation system during installation. Immediately prior to assembly, all pipes, valves, and fittings and control tubes 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.

J. 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 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 the Contractor. 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.

K. 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 3 feet from the curb or paved shoulder unless otherwise noted on the plans.

L. All nozzle lines, except those installed on a fence or guard railing, shall be installed on 3/4-inch pipe anchor posts unless otherwise shown on the plans.

M. Sprinkler connections shall be installed on swing joints as detailed on the plans.

N. 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 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.

O. The cement solution shall be applied to the pipe and fitting socket with an applicator having a width of approximately one half 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 are in the fitting socket. Twist the pipe 1/8 to 1/4 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.

P. Cement solution for flexible PVC shall be an approved type for joining flexible PVC to itself or to rigid PVC.

Q. 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 trenches shall be partially backfilled between joints with small amounts of backfill material to prevent movement during the pressure test.

213.03.08 CONTROL TUBING PLACEMENT

A. Control tubing shall be placed with the main supply line. Tubing shall be bundled together by 4 wraps of friction tape at 6-foot intervals. Location of the bundle of control tubing shall be 6 inches to one side of the pipe, and a minimum of 2 inches from any galvanized pipe.

213.03.09 FLUSHING AND TESTING

A. All main supply lines shall be flushed completely of foreign particles before placing section control valves, quick-coupler valves and hose bibbs. After flushing and when valves are in place, all main supply lines shall be tested at 150 psi with valves closed. Pressure shall be maintained for a period of 8 consecutive hours. All joints showing leaks shall be cleaned, remade, and tested.

B. 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 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 above for the main supply lines. Tubing shall be flushed for 5 minutes before connection with the control valves.

C. Automatic controllers shall be tested by actual operation for a period of 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

A. 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

A. 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 3-inch sand or sandy loam cushion free from rocks or stones larger than 3/8 inch in diameter placed over all control tubing. Backfill from the bottom of the trench to approximately 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 18 inches of any pipe. All backfill material shall be free from rocks, roots, or other objectionable material. The top 6 inches of the backfill shall be of top soil material or the first 6 inches of material removed in the excavation.

213.03.12 AS-BUILT RECORD DRAWINGS

A. The Contractor shall provide and keep up to date a complete set of as-built drawings which shall be corrected daily to show changes in sprinkler locations, controller locations, pump locations, piping locations, and other deviations from the original irrigation design

drawings as provided to the Contractor. All isolation valve locations shall be shown with actual measurements to reference points so the valves may be located easily in the field.

B. Upon completion of the work, the Contractor shall furnish the Engineer with a complete set of as-built drawings showing the sprinkler system as installed. This is the responsibility of the Contractor and shall not be construed to be the responsibility of any other party.

METHOD OF MEASUREMENT

213.04.01 MEASUREMENT

A. 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.

B. 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 center lines to the point of intersection.

C. The quantity of sprinklers, couplers, heads, valves, vacuum breakers, hose, bibbs, concrete valve boxes, valve assemblies, riser assemblies, and faucets will be measured per each of the type and size specified complete and in place.

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

BASIS OF PAYMENT

213.05.01 PAYMENT

A. 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.

B. 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.

C. Payment per linear foot of conduit involved shall be full compensation for furnishing and installing pipe conduit, bedding and backfilling, caps, markers, and incidentals necessary to install the conduit complete in place including as-built drawings.

D. 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.

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

PAY ITEM	PAY UNIT
(size) (type) Pipe	Linear Foot
(size) (type) (name of attachment)	Each

SECTION 301

SELECTED MATERIAL SUBBASE

DESCRIPTION

301.01.01 GENERAL

A. This work shall consist of excavating and placing selected granular materials in one or more courses for subbase in accordance with these specifications and in conformity with the lines, grades, thicknesses, and typical cross sections shown on the plans or established by the Engineer. This material is designated to be placed below the Type II aggregate structural layer for pavements and is a part of the pavement structure.

301.01.02 REFERENCE CODES AND STANDARDS

A. Related Interagency Quality Assurance Committee (IQAC) procedures at:

http://www.accessclarkcounty.com/depts/public_works/Pages/iqac.aspx

MATERIALS

301.02.01 GENERAL

A. Material shall be as set forth in the Special Provisions.

B. When Type I Aggregate Base is specified, the gradation acceptance limits and testing methods shall be as set forth in Subsection 704.03.03, “Type I Aggregate Base.”

CONSTRUCTION

301.03.01 SUBGRADE PREPARATION

A. The surface of the subgrade upon which the selected material is to be placed shall conform to the established lines and grade, shall be smooth and uniform, and shall be compacted to the required density. The tolerance to the plan elevation grade shall be +0 inches and -1/2 inch.

301.03.02 PLACING

A. 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 6 inches, the material shall be placed in layers, none of which shall exceed 6 inches in depth after compaction, except as provided in Subsection 301.03.04, "Compaction."

B. After the material has been uniformly deposited, it shall be thoroughly blade-mixed to the full depth of the layer by alternately blading the entire layer to the center and back to the edges of the roadbed.

1. The material shall then be spread and finished to the required cross section.
2. At the option of the Contractor, selected material may be spread with equipment meeting the requirements of Subsection 303.03.03, "Surface Tolerances."

C. Binder material, if required, shall be incorporated either in the surfacing aggregate at the plant where the aggregate is produced or uniformly on the roadbed in amounts designated by the Engineer.

301.03.03 WATERING

A. 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.

B. Water shall also be applied during the compaction and maintenance stages in sufficient amounts to attain compaction and prevent raveling.

301.03.04 COMPACTION

A. Compaction shall immediately follow the spreading operation.

1. Where the required thickness is 6 inches or less, the base course may be spread and compacted in one layer.

2. 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 8 inches.

B. Aggregate bases placed on road approaches and connections, street intersection areas, median strip areas, shoulder areas, and at locations that are inaccessible to the spreading equipment may be spread in one or more layers by any means to obtain the specified results.

C. Each layer of material shall be compacted to not less than 95 percent relative compaction, except under sidewalk areas. Under sidewalk areas, the material shall be compacted to not less than 90 percent compaction.

D. A loss of density in the upper portions of the material may occur due to the elements 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

A. 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.

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

BASIS OF PAYMENT

301.05.01 PAYMENT

A. The accepted quantity of selected material base or surfacing, measuring 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.

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

C. Partial payments may be made in accordance with Subsection 109.06, "Partial Payment."

D. Payment will be made under:

PAY ITEM	PAY UNIT
Selected Material Subbase	Cubic Yard, Ton

SECTION 302

AGGREGATE BASE COURSES

DESCRIPTION

302.01.01 GENERAL

A. This work shall consist of furnishing, placing, and compacting aggregate base courses constructed as specified below and in conformity with the lines, grades, thicknesses, and cross sections shown on the plans or established by the Engineer.

302.01.02 REFERENCE CODES AND STANDARDS

A. Related Interagency Quality Assurance Committee (IQAC) procedures at:

http://www.accessclarkcounty.com/depts/public_works/Pages/iqac.aspx

MATERIALS

302.02.01 GENERAL

A. Materials shall meet the requirements of the following subsections:

Materials	Subsection
Type I Aggregate Base	704.03.03
Type II Aggregate Base	704.03.04

CONSTRUCTION

302.03.01 SUBGRADE PREPARATION

A. 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.

1. The above mentioned repairs shall be made at no additional cost to Contracting Agency, except as provided for in Subsection 203.03.03, "Unsuitable Material."

2. The tolerance to the plan elevation grade shall be +0 foot and -0.1 foot.

B. Unless otherwise specified, the top 6 inches of subgrade shall be compacted to not less than 90 percent compaction.

302.03.02 SPREADING AGGREGATES

A. The aggregate shall be uniformly deposited on the approved subgrade by means of the hauling vehicle with or without spreading devices. Aggregate shall be distributed over the surface to the depth specified on the plans or established by the Engineer.

B. 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. The material shall then be spread and finished to the required cross section by means of a self-propelled pneumatic-tired motor grader.

C. At the option of the Contractor, the aggregate may be spread with an approved 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 Subsection 302.03.03, "Watering and Mixing Aggregates."

D. Reference points will be established on one side of the roadway at intervals approved by the Engineer.

E. Furnish, place, maintain, remove, and dispose of all materials required to provide continuous line and grade control to the placing machine.

302.03.03 WATERING AND MIXING AGGREGATES

A. The base course material and water may be mixed at the plant in a mixer approved by the Engineer.

B. 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.

C. After mixing to the extent that the product has a uniform homogeneous appearance, the material shall be transported to the job while it contains the proper moisture content and may be placed on the roadbed by means of an approved self-propelled aggregate spreader.

D. 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.

302.03.04 WATERING

A. Water may 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.

B. Water shall be applied during the compaction and maintenance stages in sufficient amounts to assist in compaction and prevent raveling.

C. Comply with Section 210, "Watering."

302.03.05 COMPACTION

A. Compaction shall immediately follow the spreading operation.

1. Where the required thickness is 6 inches or less, the base course may be spread and compacted in 1 layer.

2. 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 1 layer may be increased to 8 inches.

B. Aggregate bases placed on road approaches and connections, street intersection areas, median strip areas, shoulder areas, and at locations that are inaccessible to the spreading equipment may be spread in one or more layers by any means to obtain the specified results.

C. Each layer of material shall be compacted to not less than 95 percent compaction, except for under sidewalk areas, where the material shall be compacted to not less than 90 percent compaction.

D. A loss of density in the upper portions of the material may occur due to the elements 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.

302.03.06 TOLERANCE FOR FINISHED SURFACE

A. When a 10-foot straightedge is laid in any direction, the finished surface shall not deviate at any point more than 1/2 inch from the bottom thereof.

B. The tolerance to the plan elevation grade shall be +0 foot and -0.05 foot.

METHOD OF MEASUREMENT

302.04.01 MEASUREMENT

A. The quantity of aggregate base to be measured for payment will be the number of cubic yards or tons complete and in place.

1. 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.
2. Optimum moisture will be determined by AASHTO T180 by the Contractor with the moisture content determined by AASHTO T255 and confirmed by the Engineer.
3. The weight of water thus deducted will not be measured for payment.

B. Due to possible variations in the specific gravity and voids of the aggregates, the tonnage used may vary from proposal quantities and no adjustment in contract unit price will be made because of such variation.

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

BASIS OF PAYMENT

302.05.01 PAYMENT

A. 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 specified, which shall be full compensation for stripping the pit, crushing, screening, mixing, hauling, placing, compacting, and maintaining the base course as shown on the plans and as directed by the Engineer.

B. Deviations in thickness will likely occur in placing aggregate base courses. The Contractor shall 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 course to grade.

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

D. Partial payments may be made in accordance with Subsection 109.06, "Partial Payment."

E. Payment will be made under:

PAY ITEM	PAY UNIT
Type I Aggregate Base	Cubic Yard, Ton
Type II Aggregate Base	Cubic Yard, Ton

SECTION 303

PLANTMIX BITUMINOUS BASE

DESCRIPTION

303.01.01 GENERAL

A. 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 conformance with the lines, grades, thickness, and typical cross sections shown on the plans or established by the Engineer.

B. The requirements of Section 401, "Plantmix Bituminous Pavements - General," shall be applicable to this work, except as hereinafter specified.

MATERIALS

303.02.01 GENERAL

A. The materials shall conform to the requirements as specified in Subsection 401.02.01, "Composition of Mixtures," through Subsection 401.02.04, "Bituminous Materials."

CONSTRUCTION

303.03.01 GENERAL

A. The construction requirements shall conform to the requirements as specified in Subsection 401.03.01, "Bituminous Mixing Plant," through Subsection 401.03.15, "Surface Tolerances," with the exceptions contained in the following two subsections.

303.03.02 SPREADING AND FINISHING

A. Unless otherwise specified, bituminous plantmix base shall not be placed in courses exceeding 4 inches in compacted thickness.

B. When more than 1 course is placed, the courses shall be of approximately equal thickness.

303.03.03 SURFACE TOLERANCES

A. The completed surfacing shall be thoroughly compacted, smooth, and free from ruts, humps, depressions, or irregularities.

1. When a straightedge 10 feet long is laid on the finished surface and parallel with the centerline of the highway, the surface shall not vary more than 1/2 inch from the lower edge of the straightedge.

2. The transverse slope of the finished surface shall be uniform to a degree such that no depressions greater than 1/2 inch are present when tested with a straightedge 12 feet long laid in a direction transverse to the centerline and extending from edge to edge of a 12-foot traffic lane.

B. 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.

C. 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

A. Plantmix bituminous base will be measured for payment as specified in Subsection 401.04.01, "Measurement."

BASIS OF PAYMENT

303.05.01 PAYMENT

A. The accepted quantity of plantmix bituminous base will be paid for at the contract unit price bid per ton which shall include all asphalt cement. This price shall be full compensation for furnishing all material, mixing, loading, hauling, placing, compacting, and incidentals necessary for doing all the work involved in constructing plantmix bituminous base.

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

C. Partial payments for plantmix bituminous base aggregate may be made as set forth under Subsection 109.06, "Partial Payment."

D. Payment will be made under:

PAY ITEM	PAY UNIT
Plantmix Bituminous Base	Ton

SECTION 304

PORTLAND CEMENT TREATED BASE

DESCRIPTION

304.01.01 GENERAL

A. This work shall consist of constructing 1 or more courses of a mixture of aggregate and Portland cement on a prepared surface in accordance with these specifications, in conformity with the lines, grades, thicknesses, and typical cross sections shown on the plans, or as established by the Engineer.

B. As used in these specifications, Portland cement shall be defined as hydraulic cement.

C. The method to be used, either plantmix or roadmix, will be at the Contractor's option.

MATERIALS

304.02.01 GENERAL

A. Materials shall meet the requirements of the following sections and subsections:

Materials	Section/Subsection
Hydraulic Cement	701
Water	722
Aggregate for Portland Cement Treated Base	704.03.08
Liquid Asphalt	703.03.03
Emulsified Asphalt	703.03.04

CONSTRUCTION

304.03.01 PROPORTIONING

A. Portland cement shall be applied to the mineral aggregate at the rate specified in the Special Provisions or as determined by the Engineer.

304.03.02 MIXING - ROADMIX METHOD

A. Portland cement shall be added at the rate specified, or at a rate ordered by the Engineer.

1. Variations in excess of 10 percent from the rate set will not be permitted.
2. The Portland cement shall be added in a manner to ensure that correct and uniform proportions will enter the mixer at all times.

B. The specified base material, cement, and water shall be mixed by means of a traveling mixer.

1. The mixer shall be so constructed that it will pick up all the base material to be treated during the time of mixing.
2. The mixer may be of the pugmill, auger, or transverse shaft type that mixes the materials by means of revolving paddles which lift all the loose material from the subgrade.

C. The traveling mixer shall have provision for introducing water at the time of mixing through a metering device.

1. The water shall be applied by means of controls that will supply a uniform ratio of water to the amount of material passing through the mixer and produce a completed mixture with a uniform moisture content.

2. Leakage of water from equipment will not be permitted.

3. Care shall be exercised to avoid the addition of water from any source except through the metering device.

4. Mixing shall be accomplished in 2 or more passes of the material through the mixer but, in any event, mixing shall be continued until the resulting mixture is entirely uniform in cement content, moisture, and the distribution of coarse and fine particles.

5. At least 1 pass shall be made before any water is added to the material.

D. The device by which the mixer picks up the material shall be so controlled and operated on each pass of the mixer as to pick up all the material to be treated and at the same time avoid cutting into the subgrade or picking up unmixed material on successive passes of the mixer.

E. The lengths of sections to be mixed at any 1 time shall be regulated to permit compliance with the time requirements specified herein.

F. Should the Contractor elect to perform road-mixing operations off the roadbed at a designated location, the preparation of the material for mixing and the mixing of base material, cement, and water shall conform to the applicable provisions specified herein for preparing and mixing the materials on the roadbed.

1. When the materials are road-mixed off the roadbed, the device for loading the mixed material into the transporting vehicle shall be so constructed and so operated that no untreated material will be picked up.

2. The time required for loading and hauling the material shall be taken into account when determining the amount of material to be mixed at any 1 time.

G. After final mixing operations have been completed, the mixture shall be spread and compacted as specified in Subsection 304.03.04, "Spreading."

304.03.03 MIXING - PLANTMIX METHOD

A. 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.

B. If the Contractor so elects, the base material, cement, and water may be mixed at a central plant using a pugmill, rotary drum, or a continuous type of mixer.

C. If a pugmill or rotary drum type of mixer is used, the materials shall be proportioned by batch weights. If a continuous type of mixer is used, the materials shall be proportioned by volume.

D. Should the Contractor elect to proportion the materials by volumetric methods and perform the mixing in a continuous type of mixer, the completed mixture shall be as uniform in character and consistency with respect to grading, cement content, and water as that obtainable by weight proportioning and batch mixing.

E. If the Contractor elects to use a continuous type of mixer, the correct amount of aggregate introduced into the mixer shall be drawn from the storage bin by means of a continuous feeder through an adjustable calibrated gate, which will supply the correct amount of aggregate in proportion to the cement and water.

F. The mixer shall be equipped with metering devices that will introduce the cement and water into the mixer in the specified proportions.

1. The metering devices and feeder shall be interlocked and so synchronized as to maintain a constant ratio of cement and water to aggregate.

2. Storage bins shall be equipped with overflow chutes for each compartment.

3. A positive signal system shall be provided to indicate when the level of material approaches the strikeoff capacity of the feed gate.

4. The plant shall not be permitted to operate unless this signal system is in good working condition.

5. The plant shall be equipped with facilities for calibrating gate openings by weighing check samples.

G. Water shall be proportioned by weight or volume.

1. The quantity of water added to the mixture shall be adjusted to produce optimum moisture content.

2. All water additions shall be made under conditions that will permit an accurate determination of the quantity of water added.

H. Portland cement shall be added at the rate specified or at a rate ordered by the Engineer. Variations from this rate in excess of 10 percent will not be permitted.

I. The weight of charge in a batch mixer, or the rate of feed to a continuous type mixer, shall not exceed that which will permit complete mixing of all the material. Dead areas in the mixer, in which the material does not move or is not sufficiently agitated, shall be corrected either by a reduction in the volume of material or by other adjustments.

J. Mixing of materials shall be continued until the cement and water are evenly distributed through the mass and a uniform mixture of unchanging appearance is obtained.

304.03.04 SPREADING

A. Prior to spreading the cement treated material, the surface of the prepared roadbed shall be moistened and kept moist, but not excessively wet, until covered by the mixture.

B. Materials mixed at a location off the roadbed shall be deposited by means of approved spreading equipment. Dumping in piles upon the subgrade will not be permitted.

C. The mixture shall be spread and compacted in 1 or more layers of uniform density and of the width and thickness that, after compacting and trimming, the finished subgrade or base will conform to the required grade and cross section. The mixture shall be spread for the full width of the roadbed or the traffic lane under construction.

D. Varied Thickness Requirements:

1. Where the required thickness is 6 inches or less, the mixture may be spread and compacted in 1 layer.

2. Where the required thickness is more than 6 inches, the mixture shall be spread and compacted in 2 or more layers of approximately equal thickness, provided that the

maximum compacted thickness of any 1 layer does not exceed 6 inches unless otherwise approved by the Engineer.

3. Thicknesses greater than 6 inches may be compacted in 1 layer, when it is determined by the Engineer that the thickness of the layer is compatible with the compaction equipment being used and that the specified density can be achieved.

E. Work on each layer shall be performed in a similar manner, except that a curing seal need not be applied to a lower layer if the surface of the compacted material is kept moist until covered with the next layer. The exposed area of a lower layer shall not be greater at any time than can be covered with the next layer in 1 day of normal operations.

F. The mixed materials shall be spread for the full width of the subgrade or base under construction, either by 1 spreader or by several spreaders operating in a staggered position across the subgrade, unless traffic conditions require part-width construction. Should 1 spreader only be used, not more than 45 minutes shall elapse between the time of placing material in adjacent lanes at any location without trimming the longitudinal joint.

G. If traffic or other conditions make part-width construction of a base necessary, a windrow of shoulder material or soil shall be placed and compacted to form a choker to restrain the inner edge of the base during compacting operations.

1. The choker shall be constructed to the same elevation as that of the compacted base, and shall be completed in advance of the spreading of the treated material.

2. The toe of the choker shall not be less than 3 inches outside the finished trimming line of the compacted section of base material.

3. The use of side forms, or other method that will satisfactorily retain the base material during compacting operations, will be permitted in lieu of a choker.

H. After a part-width section has been completed, the longitudinal joint against which additional material is to be placed shall be trimmed to the neat line of the section and with a vertical edge. Choker material and material cut away in trimming shall be used in the construction of adjacent shoulders or otherwise disposed of unless suitable for incorporation in the work.

I. The use of self-propelled graders will be permitted for trimming, for spreading material mixed on the roadbed, or for spreading material mixed at a location off the roadbed after such materials have been deposited in an approved manner.

304.03.05 COMPACTION

A. The provisions contained in this subsection apply to both plantmix and roadmix methods.

B. Cement treated base shall be compacted to a minimum of 95 percent of the laboratory maximum density as determined by ASTM D558.

C. Compacting equipment shall produce the required compaction within the operation time limit specified in Subsection 304.03.07, "Time Requirements."

D. 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."

E. Water shall be applied without driving equipment over the uncompacted material.

F. Rolling shall commence by completely covering the outer edge of the material. Subsequent rolling shall lap at least 25 percent of previously compacted material.

G. Areas inaccessible to rollers shall be compacted to the required density by other means.

304.03.06 FINISHED SURFACE

A. Surface Tolerances:

1. The finished surface of cement treated base shall be uniform and shall not deviate at any point more than 3/8 inch from the bottom of a 10-foot straightedge laid in any direction.

2. The surface of the finished cement treated base at any point shall not vary more than 5/8 inch above or below the grade established by the Engineer, except that when Portland cement concrete pavement is to be used 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.

B. 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.

1. The excess materials 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.

2. 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.

C. Cleated equipment shall not be allowed on new cement treated base unless street pads are used on the cleats.

304.03.07 TIME REQUIREMENTS

A. Any mixture of aggregate, cement, and water that has not been compacted shall not be left undisturbed for more than 30 minutes.

B. Not more than 2 hours shall elapse between the time water is added to the aggregate and cement and the time of completion of initial rolling.

C. Not more than 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

A. At the end of each day's work and when cement treated base operations are delayed or stopped for more than 2 hours, a construction joint shall be made in thoroughly compacted material, normal to the centerline of the roadbed with a vertical face.

B. Additional mixture shall not be placed until the construction joint has been approved by the Engineer.

C. Where cement treated base has been finally compacted more than 1 hour, longitudinal joints shall be constructed by cutting vertically into the existing edge for approximately 3 inches and the material cut away may be disposed of in the adjacent lane to be constructed.

D. The face of the cut joints shall be moistened in advance of placing the adjacent base.

304.03.09 PROTECTION AND CURING

A. 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 of application free of pressure at the surface being treated.

B. The completed cement treated base shall be covered with a bituminous curing seal as protection against drying.

1. Curing seal will be required only for the top layer of cement treated base.
2. The curing seal shall be applied as soon as possible, but not later than 8 hours after the completion of final rolling.
3. The surface shall be kept moist until the seal is applied.
4. Curing seal shall be bituminous material, 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.
5. 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.
6. 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.
7. If necessary to ensure this, sufficient water to fill the surface voids shall be applied immediately before the asphalt is applied.

C. Equipment or traffic shall not be permitted on the cement treated base during the first 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.

D. When equipment or traffic is permitted on the cement treated base and such permission is granted for the sole convenience of the Contractor, the Contractor shall protect the curing seal at no additional cost to Contracting Agency.

E. 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

A. Cement treated base shall not be mixed or placed while the atmospheric temperature is below 35 degrees F, or when conditions indicate that the temperature will fall below 35 degrees F for a sustained period of 4 hours.

B. Cement treated base shall not be placed on frozen ground and all material shall be protected from freezing and frost for a period of 5 days after placing.

METHOD OF MEASUREMENT

304.04.01 MEASUREMENT

A. The quantity of Cement Treated Base will be measured for payment by the square yard.

B. The quantity of Portland Cement for Cement Treated Base will be measured for payment by the hundred weight.

BASIS OF PAYMENT

304.05.01 PAYMENT

A. Cement treated base and subbase will be paid for by the square yard, in place, as shown on the plans or as directed by the Engineer. The price per square yard shall include payment for the furnishing of untreated base or subbase material required by the plans or specifications and shall include mixing, spreading, shaping, compacting, trimming, and curing the treated material.

B. Portland cement for treating base and subbase will be paid for by the hundred weight for the quantity required to treat the base at the rate prescribed on the plans or directed by the Engineer.

1. The price per hundred weight shall include payment for furnishing and spreading cement on the job.

2. Cement will not be considered a major bid item for the purpose of adjusting quantities.

C. Payment for curing seal will be considered as included in the price bid for cement treated base.

D. Payment will be made under:

PAY ITEM	PAY UNIT
Cement Treated Base	Square Yard
Portland Cement for Cement Treated Base	Hundred Weight

SECTION 306

LIME STABILIZED SUBGRADE

DESCRIPTION

306.01.01 GENERAL

A. This work consists of stabilizing in place subgrade material, by combining lime and water with the pulverized subgrade material to the specified depth and compacting the mixture to the specified density, in conformance to the lines, grades, and dimensions shown on the plans and as specified in these specifications and the Special Provisions.

MATERIALS

306.02.01 SUBGRADE MATERIAL

A. Subgrade material shall be the native in-situ soil or imported embankment material.

B. The material to be stabilized shall be free of organic materials or other deleterious matter, and shall be limited to such a size that all the material can be passed through the mixing machine at each operation.

C. When sulfates are found in the subgrade and embankment material, the subgrade shall be stabilized in accordance with the table below for recommended mellowing time.

D. Soluble sulfate content shall be determined in accordance with California Test Method 417 modified to use 10 parts water to 1 part soil.

HYDRATED LIME SLURRY - SULFATE CHART

AMOUNT OF SULFATES %	RECOMMENDED MELLOW TIME
0.0 - 0.3	None
0.3 - 0.5	1 Day
0.5 - 0.8	2 - 3 Days
0.8 - 1.0	* Double Application

When sulfate rate is above 0.8 percent, Engineer review and approval is required.

* Double Application - One half of the specified hydrated lime shall be applied, mixed, and mellowed for 5 days at above optimum moisture conditions. The second half of the slurry shall then be applied, mixed, and compacted.

306.02.02 LIME

A. Lime shall be either a hydrated lime or quicklime, and shall conform to ASTM C977.

B. Lime may only be used in the production of a lime slurry.

C. The direct application of dry hydrated lime or quicklime to the subgrade material is strictly prohibited.

D. All lime shall come from a single source. If the source is changed, new information shall be submitted for the Engineer's approval.

E. All batches of lime furnished to the project shall have the supplier's certificate of compliance.

306.02.03 WATER

A. Water used for mixing lime slurry or curing shall be reasonably clean and free of oil, salt, acid, alkali, sugar, vegetable, or other substances injurious to the finished product.

B. Water shall be tested in accordance with and shall meet the requirements of AASHTO T26.

C. Water known to be of potable quality may be used without testing.

CONSTRUCTION

306.03.01 PROPORTIONING

A. Before commencing lime treatment work, the Contractor shall furnish in writing to the Engineer a proposed mix design determined by a testing laboratory under the direction and control of a registered professional engineer.

B. The mix design shall be determined using the in-place soils to be stabilized and lime from the proposed supplier and shall determine the following:

1. Percent of lime and rate of application of lime slurry in the treated subgrade material.
2. Optimum water content during mixing, curing, and compaction.
3. Gradation of in-situ mixture after treatment.
4. Additional mixing or equipment requirements.
5. Mellowing time requirements, if needed.

C. The mix design shall comply with the following requirements:

1. Minimum pH: 12.4 after completion of initial mixing with lime at ambient temperature, in accordance with Eades-Grim pH test method (ASTM C977, Appendix).
2. Plasticity Index: Less than 3, in accordance with ASTM D4318, after 16 hours of cure time with the lime.
3. Swell Potential: 1 percent or less vertical expansion of an air dried soil when inundated with water and allowed to swell at a confined pressure of 60 psf.
4. Minimum Hydrated Lime Content: 5.0 percent by dry weight of the combined lime/soil mixture, in accordance with ASTM D3155.
5. Minimum Unconfined Compressive Strength: At least 160 psi in 5 days of curing at 100 degrees F when tested in accordance with ASTM D1633, Method A.

306.03.02 SUBGRADE PREPARATION

A. Subgrade material to be stabilized shall be scarified and thoroughly broken up to the full depth and width to be lime treated. The material shall then be shaped and sized for the addition of lime slurry.

B. When the design requires treatment to a depth greater than 1 foot, the subgrade soil shall be treated in 2 equal layers.

1. The top layer of soil shall be treated in place, and then removed and stockpiled. The moisture content of the stockpile shall be maintained at the specified moisture.
2. The lower layer of soil to be treated shall then be treated and allowed to mellow in place.

3. After final mixing, the lower layer shall be compacted.

4. The stockpiled lime-soil mixture shall then be placed, mixed, and compacted.

306.03.03 LIME APPLICATION

A. Lime shall be applied as a slurry to the subgrade material at the rate specified for the depth of subgrade treatment shown.

1. The treatment rate shall be determined from a design using the subgrade materials, and shall meet the requirements in Subsection 306.03.01, "Proportioning."

2. Rate of application shall be verified using methods outlined in ASTM D3155.

3. Lime slurry shall be spread only on that area where the mixing operations can be completed during the same working day.

4. Lime slurry shall not be left exposed to the air for more than 4 hours.

5. No traffic other than the mixing equipment shall be allowed to pass over the spread lime slurry until after completion of mixing.

B. The Engineer reserves the right to vary the rate of application of lime from the specified application rates during the progress of construction as necessary to maintain a pH of the lime/soil mixture above 12.4 and the desired characteristics of the treated subgrade.

C. The lime shall be mixed with water in approved slakers and applied as a slurry by approved trucks with distributors or applicators approved by the Engineer.

1. When using dry hydrate to make a slurry, agitators are mandatory in distributor trucks.

2. The distribution of lime slurry shall be attained by successive applications over a measured section of subgrade until the proper amount of lime has been spread.

3. The amount of lime spread shall be the amount required for mixing to the specified depth which will result in the percentage determined in the mix design.

306.03.04 MIXING

A. The lime stabilized subgrade shall not be mixed when the ambient air temperature at ground level is below 40 degrees F or as approved by the Engineer, or when it is rainy, or when the temperature of the subgrade material is below 35 degrees F.

B. The lime subgrade shall be maintained at a temperature of 35 degrees F or above until the lime stabilized material has been compacted.

C. The full depth of the stabilized subgrade layer shall be mixed with an approved mixing machine.

1. The use of disc plows or blades are strictly prohibited except in areas specified by the Engineer.

2. The mixing machine shall make 2 or more coverages, as determined by the Engineer.

3. Water shall be added to the subgrade material during mixing to provide a moisture content at least 3 percent above the optimum moisture content as determined by the mix design to ensure chemical reaction of the lime and subgrade material.

4. This moisture content shall be maintained throughout the mellowing and curing time.

5. During the mellowing period, the material shall be sprinkled as directed.

D. Mixing and remixing shall be done as necessary to assist the lime-soil reaction, and shall continue until the combination of lime slurry and subgrade materials is free of streaks or pockets of lime, and the mixture is of uniform consistency and contains no clods or lumps greater than 1 inch or less than 60 percent passing the No. 4 sieve when tested dry.

E. After the required mellowing time, the lime stabilized subgrade material shall be uniformly mixed for final mixing.

F. After final mixing, the treated subgrade material shall be tested for plasticity index in accordance with ASTM D4318 and for compressive strength.

1. The lime mixture shall develop compressive strength of at least 160 psi in 5 days of curing at 100 degrees F when tested in accordance with ASTM D1633, Method A.

2. Cylinders shall be molded from treated soil within 2 hours of final mixing with the material compacted to at least 95 percent compaction at the field moisture content.

3. Moisture density field relationships for the treated soil shall be determined in accordance with ASTM D698.

G. The treated subgrade shall then be tested for lime content.

1. When the percentage of lime is found to be deficient less than 0.5 percent from the design, the material may be left in place.

2. When the percentage of lime is deficient between 0.5 percent and 1.0 percent, payment will be made in accordance with Subsection 306.05.01, "Payment."

3. When the percentage of lime is deficient more than 1.0 percent, the entire area shall be reprocessed at no additional cost to the Contracting Agency.

306.03.05 COMPACTION

A. Compaction of the lime stabilized subgrade shall begin immediately after final mixing.

1. The material shall be aerated or sprinkled as necessary to maintain the moisture content of the mixture between 0 to 3 percent above the optimum moisture content.

2. The field density of the compacted mixture shall be at least 95 percent of the maximum laboratory density.

3. The optimum moisture content and maximum laboratory density shall be determined in accordance with ASTM D698.

B. Initial compaction shall be by means of sheep-foot rollers or segmented wheel rollers. Final rolling shall be with steel-wheeled or pneumatic-tired rollers. Areas inaccessible to rollers shall be compacted to the required compaction by other means satisfactory to the Engineer.

C. In addition to the requirements specified for density, the full depth of the lime treated subgrade shown on the Drawings shall be compacted to the extent necessary to remain firm and stable under construction equipment.

1. All irregularities, depressions, or weak spots which develop as determined by the Engineer shall be corrected immediately by scarifying the areas affected, adding or removing materials as required, reshaping, and recompacting by moisture conditioning and rolling.

2. After each section is completed, tests will be made by the Engineer.

3. If the material fails to meet the density requirements, the material shall be reworked to meet these requirements.

4. Should the material, due to any reason or cause, lose the required stability, density, or finish before the next course or pavement is placed, the material shall be recompacted and refinished at no additional cost to the Contracting Agency.

306.03.06 FINISHING AND CURING

A. The surface of each layer of lime treated material shall be kept moist for a minimum of 1 day before further courses are added or any traffic is permitted, unless otherwise directed by the Engineer.

B. The moisture cured duration may be reduced if a non-yielding surface is obtained to support construction traffic and either the next layer of treated soils are placed or the pavement layer is constructed, as approved by the Engineer.

C. After the final layer of lime stabilized subgrade has been compacted, the subgrade shall be brought to the required lines and grades in accordance with the typical sections.

1. If the surface of the finished layer is above the grade tolerance specified in this section, the excess material shall be trimmed, removed, and disposed of.

2. No loose material shall be left in place.

3. After trimming, the material shall be rolled with steel-wheeled or pneumatic-tired rollers.

4. The finished surface shall not deviate by more than 0.04 feet from the actual finish grade.

5. The surface of the course shall be maintained in a smooth condition, free from undulations and ruts, until other work is placed thereon or the work is accepted.

D. The finish thickness of the lime stabilized subgrade shall not be deficient by more than 1 inch from the planned thickness at any point. If the thickness is deficient by more than 1 inch, the pavement structural section shall be adjusted by the Contractor to compensate for the deficiency in stabilized subgrade thickness, subject to the approval of the Engineer and at no added cost to the Contracting Agency.

METHOD OF MEASUREMENT

306.04.01 MEASUREMENT

A. The area of lime stabilized subgrade will be measured for payment by the square yard complete in place and accepted.

BASIS OF PAYMENT

306.05.01 PAYMENT

A. Payment shall be made at the contract unit price per square yard for the lime stabilized subgrade of the thickness specified. The price shall be full compensation for furnishing all labor, material including the lime, tools, equipment and incidentals, and for doing all the work involved in constructing the lime stabilization complete in place, as shown on the plans, and as specified in these specifications and the Special Provisions, and as directed by the Engineer. The pavement structural section shall be adjusted by the Contractor to compensate for any deficiency in stabilized subgrade thickness.

B. Payment will be made under:

PAY ITEM	PAY UNIT
Lime Stabilized Subgrade	Square Yard

Payment Table

% Deviation from design Lime Content	Pay Schedule % of Unit Price
less than 0.5%	100%
minus 0.51 to 0.6%	80%
minus 0.61 to 0.7%	60%
minus 0.71 to 0.8%	40%
minus 0.81 to 0.9%	20%
minus 0.91 to 1.0%	0%

SECTION 400

ASPHALT RUBBER PAVEMENT SURFACE

DESCRIPTION

400.01.01 GENERAL

A. The work shall consist of placing one or more surfaces of compacted asphalt rubber pavement overlay on an existing bituminous surface or on a prepared aggregate base course.

B. The asphalt rubber pavement mix shall consist of a surface course composed of mineral aggregate along with a reacted asphalt rubber binder.

C. The reacted asphalt rubber binder shall consist of asphalt cement, crumb rubber modifier, and other additives if required.

D. The asphalt rubber pavement mixture shall be prepared in a central mixing plant and placed in accordance with these specifications.

E. Rubberized asphalt concrete shall conform to these specifications and to the lines, grades, thickness, and typical cross-sections shown on the plans.

F. All mix designs shall be performed by the Contractor.

MATERIAL

400.02.01 ASPHALT RUBBER PAVEMENT MIX REQUIREMENTS

A. Asphalt rubber pavement shall conform to the following requirements:

Table 1 – Asphalt Rubber Pavement Mix Requirements

Parameter	Requirement
Marshall Stability, 75 blows, lbs, min.	1,200
Flow, 0.01 inch, min.	16
Percent air voids	3-5
Voids in mineral aggregate min. percent	19
Compaction number of blows each end of test specimen	75
Asphalt rubber binder content percent range	7.5-8.5

B. For bidding purposes, the percent of asphalt rubber binder in the mix shall be 8 percent. The exact amount of asphalt rubber binder in the mix shall be determined by the Contractor's mix design.

C. The Contractor shall submit 5 copies of an asphalt rubber pavement mix design 15 days prior to production of the asphalt rubber hot mix.

1. The mix design shall conform to the mix design requirements as shown in Table 1.
2. Asphalt rubber pavement mix design shall be performed in accordance with AASHTO T245 (modified), and test specimens compacted at 295 degrees F ±5 degrees F (75 blows) and in accordance with the Asphalt Institute MS-2, latest edition, Marshall Method.

D. The mix design shall include all tests and product certifications specified herein and shall also contain information on the following items:

1. Aggregate:
   a. Source.
   b. Gradation.
   c. Blend Percentages.
   d. Mixture gradation.
2. Asphalt Rubber Binder:
   a. Source, grade, and percent of asphalt cement.
   b. Source, grade, and percent of crumb rubber modifier.
   c. Type and amount of admixture.
3. Recommended asphalt rubber binder content by both weight of total mix and weight of dry aggregate.
4. Recommended mixture production temperature.
5. Recommended lay down temperature.
6. Density requirement.
7. Anti-stripping agent (if required).
8. The results of all testing.
9. Admixtures:
   a. Source and percentage.
   b. By weight of aggregate.
10. Bulk density.
11. Percent effective air voids.
12. Specific gravity of aggregates.

E. The Engineer will review the mix design proposal to ensure that it contains all required information. If it does not, it will be returned for further action and resubmission by the Contractor.

400.02.02 MINERAL AGGREGATE

A. The aggregate for the asphalt rubber pavement mixture shall meet the following requirements:

1. Minimum sand equivalent value shall be 65 percent.
2. Rock and gravel shall be clean, hard, sound, durable, and uniform in quality and free of any detrimental quantity of soft, friable, thin, elongated, or laminated pieces, disintegrated material, organic matter, oil, alkali, or other deleterious substance.
3. Water absorption of the combined aggregates shall not exceed 3 percent. Water absorption shall be determined separately for each aggregate material proposed for use. For fine fractions (minus No. 4) water absorption shall not exceed 3 percent. For coarse fractions, water absorption shall not exceed 3 percent.
4. L.A. abrasion limits for each aggregate proposed for use shall be as follows:
   a. Maximum: 9 percent abrasion at 100 revolutions.

b. Maximum: 35 percent abrasion at 500 revolutions.

5. Recycled aggregates will not be permitted.

6. The gradation shall be as follows:

Table 2 – Aggregate Gradation

Sieve Size	Percent Passing
1-inch	100
3/4-inch	90-100
1/2-inch	65-85
3/8-inch	60-70
No. 4	22-42
No. 8	15-25
No. 30	5-15
No. 200	3-7

400.02.03 ASPHALT RUBBER BINDER

A. The asphalt rubber binder shall be a uniform reacted mixture of compatible paving grade asphalt cement, granulated reclaimed crumb rubber, and anti-stripping agent if necessary.

B. The asphalt rubber binder shall meet the following physical parameters when reacted with the asphalt cement at 375 degrees F, ±25 degrees F for a minimum of 30 minutes:

Table 3 – Asphalt Rubber Binder Requirements

Parameter	Test Method	Requirement
Rotational Viscosity; 350°F; Pascal seconds, Haake type viscometer[1]	--	1.5-4.0
Penetration, 39.2°F, 200g, 60 sec.; 1/10 mm	ASTM D5	10 Minimum
Penetration, 77°F, 100g, 5 sec.; 1/10 mm	ASTM D5	25-75
Softening Point, °F	ASTM D36	135° Minimum
Resilience, 77°F	ASTM D5329	20% Minimum
Ductility, 39.2°F, 1 CPM	ASTM D113	5 Minimum

[1] The viscometer used shall be correlated to a Haake Viscometer, Model VT-04, Rotor No. 1.

C. The Contractor shall provide documentation that the Haake Viscometer has been calibrated (2 point minimum) within 6 months prior to use on the project.

D. The percentage of crumb rubber modifier shall be 20 percent plus or minus 3 percent by weight of total asphalt rubber mixture.

E. The exact crumb rubber content shall be determined by the asphalt rubber binder mix design prepared by the Contractor.

400.02.04 ASPHALTIC CEMENT

A. Asphalt cement shall be grade AC-20.

B. The exact amount shall be determined by the Contractor's mix design and shall be approved by the Engineer.

400.02.05 CRUMB RUBBER MODIFIER

A. Rubber shall be a recycled vulcanized rubber produced primarily from the processing of scrap tires.

B. Gradation of the rubber shall be in accordance with ASTM C136 (dry sieve only) using 50 grams ±1 gram.

C. Samples shall meet the following requirements:

Table 4 – Crumb Rubber Modifier Gradation

Sieve Size	Percent Passing
No. 10	100
No. 16	75-100
No. 30	25-60
No. 50	0-20
No. 200	0-5

D. The use of rubber of multiple types from multiple sources is acceptable provided that the overall blend of rubber meets the above gradation requirements.

E. The ground rubber shall have a specific gravity of 1.15 (±0.05) and shall be substantially free of loose fabric, wire, and other contaminants.

1. However, up to 4 percent (by weight of rubber) calcium carbonate may be included to prevent rubber particles from sticking together.
2. The rubber shall be dry so as to be free flowing and not produce foaming when blended with hot asphalt cement.
3. The length of the individual rubber particles shall not exceed 3/16 inch.

F. Fiber content in the rubber shall be less than 0.1 percent by weight.

G. The moisture content in the rubber shall be less than 0.75 percent by weight.

H. Mineral contaminant in the rubber shall not be greater than 0.25 percent by weight, as determined after separating a 50-gram rubber sample in a 1-liter glass beaker of water.

I. The rubber shall contain no visible metal particles, as indicated by a thorough stirring of a 50-gram sample with a magnet, and shall conform to the chemical analysis in Table 5:

Table 5 – Crumb Rubber Modifier Chemical Analysis Requirements

Test	Test Method	Requirement
Acetone Extract	ASTM D297	6%-16%
Ash Content	ASTM D297	0%-8%
Carbon Black Content	ASTM D297	28%-38%
Rubber Hydrocarbon	ASTM D297	42%-65%
Natural Rubber Content	ASTM D297	22%-39%

J. Certification that the ground rubber meets or exceeds the requirements as set forth in these specifications shall be provided from the rubber supplier.

400.02.06 ADMIXTURE

A. If required by the job mix formula to produce appropriate water resistance and ensure proper adhesion and/or coating of aggregate, an anti-stripping agent shall be incorporated into the mineral aggregate.

B. The admixture shall be either hydrated lime (ASTM C1097) or Portland Cement II (ASTM C150).

C. The amount needed for the admixture shall be as determined by the Contractor's mix design.

400.02.07 MIX DESIGN REQUIREMENTS

A. The mix designs shall be performed by a Nevada registered professional engineer knowledgeable in asphalt mix design. The laboratory used to prepare the mix design may be the Contractor's laboratory or an independent geotechnical-materials laboratory provided the laboratory complies with the following:

1. The lab is, at the time of submittal, and remains certified by the National Bureau of Standards in the National Voluntary Laboratory Accreditation Program (NVLAP) for Construction Services (ASPHALT) or the AASHTO Accreditation Plan (AAP).

2. A copy of the certification will be required with each submittal as described above.

B. The asphalt rubber binder mix design shall be a 24-hour design.

CONSTRUCTION

400.03.01 ASPHALT RUBBER BINDER MIXING AND PRODUCTION EQUIPMENT

A. All equipment utilized in production and proportioning of the asphalt rubber binder shall be as described in this subsection.

B. An asphalt heating tank with a hot oil heat transfer system or retort heating system capable of heating asphalt cement to the necessary temperature for blending with the granulated rubber. This unit shall be capable of heating a minimum of 3,000 gallons of asphalt cement.

C. An asphalt rubber binder mechanical blender with a 2-stage continuous mixing process capable of producing a homogenous mixture of asphalt cement and ground rubber, at the mix design specified ratios, as directed by the Engineer.

1. This unit shall be equipped with a ground rubber feed system capable of supplying the asphalt cement feed system so as not to interrupt the continuity of the blending process.

2. A separate asphalt cement feed pump and finished product pump are required.

3. This unit shall have both an asphalt cement totalizing meter in gallons and a flow rate meter in gallons per minute.

D. An asphalt rubber binder storage tank equipped with a heating system to maintain the proper temperature for pumping and adding of the binder to the aggregate and an internal mixing unit within the storage vessel capable of maintaining a proper mixture of asphalt cement and ground rubber.

E. An asphalt rubber binder supply system equipped with a pump and metering device capable of adding the binder by volume to the aggregate at the percentage required by the approved rubberized asphalt concrete formula.

1. The temperature and viscosity of the asphalt rubber binder shall be within the range specified in the approved rubberized asphalt concrete formula.

2. An armored thermometer of adequate range in temperature reading shall be in position in the asphalt rubber feed line at a suitable location near the mixing plant.

400.03.02 ASPHALT RUBBER BINDER MIXING AND REACTION PROCEDURE

A. Asphalt Cement Temperature: The temperature of the asphalt cement shall be between 375 degrees F and 450 degrees F at the time of addition of the granulated rubber.

B. Blending and Reacting:

1. The asphalt and ground rubber shall be combined and mixed together in a blender unit, pumped into the agitated storage tank, and then reacted for a minimum of 45 minutes from the time the granulated rubber is added to the asphalt cement.

2. Temperature of the asphalt rubber mixture shall be maintained at or above 350 degrees F during the reaction period, but shall not exceed 450 degrees F at any time.

3. Exceeding 450 degrees F will be grounds for rejection of the affected material.

4. The asphalt rubber binder may be allowed to cool to between 300 degrees F and 350 degrees F only after the reaction time is complete and the viscosity is within the specified range.

C. Transfer: After the material has reacted for at least 45 minutes, the asphalt rubber shall be metered into the mixing chamber of the asphalt concrete production plant at the percentage required by the approved job mix formula.

D. Delays:

1. When a delay occurs in binder use after its full reaction, the asphalt rubber binder shall be allowed to cool.

2. The asphalt rubber binder shall be reheated slowly just prior to use to a temperature between 300 degrees F and 335 degrees F, and shall also be thoroughly mixed before pumping and metering into the hot plant for combination with the aggregate.

3. The Engineer shall be notified of any material that is held over and allowed to cool.

4. A viscosity test shall be required to determine if the viscosity is out of the range specified. The asphalt rubber binder shall be adjusted by the addition of asphalt cement or ground rubber to produce a material with the appropriate viscosity.

5. The Engineer or Engineer's representative shall be present at the time of testing.

400.03.03 ASPHALT RUBBER BINDER/AGGREGATE MIXING EQUIPMENT

A. The addition and mixing of the asphalt rubber with the aggregate shall be accomplished with one of the following types of hot-mix asphalt plants:

1. Batch Mixing:

a. Batch mix plant consisting of cold aggregate storage and feed, drier, gradation control unit, hot aggregate storage bins aggregate with-hopper, and twin-shaft pugmill mixing unit.

b. Also, the plant may be equipped with hot-mix surge or storage bins for short-term holding of the mixture until spreading.

2. Drier-Drum Mixing: Drier-drum mix plant consisting of cold aggregate storage and feed, automatic weighing system, drier-drum mixer, and hot-mix surge or storage bins for short-term holding of the mixture until spreading.

B. The asphalt rubber binder/aggregate mixing equipment shall be capable of producing a paving mixture meeting all of the requirements contained in this specification. Specifically the plant shall provide proper aggregate gradation, asphalt rubber content, and mixing temperature.

C. The introduction of asphalt rubber binder shall be controlled by an automated system fully integrated with the controls for mineral aggregate and mineral admixture. Failure to provide electronic integration of the feed controls at all times will be grounds for immediate suspension of production.

400.03.04 AGGREGATE PREPARATION/AGGREGATE MIXTURE PREPARATION

A. The Contractor will not be allowed to feed the hot plant from stockpiles containing less than 2 full days of production, unless only 2 days' production remains to be done.

1. Mineral aggregate shall be separated and stockpiled so that segregation is minimized.

2. An approved divider of sufficient size to prevent intermingling of stockpiles shall be provided.

B. If a batch plant is used, the mineral admixture shall be added and thoroughly mixed in the pugmill prior to adding the asphalt rubber binder.

C. A positive signal system and a limit switch device shall be installed in the plant, at the point of introduction of the mineral admixture.

1. The positive signal system shall be placed between the metering device and the drum drier, and utilized during production, whereby the mixing shall automatically be stopped if the admixture is not being introduced into the asphalt rubber concrete mixture.

2. Failure to provide electronic integration of the feed controls at all times will be grounds for immediate suspension of production.

D. When mineral aggregate, mineral admixture, and asphalt rubber binder are proportioned by weight, all boxes, hoppers, buckets, or similar receptacles used for weighing materials, together with scales of any kind used in batching materials, shall be insulated against the vibration or movement of the plant.

1. The entire plant operating shall not exceed 2 percent for any setting, nor 1-1/2 percent for any batch.

2. Bituminous material shall be weighed in an insulated bucket suspended from a springless dial scale system.

3. All scales shall be certified.

E. No fine material that has been collected in the dust collection system shall be returned to the mixture, unless the Engineer, on the basis of tests, determines that all or a portion of the collected fines can be utilized.

F. If the Engineer so determines, the Engineer will authorize, in writing, the utilization of a specific proportion of the fines; however, authorization will not be granted unless the collected fines are uniformly metered into the mixture.

G. When mineral aggregate, mineral admixture, and asphalt rubber binder are proportioned by volume, the correct portion of each mineral aggregate size introduced into the mixture shall be drawn from the storage bins by an approved type of continuous feeder.

H. The continuous feeder will supply the correct amount of mineral aggregate in proportion to the bituminous material, and shall be arranged so that the proportion of each mineral aggregate size can be separately adjusted.

1. The continuous feeder for the mineral aggregate shall be electrically actuated.

2. Failure to provide electronic integration of the feed controls at all times will be grounds for immediate suspension of production.

I. The introduction of asphalt rubber binder shall be controlled by an automated system, fully integrated with the controls for mineral aggregate and mineral admixture. Failure to provide electronic integration of the feed controls at all times will be grounds for immediate suspension of production.

J. A positive signal system shall be provided to indicate the low level of mineral aggregate in the bins.

1. The plant will not be permitted to operate unless this signal system is in good working condition.

2. Each bin shall have an overflow chute or a divider to prevent material from spilling into adjacent bins.

K. The mixing operation shall be sufficient to achieve a satisfactory mixture with 100 percent coated particles as determined by AASHTO T195 or ASTM D2489.

L. The aggregate shall be dried and heated to provide a rubberized asphalt concrete mixture immediately after mixing, having a temperature of 290 degrees F to 335 degrees F, and having a moisture content not exceeding 1 percent by weight of mixture.

400.03.05 ASPHALT RUBBER BINDER CONTROL

A. The asphalt rubber binder shall be a minimum of 300 degrees F when pumped and metered into the mixing plant.

B. The crumb rubber modifier content shall not fluctuate more than 1 percent by weight of total rubberized asphalt concrete mixture.

400.03.06 ASPHALT RUBBER PAVEMENT CONTROL

A. The asphalt rubber pavement mixture shall have a temperature not exceeding 335 degrees F and a moisture content not exceeding 1 percent by weight of mixture immediately upon discharge from the mixer.

B. If the asphalt rubber concrete is discharged from the mixer into a hopper, the hopper shall be constructed so that the segregation of the mix will be minimized.

C. The moisture content of the asphalt rubber concrete immediately behind paver shall not exceed 1 percent by total weight of the mix. Drying and heating shall be accomplished in such a manner as to preclude the mineral aggregate from becoming coated with fuel oil or carbon.

400.03.07 TRANSPORTING ASPHALT RUBBER PAVEMENT MIXTURE

A. Trucks used for hauling the paving mixture shall be capable of discharging directly into the spreading equipment.

1. Discharge onto the surface being paved shall not be permitted.
2. The truck beds shall be clean of materials such as dirt, mud, and aggregates.
3. Just prior to loading the mixture, the truck bed shall be sprayed with a light application of a soapy solution or a silicone emulsion (oiling with kerosene or diesel fuel will not be permitted) to reduce sticking of the mixture to the truck bed.

B. If required by the Engineer or Engineer's representative, the load shall be covered with a tarpaulin to prevent loss of heat.

C. Mixtures that have cooled in transport shall be rejected. The temperature of the mixture, in the mat behind the paver, shall be at least 275 degrees F but shall not exceed 325 degrees F.

D. Hauling over freshly laid asphalt concrete pavement will not be permitted.

400.03.08 SPREADING ASPHALT RUBBER PAVEMENT MIXTURE

A. Paving shall be accomplished with self-propelled mechanical spreading and finishing equipment.

1. Equipment shall have a tamping bar, vibratory screed, or strike-off assembly capable of distributing the material to not less than the full width of a traffic lane and to the depth needed to achieve the minimum compacted thickness or finished grade as required.
2. The screen or strike-off assembly shall be equipped with a heating unit that maintains the temperature needed to prevent tearing of the pavement during spreading.
3. The spreading temperatures shall be in accordance with the approved job mix formula.

B. The mixture shall not be placed on any wet surface or when weather conditions will otherwise prevent its proper handling or finishing.

C. Mixtures shall be placed only when the surface temperature is 60 degrees F and rising.

D. A ski not less than 30 feet shall be used at all times on the through lane paving.

1. A longer ski is preferred, if available.
2. Paving will be halted immediately if the auto screed controls fail and may not proceed without approval of the Engineer.

E. Asphalt rubber pavement shall be placed in 2-inch maximum lifts.

400.03.09 COMPACTING ASPHALT RUBBER PAVEMENT MIXTURE

A. A minimum of 2 self-propelled 2-axle steel-wheel rollers shall be furnished for each spreader and finisher. Rollers shall have a minimum roller weight of 8 tons and maximum roller weight of 12 tons.

B. All rollers shall be equipped with pads and a watering system to prevent sticking of the paving mixture to the steel-wheeled drums.

1. Vibratory rollers may not be used on 1 inch or less asphalt rubber pavement thickness.

2. Pneumatic tire rollers shall not be used due to the increased adhesiveness of the asphalt rubber binder.

C. Initial or break down compaction shall commence immediately after mixture spreading and shall consist of 3 full coverage before the pavement temperature reaches 200 degrees F unless otherwise directed by the Engineer or Engineer's representative.

1. A coverage shall be as many passes as are necessary to cover the entire width being paved with a pass being 1 movement of a roller in either direction.

2. Each coverage shall be complete before subsequent coverage is started.

3. Final rolling, consisting of not less than 1 complete coverage, shall be used to smooth the surface of the mat.

4. All rolling shall be accomplished without excessive aggregate fracturing or mixture shoving.

D. The asphalt shall be compacted to a minimum of 95 percent of the 75-blow design density, as specified in the approved job mix formula.

400.03.10 JOINTS

A. Longitudinal joints of each course shall be staggered a minimum of 12 inches with relation to the longitudinal joint of the immediate underlying course.

B. The Contractor shall schedule paving operations to minimize exposed longitudinal edges.

1. Unless otherwise approved by the Engineer, the Contractor shall limit the placement of asphalt rubber concrete courses, in advance of adjacent courses, to 1 shift of asphalt rubber concrete production.

2. The Contractor shall schedule paving operations in such a manner as to eliminate exposed longitudinal edges over weekends or holidays.

C. Longitudinal joints shall be located within 12 inches of the center of a lane, or within 12 inches of the centerline between 2 adjacent lanes.

D. Before a surface course is placed in contact with a cold traverse construction joint, the cold existing asphalt concrete shall be trimmed to a vertical face by cutting the existing asphalt concrete back for its full depth and exposing a fresh face.

1. After placement and finishing of the new asphalt concrete, both sides of the joint shall be dense, and the joint shall be well sealed.

2. The surface in the area of the joint shall conform to the requirements specified below for surface tolerances when tested with the straightedge placed across the joint.

E. No hot lap transverse jointing will be allowed in the paving of the through lanes. When stopping the paving for the shift or for any reason, the resulting transverse joint shall be formed on a skew of approximately 15 degrees from a line perpendicular to the centerline of the road.

400.03.11 PRODUCTION START-UP PROCEDURE

A. On the first day of construction, the Contractor shall produce 500 tons of asphalt rubber pavement mix and then stop production for the day.

1. The 500 tons of asphalt rubber pavement mix shall be placed within the project limits as a test strip.
2. The Engineer or Engineer's representative will evaluate the test strip, which will also be used to establish a rolling pattern for compaction, calibration of nuclear density gauges for core densities, and to verify the mix design.

B. Mix production and construction will not proceed until the test strip has been accepted by the Engineer.

400.03.12 WEATHER LIMITATIONS

A. The asphalt rubber pavement shall be placed when temperature of the existing pavement surface is 60 degrees F and rising before placement.

400.03.13 TACK COAT

A. An SS-1h tack coat shall be applied, as directed by the Engineer, at a rate of 0.05 to 0.10 gallon per square yard.

B. Immediately before applying the bituminous material, the area to be surfaced shall be cleaned of dirt and other objectionable material.

1. In urban areas, the surface shall be cleaned with a self-propelled pick-up sweeper.
2. In rural areas, power brooms may be used.

C. When necessary, cleaning shall be supplemented by hand brooms.

400.03.14 MILLING

A. The milling process shall not proceed more than 7 days ahead of the paving operation. The Engineer shall have the final decision in determining the time period between milling operations and paving operations.

B. The Contractor shall be required to protect all milled surfaces from deterioration and repair subsequent damage prior to seal coating.

C. Utility companies are not required to lower their appurtenances to facilitate edge milling or cul-de-sac milling.

D. The Contractor through the Engineer shall notify the entity Traffic Department prior to milling at signalized intersections or any location where signal loop detectors may be damaged by the milling operation.

400.03.15 PREPARATION OF SURFACES

A. The pavement shall not be used for vehicular traffic of any kind until the pavement has cooled to 180 degrees F, or less, after final rolling.

B. Traffic shall be prohibited from using the new pavement by utilization of flagging or ribbons placed between barricades.

1. The Contractor, at no additional cost to the Contracting Agency, shall be responsible for repairing the new asphalt if damaged by vehicular traffic prior to cooling and curing.
2. If traffic is permitted on the surface prior to cooling and curing of the asphalt rubber mix, a mixture of water and hydrated lime (1 bag/5,000 gallon) shall be applied followed by a water rinse to remove hydrated lime residue.
3. The Engineer or Engineer's representative will determine when the pavement can be opened to vehicular traffic and if a hydrated lime solution shall be applied.

400.03.16 CONTRACTOR SUBMITTALS DURING CONSTRUCTION

A. The Contractor shall provide certification that the ground rubber meets or exceeds the requirements as set forth in Subsection 400.02.05, "Crumb Rubber Modifier."

B. The Contractor shall furnish daily documentation to the Engineer that the required amount of mineral admixture has been incorporated into the asphalt rubber concrete.

C. The asphalt rubber supplier shall maintain records indicating the following for each batch of asphalt rubber binder produced:

1. The quantity of asphalt cement in gallons and tons.
2. The temperature of the asphalt cement.
3. The amount of anti-stripping agent or other additives, if used, in gallons and/or tons.
4. The quantity of crumb rubber modifier in pounds.

D. The Contractor shall provide the supplier's records to the Engineer on a daily basis.

E. When producing asphalt rubber pavement, a recording pyrometer or other approved recording thermometric instrument, sensitive to a rate of temperature change not less than 10 degrees F per minute, shall be placed at the discharge chute of the drier in order to automatically record the temperature of the asphalt rubber concrete or mineral aggregate. A copy of the recording shall be given to the Engineer at the end of each shift.

F. The Engineer shall be provided with all other materials certifications, samples, test reports, and unrestricted access to all plant production records. Any corrective work, due to deviations from the requirements of these specifications, shall be done at no additional cost to the Contracting Agency.

METHOD OF MEASUREMENT

400.04.01 MEASUREMENT

A. The quantity of Asphalt rubber pavement will be measured for payment by square yard, complete and in place.

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

BASIS OF PAYMENT

400.05.01 PAYMENT

A. The accepted quantity of asphalt rubber pavement will be paid for at the contract unit price bid per square yard, which shall be full compensation for furnishing all the materials

including tack coating, hydrated lime, Portland cement, aggregate, asphalt rubber binder, asphalt cement, crumb rubber modifier, and admixtures, and shall also include full compensation for mixing, loading, hauling, placing, compacting, and incidentals necessary for doing all the work involved in constructing rubberized asphalt concrete pavement as shown on the plans or established by the Engineer.

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

C. Payment will be made under:

Pay Item	**Pay Unit**
(Thickness)-Inch Asphalt Rubber Pavement (Overlay)	Square Yard

SECTION 401

PLANTMIX BITUMINOUS PAVEMENTS – GENERAL

DESCRIPTION

401.01.01 GENERAL

A. 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 requirements for each type.

B. 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 conformity with the lines, grades, thicknesses, and typical cross sections shown on the plans or established by the Engineer.

401.01.02 PAVEMENT STRUCTURAL DESIGN

A. All public pavement sections shall be designed in accordance with the 1993 AASHTO Guide for Design of Pavement Structures. The following parameters, based upon the AASHTO Guide and the 1996 Nevada Department of Transportation Pavement Structural Design and Policy Manual, shall be used in the design calculations. Parameters which are specific to a road classification are identified by the right-of-way dimension. The design shall be stamped and signed by a professional engineer registered in the state of Nevada.

1. The reliability factor will be a minimum of 80 percent with a standard normal deviate (ZR) of -0.841 for 51-foot, 60-foot, and 80-foot rights-of-way, and a minimum 90 percent with a standard normal deviate (ZR) of -1.282 for 100-foot rights-of-way.

2. The standard deviation will be 0.45 for all classifications.

3. The initial service index will be 4.2 and the final service index 2.5 for all classifications.

4. Drainage coefficients shall not exceed 1.0.

5. The structural coefficient for asphalt will be 0.35.

6. For materials meeting Subsection 704.03.04, "Type II Aggregate Base," the elastic modulus shall be 25,000 psi and the structural coefficient shall be 0.12.

7. For materials meeting Subsection 704.03.03, "Type I Aggregate Base," the elastic modulus shall be 15,000 psi and the structural coefficient shall be 0.11.

8. Prior to design, soil testing will be performed in accordance with ASTM D2844 or AASHTO T190 to determine a representative Resistance (R) value for the prepared subgrade. The subgrade shall be prepared in accordance with the Geotechnical Soils Investigation Report, and soil sampling performed subsequent to rough grading to confirm the original results. An average of the R-values may be used if the soil classification results are consistent, or if the values do not differ by more than 10. The minimum testing requirements are 1 right-of-way R-value test and post grading soil classifications every 1,000 linear feet of roadway, with a minimum of 2 classifications per project.

9. The subgrade R-value (psi) shall be converted to a Resilient Modulus (M_R, psi) using the following correlation: MR=145*(10^((0.0147*R)+1.23)).

10. The minimum AC sections are 2.0 inches for a residential street, 3.0 inches for a minor collector, 4.0 inches for a major collector, and 4.0 inches for an arterial street.

11. All designs require a minimum of 4 inches Type II aggregate base material.

12. The subgrade shall be scarified and recompacted to a minimum of 95 percent, to minimum depth of 8 inches.

13. Expansive soils may require additional design compensation. If native soils classify as either an AASHTO A-6 or A-7 (more than 36 percent passing the #200 sieve and a PI equal to or greater than 11), the design may include stabilization, over-excavation, or utilization of a geomembrane, as recommended by the geotechnical engineer.

14. Hydro-collapsible soils, or the presence of soluble materials, may require additional design compensation, as recommended by the geotechnical engineer.

B. The minimum design equivalent axial loads (EAL) based on a 20-year design are 7.2E+3 for a residential street, 3.3E+4 for a minor collector, 3.7E+5 for a major collector, and 1.0E+6 for an arterial street. Locations with heavier than normal traffic shall be designed accordingly. A traffic study may be required for roads with a projected TI greater than 9.5. If required by the Contracting Agency, actual vehicle count data and assigned axle factors shall be used in the design of the pavement section. Definition of the roadway classifications, for design purposes, are listed below:

1. Residential roadways are those that provide access for residential areas only: Most 51-foot right-of-way roads are residential. The normal design TI is 5.0. A Residential road is considered to have heavy traffic, and a TI of 5.5, if minor amounts of thru-traffic use the road or bus traffic is encountered due to an adjacent school. Category II mix designs shall be used on residential streets.

2. Minor Collector roadways are those that collect residential traffic or service limited commercial facilities: Most 60-foot and some 51-foot right-of-way roads fit this classification. The normal design TI is 6.0. A Minor Collector is assumed to have heavy traffic and a TI of 6.5 if there is substantial commercial truck traffic or bus traffic due to an adjacent school.

3. Major Collector roadways are those that serve as destination roadways or service normal commercial or light industrial facilities: Most 80-foot, and some 60-foot, right-of-way roads fit this classification. The normal design TI is 8.0. A Major Collector is assumed to have heavy traffic, and a TI of 8.5, if there is substantial commercial or industrial truck traffic.

4. Arterial roadways are those that provide primary traffic routes or service heavy industrial facilities: All 100-foot, and some 80-foot and 60-foot, right-of-way roads fit this classification. The normal design TI is 9.5. An arterial may have light traffic, if there is a disruption or decrease in the road capacity, in which case the design TI is 9.0. An Arterial is assumed to have heavy traffic if it is at full capacity with substantial truck traffic, or if there is heavy industrial traffic. A traffic study is recommended in those situations.

MATERIALS

401.02.01 COMPOSITION OF MIXTURES

A. The bituminous plantmix shall be composed of a mixture of aggregate, mineral 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.

B. Before starting work, the Contractor shall submit a proposed job-mix formula in writing, for use by the Engineer in setting the job-mix formula to be used.

1. The proposed job-mix formula shall be determined by a testing laboratory under the direction and control of a registered professional engineer, based on tests performed in accordance with the "Marshall Method of Mix Design" as described in the Asphalt Institute Manual Series No. 2 (MS-2), latest edition.

2. The number of compaction blows to be applied to the specimens will be based on the appropriate traffic category.

3. Traffic Category I will use a 75-blow design and will apply to all arterial streets and wherever "heavy" traffic is expected.

4. Traffic Category II will use a 50-blow design and will apply to collector and local streets.

5. Unless otherwise specified, voids determinations and effective asphalt contents will be determined and reported in accordance with procedures described herein.

C. The job-mix formula shall be selected in accordance with the following procedures:

1. Determine asphalt content required for 4 percent air voids, and

2. Determine the average asphalt content for:

a. Maximum density.

b. Maximum stability.

c. 4 percent air voids.

3. The lower of the asphalt contents obtained for a. or b. above will be used as the design asphalt content for the job-mix formula.

D. The job-mix formula asphalt content shall satisfy all Marshall design criteria as shown in the following table:

MARSHALL DESIGN CRITERIA

TRAFFIC CATEGORY*	**I TRAFFIC INDEX (TI) ≥ 7.0**		**II TRAFFIC INDEX (TI) < 7.0**	
Compaction Blows Each End of Specimen	**75**		**50**	
Test Property	**Min.**	**Max.**	**Min.**	**Max.**
Stability, Lb.	1800	--	1500	--
Flow, 0.01 In.	8	14	8	16
Percent Total Air Voids	3	5	3	5
Percent Voids Filled With Asphalt	65	75	65	78
Minimum Voids In Mineral Aggregate - Percent	See Table In Asphalt Institute MS-2 Manual			

* Traffic Category I - Applies to arterials and major collectors. See roadway classification in Subsection 401.01.02.
Traffic Category II - Applies to minor collectors and residential streets. See roadway classification in Subsection 401.01.02.

E. In addition to the Marshall Design Criteria set forth herein, the job-mix formula shall also meet the following tensile strength requirements for all traffic categories:

TEST PROPERTY	TEST METHOD	REQUIREMENTS
Indirect Tensile Strength (Unconditioned)	AASHTO T283	65 psi minimum (50 psi minimum with AC-10 asphalt)
Indirect Tensile Strength (Retained Strength)	AASHTO T283	70 percent minimum

F. Should the job-mix formula fail to meet the tensile strength requirements, the Contractor shall add hydrated lime (hereinafter referred to as mineral filler) to the plantmix bituminous aggregates as specified in Subsection 401.03.08, "Preparation of Aggregates." If the addition of mineral filler fails to achieve the minimum tensile strengths, the Contractor will be required to change sources of material, and submit a new job-mix formula that will satisfy all design criteria.

G. The test report shall show the curves and data tabulations used to determine the following characteristics:

1. Unit weight per cubic foot.
2. Percentage of air voids.
3. Percent voids filled with asphalt.
4. Marshall stability.
5. Percent voids in mineral aggregate (VMA).
6. Marshall flow.
7. Indirect tensile strength (Unconditioned and Retained strength).

H. Data tabulations shall include indications of the water absorption, aggregate bulk specific gravities for both coarse (retained on No. 8 sieve) and fine (passing No. 8 sieve) aggregate, theoretical specific gravity of bituminous mixture, absorbed asphalt, and effective asphalt content as determined in accordance with referenced Asphalt Institute procedures. ASTM D2041 will be used for determination of theoretical maximum specific gravity of bituminous paving mixtures.

I. The test report shall give the recommended asphalt content and the values for:

1. Unit weight per cubic foot (bulk density).
2. Stability.
3. Flow.
4. Air voids.
5. Voids filled with asphalt.
6. Voids in mineral aggregate (VMA).
7. Indirect tensile strength (Unconditioned and Retained strength).

J. The formula submitted shall propose definite single values for:

1. The percentage of aggregate passing each specified sieve.
2. The percentage of bitumen to be added (to 0.1 percent) based on weight of total mix.

3. The percentage of mineral filler to be added to the aggregate.

4. The temperature of the mixture leaving the mixer.

5. The temperature of the mixture in the hopper of the paving machine.

K. The job-mix formula aggregate with the allowable tolerances herein shall conform to Section 705, "Aggregates for Bituminous Courses," for plantmix bituminous base aggregates, plantmix bituminous surface aggregate, or plantmix bituminous open-graded aggregate, as applicable.

L. The Engineer will determine a job-mix formula with single values for Subsection 401.02.01.J, paragraphs 1 through 5 above, and so notify the Contractor in writing. This job-mix formula shall not be modified except with the written approval of the Engineer. The mix furnished shall conform to this job-mix formula, within the following range of tolerances:

1. Aggregate passing the No. 4 and larger sieves: ±7 percent

2. Aggregate passing the No. 8 to No. 100 sieves: ±4 percent

3. Aggregate passing the No. 200 sieve: ± 2 percent, but not to exceed upper limit of specification. Mineral filler is not considered as part of the aggregate.

4. Bitumen content: ±0.3 percent

5. Temperature leaving the mixer: ± 20 degrees F

6. Temperature in hopper of paving machine: ± 20 degrees F

M. Should there be a change in sources of materials, a new job-mix formula shall be established before the new material is used. Check tests of properties of the plantmix bituminous materials shall be made on the first day of production and as requested by the Engineer during period of construction to confirm that all properties are in compliance with Marshall Design Criteria and tensile strength requirements. Adjustments in gradation, mineral filler content, and asphalt content shall be made as necessary to meet design criteria.

N. The temperature of the bituminous material just prior to mixing and of the completed mixture in the hauling vehicle just prior to leaving the plant shall conform to the following table:

PLANTMIX BITUMINOUS MIXTURE WITH ASPHALT CEMENT

Grade of Asphalt Cement	Bituminous Material		Plantmix Bituminous Base of Surface Mixtures		Plantmix Bituminous Open-Graded Mixtures	
	Min.	Max.	Min.	Max.	Min.	Max.
AC-40	275°F	350°F	255°F	350°F	245°F	275°F
AC-20, AC-30	265°F	330°F	245°F	325°F	245°F	275°F
AC-10	255°F	325°F	235°F	325°F	--	--
AC-20P	280°F	350°F	300°F	350°F	300°F	350°F

401.02.02 AGGREGATES

A. Aggregates shall comply with Section 705, "Aggregates for Bituminous Courses."

401.02.03 COMMERCIAL MINERAL FILLER

A. Commercial mineral filler shall comply with Subsection 705.03.04, "Commercial Mineral Filler."

401.02.04 BITUMINOUS MATERIALS

A. The bituminous material shall comply with Section 703, "Bituminous Materials." Bituminous material may be conditionally accepted at the source.

B. Unless otherwise specified in the Special Provisions for Category I pavements, the grade of bituminous material for dense-graded mixes shall be AC-30 asphalt cement. An AC-30, or AC-20P asphalt cement shall be used for open-graded mixes as specified in Subsection 403.02.02, "Composition of Mixture." The grade may be changed one step by the Engineer.

C. Unless otherwise specified in the Special Provisions, for Category II pavements the grade of bituminous material for dense-graded mixes shall be AC-20 asphalt cement. The grade may be changed one step by the Engineer.

D. Certificates of Compliance for the asphalt, showing test values necessary for specification compliance, shall be made available upon request by the Engineer.

401.02.05 FIELD COMPACTION AND MIX DESIGN CORRELATION

A. Type 2 coarse mix design annual submittals only.

B. In an effort to establish the “point of refusal,” if it has been determined that the in-place air voids are less than 6 percent or more than 8 percent, the mix design bitumen content shall be adjusted. This procedure will be required as a part of all new mix designs, and any field adjustment shall be noted.

C. The field compaction shall be as required in Section 401.03.11, "Rolling and Compaction."

1. The in-place air voids, as based on the Maximum Theoretical Specific Gravity and 10 correlated nuclear tests or 5 cores, shall then be calculated.

2. If the mean percent air voids is outside the limits noted above, the bitumen content shall be mathematically increased or reduced and noted on the mix design submittal. If adjustment is made, then a new control strip is required.

3. Once the control strip meets the above requirements, it becomes the control strip for subsequent mix placements.

D. Subsequent compaction testing lots shall be tested in accordance with Section 401.03.12, "Acceptance Sampling and Testing of Bituminous Mixture." If the compaction cannot be maintained between the above limits, a new control strip shall be implemented to re-establish the mean density for testing.

CONSTRUCTION

401.03.01 BITUMINOUS MIXING PLANT

A. 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.

B. Mixing plants shall be of sufficient capacity and coordinated to adequately handle the proposed bituminous construction.

C. **Mixing Plants.** Plants used for the preparation of bituminous mixtures shall conform to the following requirements:

1. Equipment for Preparation of Bituminous Material:

   a. Tanks for the storage of bituminous material shall be equipped to heat and hold the material at the required temperatures.

   b. The heating shall be accomplished by steam coils, electricity, or other approved means so that no flame shall be in contact with the tank or contents.

   c. The circulating system for the bituminous material shall be designed to ensure proper and continuous circulation during the operating period.

   d. Provisions 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:

   a. 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.

   b. The plant shall 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 aggregate.

   c. 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 and county regulations as set forth by the Clark County Air Pollution Control Officer, and state laws pertinent to air pollution.

5. Truck Scales:

   a. 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 no cost to the Contracting Agency.

   b. Such scales shall be platform scales and conform to the provisions of Subsection 109.01, "Measurement of Quantities."

6. Safety Requirements:

   a. 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.

   b. 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.

   c. A hoist or pulley system shall be provided to raise scale calibration equipment, sampling equipment, and other similar equipment from the ground to the mixer platform and return.

   d. All gates, pulleys, chains, sprockets, and other dangerous moving parts shall be thoroughly guarded and protected.

e. Ample and unobstructed passage shall be maintained at all times in and around the truck loading area.

f. This area shall be kept from drippings from the mixing platform.

D. **Batching Plants.** Batch mixing plants shall conform to the following requirements:

1. Plant Scales:

a. Scales shall be accurate to 0.5 percent of the minimum load that may be required. Poises shall be designed to be locked in any position to prevent unauthorized change of position.

b. Scales shall be as described in Subsection 109.01, "Measurement of Quantities." 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 control system. Such weights shall be evidenced by a weight ticket for each load.

c. 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 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 the aggregate to the specified sizes will be required.

4. Bins:

a. The plant shall include storage bins of sufficient capacity to supply the mixer when it is operating at full capacity.

b. Bins shall be arranged to ensure separate and adequate storage of appropriate fractions of the mineral aggregates.

c. Separate dry storage shall be provided for mineral filler when used and the plant shall be equipped to feed such material into the mixer.

d. 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.

1) Each compartment shall be provided with its individual outlet gate constructed so that when closed there shall be no leakage.

2) The gates shall cut off quickly and completely.

3) Bins shall be so constructed that samples representative of the entire material in the bin can be readily obtained.

5. Weigh Box or Hopper:

a. All materials shall be proportioned by weight.

b. Aggregate scales shall be one of the following:

1) Multiple beam scale.

2) Springless dial type scale.

3) Fully automatic solid-state digital strain gauge transducer measuring device.

c. Aggregate scales shall have a capacity exceeding 1-1/4 times the total amount of materials to be weighed in one operation. Each scale gradation shall be approximately 1/1000 of the total capacity of the scale.

d. All scales used for proportioning materials shall be accurate to within 1 percent.

1) The scales shall be sealed and certified by the State Sealer of Weights and Measures.

2) Certifications shall be dated within the past 12 months and shall be renewed whenever required by the Engineer.

3) If the plant is moved, a new certificate will be required.

e. All scales shall be of such size and so arranged that they may be read easily from the operator's platform.

1) The scales shall indicate the true net weight without the application of any factor.

2) The dials of scales shall not be less than 12 inches in diameter.

3) The figures on the scale dials shall be clearly legible.

f. Weighing equipment shall be so insulated against the vibration or movement of other operating equipment in the plant that the error in weighing with the entire plant running will not exceed 1-1/2 percent for any batch.

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:

a. The equipment used to measure the bituminous material shall be accurate to plus or minus 0.5 percent.

1) The bituminous material bucket shall be a non-tilting type with a loose sheet metal cover.

2) The length of the discharge opening or spray bar shall be not less than three-fourths the length of the mixer and it shall discharge directly into the mixer.

3) The bituminous material bucket, its discharge valve or valves, and spray bar shall be adequately heated.

4) 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.

5) The capacity of the bituminous material bucket shall be at least 15 percent in excess of the weight of bituminous material required in any batch.

6) The plant shall have an adequately heated quick-acting, non-drip, charging valve located directly over the bituminous material bucket.

b. 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 1,000 pounds in 2-pound gradations.

1) The indicator dial shall have a capacity of at least 15 percent in excess of the quantity of bituminous material used in a batch.

2) 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.

3) The dial shall be in full view of the mixer operator.

c. The flow of bituminous material shall be automatically controlled so that it will begin when the dry mixing period is over.

1) All of the bituminous material required for one batch shall be discharged in not more than 15 seconds after the flow has started.

2) The size and spacing of the spray bar openings shall provide a uniform application of bituminous material the full length of the mixer.

3) 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 accuracy of the meter when a metering device is substituted for a bituminous material bucket.

8. Mixer:

a. The batch mixer shall be of a twin pugmill type, steam jacketed, or heated by other approved means and capable of producing uniform mixtures within the specified tolerances.

b. 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.

c. At the beginning of the mixing operation, the clearance between paddle tips and liner shall not exceed half the maximum aggregate diameter for the specified job mix.

d. The clearance of the paddles or blades from all fixed and moving parts shall not exceed 1 inch.

e. Badly worn or defective paddles or blades shall not be used in mixing operations.

9. Control of Mixing Time:

a. The mixer shall be equipped with an accurate time lock to control the operations of a complete mixing cycle.

1) 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.

2) It shall lock the mixer gates throughout the dry and wet mixing periods.

3) 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.

4) The wet mixing period is the interval of time between the start of introduction of bituminous material and the opening of the mixer gate.

b. 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.

1) The device shall measure the time of mixing within an accuracy of 2 seconds.

2) A suitable automatic device for counting the number of completely mixed batches shall be provided and maintained in proper working condition.

c. When the aggregate and the bituminous material have been combined, the entire mass shall be mixed in a approved mixer.

1) The mixing shall continue until homogeneity and a uniform coating are achieved.

2) The output rate shall not exceed the manufacturer's capacity rating.

E. **Drier Drum Mixing Plants.** Drier drum mixing plants shall conform to the following requirements:

1. Aggregate Stockpiles: Comply with Subsection 401.03.08, paragraphs A through C.

2. Aggregate Proportioning:

a. The plant shall include a means for accurately proportioning each bin size of aggregate prior to the drying operation.

b. The plant shall have a mechanical feeder mounted under each compartment bin.

1) Each compartment bin shall have an accurately controlled individual gate for volumetrically measuring the material drawn from each compartment.

2) The feeding orifice shall be rectangular with one dimension adjustable by positive means.

3) Indicators shall be provided for each gate to show the respective gate opening in inches.

c. 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 10 percent of the required amount.

3. Weight Calibration of Aggregate: The plant shall include a means for calibration for each aggregate feeder by weighing test samples.

4. Bituminous Metering Device: The bituminous material shall be introduced into the mixer through a gallonage meter by a positive displacement metering device, equipped with a ready means of varying the bituminous material delivery rate.

5. Synchronization of Aggregate Feed and Bituminous Material Feed:

a. Satisfactory means shall be provided to afford a positive interlocking control between the flow of aggregate from each feeder and the flow of bituminous material.

b. 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:

a. The plant shall include a mixing device which will obtain homogeneity and a uniform coating.

b. The mixing output shall not exceed the manufacturer's capacity rating.

c. The moisture content of the bituminous mixture shall not exceed 3 percent at the discharge end of the dryer.

7. Surge Bins: The plant will be equipped with an approved surge bin at the discharge. This surge bin will be in excess of 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

A. Trucks used for hauling bituminous mixtures shall have tight, clean, smooth 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

A. Bituminous pavers shall be self-contained, self-propelled units provided with an activated screed or strike-off assembly, heated if necessary, and capable of spreading the finishing courses of bituminous plantmix material in lane widths applicable to the specified typical section and thicknesses shown on the plans.

B. 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.

C. The asphalt paver shall operate independently of the vehicle being unloaded and shall be capable of propelling the vehicle being unloaded in a satisfactory manner.

1. If necessary, the load of the haul vehicle shall be limited to that which will ensure satisfactory spreading.

2. While being unloaded, the haul vehicle shall be in contact with the machine at all times, and the brakes on the haul vehicle shall not be depended upon to maintain contact between the vehicle and the machine.

D. 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.

E. 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.

F. Pavers shall be capable of placing the bituminous mixture to meet the surface tolerances specified under the respective sections of bituminous pavement.

401.03.04 ROLLERS

A. Rollers shall be vibratory, steel-wheeled or pneumatic-tired type, in good condition.

1. Rollers shall be capable of reversing without backlash and operating at slow speeds to avoid displacement of the bituminous mixture.

2. The number, type, and weight of rollers shall be sufficient to compact the mixture to the required density without detrimentally affecting the completed material as determined by the Engineer.

3. Comply with Subsection 401.03.11, "Rolling and Compaction."

B. Rollers for the test strip shall meet the following requirements:

1. Breakdown rollers shall be either a 3-wheeled steel roller or a 2-axle tandem or a 3-axle tandem weighing not less than 10 tons.

2. Except as hereinafter permitted, pneumatic-tired rollers shall comply with the following:

a. Rollers shall consist of not less than 9 wheels equipped with pneumatic tires of equal size and diameter.

b. Tires shall be mounted on 2 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 1,000 and 2,000 pounds.

c. The tires shall have treads satisfactory to the Engineer.

d. 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 1 tread of the following tires.

e. The tires shall be uniformly inflated so that the air pressure in the several tires will not vary more than 5 pounds per square inch. Inflation pressure in pounds per square inch shall be the tire manufacturer's recommendation.

f. Minimum tire size shall be 7.50 x 15 inches, 4 ply.

3. The use of pneumatic-tired rollers with fewer wheels and a greater maximum operating weight per tire than that specified herein will be permitted subject to the following requirements:

a. The minimum width between the outer edge of the outside tires on a given axle shall be 60 inches.

b. The weight of the roller and the tire pressure can be varied to produce a ground contact pressure between 50 and 70 psi.

4. The finish roller shall be a 2-axle tandem weighing not less than 8 tons.

401.03.05 WEATHER LIMITATIONS

A. The bituminous mixture shall not be placed upon any wet surface or when the surface temperatures of the underlying course is less than specified in Table 1. The temperature requirements may be modified, but only when so directed by the Engineer.

TABLE 1 - BASE TEMPERATURE LIMITATIONS

Mat Thickness	Base Temperature (Minimum ºF)
3 Inches or Greater	40
Greater than 1 Inch but Less than 3 Inches	45
1 Inch or Less	50

B. The open-graded plantmix surface shall be placed only when the pavement surface temperature is above 60 degrees F.

401.03.06 PREPARATION OF EXISTING SURFACE

A. When the surface of the existing pavement or old base is irregular, it shall be brought to a uniform grade and cross section as shown on the plans.

B. The subgrade to receive asphalt concrete, or asphalt concrete base immediately prior to applying prime coat, shall conform to the compaction and elevation tolerance specified for the material involved and shall be free of loose or extraneous material.

C. If the plantmix bituminous surface is being constructed directly upon an existing hard-surfaced pavement, a tack coat of grade CSS-1h or SS-1h emulsified asphalt, diluted 50/50 at an approximate rate of 0.05 to 0.10 gallons per square yard, shall be uniformly applied upon the existing pavement preceding the placement of the asphalt concrete.

1. The surface shall be free of water, foreign material, or dust when the tack coat is applied.

2. To minimize public inconvenience, no greater area shall be treated in any one day than is planned to be covered by plantmix during the same day, unless otherwise authorized by the Engineer.

D. A similar tack coat shall be applied to the surface of any previous course placed longer than 24 hours, or if a satisfactory bond cannot be obtained between the surface and a succeeding course, as determined by the Engineer.

E. The contact surfaces of all cold pavement joints, curbs, gutters, manholes, and similar structures shall be painted with grade CSS-1h or SS-1h emulsified asphalt immediately before the new asphalt concrete is placed. Comply with Section 405, "Tack Coat."

F. When specified in the contract, longitudinal and transverse joints and cracks shall be sealed by the application of an approved joint sealing compound before spreading the mixture upon a Portland cement concrete surface. Excess bituminous material shall be removed from joints and cracks prior to spreading the mixture.

401.03.07 PREPARATION OF BITUMINOUS MATERIALS

A. 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

A. Aggregates proportioned prior to the heating and drying process shall be separated into at least two general sizes:

1. That portion of the material having a minimum of 80 percent passing No. 4 sieve.
2. That portion of the material having a minimum of 80 percent retained on a No. 4 sieve.

B. The material shall be maintained within the limits above with a uniformity of plus or minus 5 percent. Each portion of the material shall be stored separately.

C. 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 requirement. Plantmix operations shall not commence until sufficient aggregate material is stockpiled to ensure one day's run.

D. Aggregate proportioned immediately after the heating and drying process shall be screened into a minimum of 2 fractions when minus 1/2-inch aggregate is used, and into a minimum of 3 fractions when larger sized aggregate is used. The screened material shall be conveyed to separate compartments ready for proportioning and mixing with bituminous material.

E. If the Contractor elects to introduce baghouse fines into the mix, the material shall be drawn from a storage facility in which the material is kept in a uniform free flowing condition.

1. The baghouse fines for delivery to the plant shall be from a vane type metering device which is interlocked (electrical driven feeders shall be activated from the same circuit) to the flow of each aggregate feeder.
2. The drive shaft on the baghouse fines vane feeder shall be equipped with a revolution counter accurate to 1/10 of a revolution, and a means for varying the rate.
3. In a continuous mix and/or dryer drum plant, the baghouse fines shall be added at the asphalt feed line to ensure a uniform mix.
4. In batch plants, the baghouse fines shall be added by the use of a separate bin.
5. The baghouse fines shall be introduced at a point as approved by the Engineer at a percentage determined by the Engineer, not to exceed 2 percent by dry weight of the aggregate.
6. Baghouse fines shall be considered as part of the aggregate, and not as a mineral filler.

F. If mineral filler is required to meet the tensile strength requirements of the job-mix formula, it shall be added by one of the following methods:

1. Cold Feed Method:

a. Hydrated lime (hereinafter referred to as mineral filler) shall be added to all plantmix bituminous aggregates at the rate of not less than 1 percent nor more than 2-1/2 percent of the weight of the dry aggregate. The exact rate of application shall be as determined by the job mix formula.

b. Mineral filler shall be drawn from a storage facility in which the mineral filler is agitated by air or other means to keep it in a uniform free flowing condition.

1) The mineral filler for delivery to the mixer shall be from a vane type metering device which is interlocked, (electrical driven feeders shall be actuated from the same circuit) to the flow of each aggregate feeder.

2) The drive shaft on the mineral filler vane feeder shall be equipped with a revolution counter reading to 1/10 of a revolution, and a means for varying the rate.

c. In continuous mix and/or drum dryer plants, the mineral filler shall be added to the aggregate after the aggregate is proportioned.

d. In batch plants, the mineral filler shall be added to the aggregate prior to drying.

e. Regardless of which type of plant is used, the following methods shall be utilized:

1) Prior to the introduction of the mineral filler, sufficient moisture shall be added using spray bars at the aggregate bins to bring the aggregate to a moisture content where enough free surface moisture is available to thoroughly wet the aggregate and wet the lime.

a) This content shall be a minimum of 4 percent.

b) The actual amount of moisture required will be determined by the Engineer.

c) After the addition of water and mineral filler, the aggregate shall be mixed using a horizontal twin-shaft pugmill.

d) The mixing paddles shall be adjustable for angular position on the shaft to permit altering of the mixing pattern or retarding the flow to ensure that the aggregate is thoroughly coated with mineral filler.

e) The volume of material in the pugmill shall not extend above the vertical position of the blade tips.

f) The completed mixture shall be directly introduced into the hot plant.

g) Stockpiling of the completed mixture is strictly prohibited.

2) The moisture control valve shall be interlocked with the hot plant control room so the moisture control valve is automatically turned off when the cold feed belts are shut off. The control valve shall also turn on automatically when the cold feed belts are activated.

2. Marination Method:

a. Hydrated lime (hereinafter referred to as mineral filler) shall be added to all fractions of the plantmix bituminous aggregates.

1) The coarse aggregates shall be wet cured with mineral filler at a rate of 1 percent of the weight of dry aggregate.

2) The fine aggregates shall be wet cured with mineral filler at a minimum rate of 2 percent of the weight of the dry aggregate.

b. The aggregates shall be marinated (wet cured) in the stockpiles for a minimum of 48 hours.

c. The wet cured aggregate in the stockpile shall be used within 45 calendar days. Material marinated in stockpile in excess of 45 calendar days shall not be used for the production of plantmix bituminous aggregates unless otherwise approved by the Engineer.

d. Prior to the introduction of the mineral filler, sufficient moisture shall be added using spray bars at the aggregate bins to bring the aggregates to a moisture

content where enough free surface moisture is available to thoroughly wet the aggregate and activate the lime.

1) This content is recommended to be a minimum of 3 percent for coarse aggregates and 6 percent for the fine aggregates.

2) The actual amount of moisture required will be determined by the Engineer.

3) After the addition of water and mineral filler, the aggregate shall be mixed using a horizontal twin-shaft pugmill.

4) The mixing paddles shall be adjustable for angular position on the shaft to permit altering of the mixing pattern or retarding the flow to ensure that the aggregate is thoroughly coated with mineral filler.

5) The volume of material in the pugmill shall not extend above the vertical position of the blade tips.

e. Mineral filler shall be drawn from a storage facility in which the mineral filler is agitated by air or other means to keep it in a uniform free flowing condition.

1) The mineral filler for delivery to the mixer shall be from a vane type metering device which is interlocked (electrical driven feeders shall be actuated from the same circuit) to the flow of each aggregate feeder.

2) The drive shaft on the mineral filler vane feeder shall be equipped with a revolution counter reading to 1/10 of a revolution, and a means for varying the rate.

3. Slurry Method:

a. Hydrated lime or slaked quicklime (hereinafter referred to as mineral filler) shall be added to all plantmix bituminous aggregates in slurry form.

1) Add at a rate of not less than 1 percent nor more than 2-1/2 percent of dry mineral filler based on the weight of the dry aggregate.

2) The exact rate of application shall be as determined by the job-mix formula.

b. A slurry containing 1 part mineral filler and 2 parts water by weight is recommended.

1) The actual amount of water required in the production of the slurry will be determined by the Engineer after a visual inspection to ensure that the aggregate is thoroughly and uniformly coated with the mineral filler.

2) The addition of moisture to the aggregate prior to mixing of the mineral filler and aggregate will not normally be required.

c. The slurry shall be prepared in a central mixing tank provided with agitation for keeping the mineral filler in suspension until applied to the aggregate.

1) The slurry mixing tanks shall be capable of producing sufficient slurry for the hot mix asphalt manufacturing facility production rate, and shall produce a uniform slurry consistency.

2) The plant shall be equipped with suitable pumps and meters for introducing the required amount of slurry to the aggregate. A suitable

device shall be provided to the Engineer for determining the weight of mineral filler per gallon of slurry.

d. If quicklime is used as the mineral filler, it shall be converted to hydrated lime by using one or more slaking tanks. The slaking unit shall be capable of:

1) Complete slaking or hydration of the quicklime.

2) Providing agitation for mixing and keeping the mineral filler in suspension until use.

e. After the addition of the mineral filler slurry, the aggregate shall be mixed using a horizontal twin-shaft pugmill.

1) The mixing paddles shall be adjustable for angular position of the shaft to permit altering of the mixing pattern or retarding the flow to ensure that the aggregate is thoroughly coated with mineral filler.

2) The volume of material in the pugmill shall not extend above the vertical position of the blade tips.

3) The completed mixture shall be directly introduced into the hot plant.

4) Stockpiling of the completed mixture is strictly prohibited.

401.03.09 MIXING

A. The permissible moisture content of the bituminous mixture just behind the paver shall not exceed 1-1/2 percent as determined by test method ASTM D1461 or equivalent.

1. 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.

2. When an approved dryer drum mixing process is used, the moisture content of the bituminous mixture at discharge from the mixer shall not exceed 3 percent, and the resulting product at the discharge end of the drier shall be a homogenous mixture of uniformly distributed and properly coated aggregates of unchanging appearance.

B. The drier aggregate shall be combined in the mixer in the amount of each fraction of aggregates required to meet the job-mix formula. The bituminous material shall be measured or gauged and introduced into the mixer in the amount specified by the job-mix formula.

C. 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.

D. The time of mixing a batch shall begin on the charging stroke of the weight hopper dumping mechanism and shall end when discharge is started.

1. Mixing shall continue until a homogenous mixture of uniformly distributed and properly coated aggregates of unchanging appearance is produced.

2. In general, the time of mixing shall not be less than 30 seconds, except that the time may be reduced when, in the opinion of the Engineer, the sizes of aggregates are uniformly distributed and all particles are thoroughly and uniformly coated with asphalt binder.

3. The output rate shall not exceed the manufacturer's capacity rating.

E. Should the mixture, at the plant or in place, show an excess or deficiency of bitumen, show injury or damage due to burning or overheating, or show an improper combination of aggregates, due to the Contractor's failure to conform to the specified requirements, it shall be rejected and if still in the truck shall be disposed of as required. 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

A. The mixture shall be laid upon an approved surface, and shall be spread and struck off to the grade and elevation established. Bituminous pavers shall be used to distribute the mixture either over the entire width or over such partial width as may be practicable.

B. 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 and the rate at which the rollers can obtain the required compaction. The machine shall be operated so that material does not accumulate and remain along the sides of the receiving hopper.

C. On areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impracticable, the mixture shall be spread, raked, and compacted by hand tools. For such areas, the mixture shall be dumped, spread, and screeded to give the required compacted thickness, correct grade, and cross section.

D. 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:

1. The windrow is properly sized, thereby ensuring the delivery of the correct amount of material to the spreading and finishing machine at all times.

2. 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 paving material remaining on this base between the pickup device and the spreading and finishing machine.

3. The temperature requirements for the material in the hopper of the spreading and finishing machine are complied with. Plantmix bituminous mixture that does not meet the minimum temperatures specified shall not be incorporated in the work, but shall be wasted in a manner satisfactory to the Engineer.

E. 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.

F. The bituminous mixture spread through the paving machine during one day's operation shall come from a single plant manufacturer. Intermixing from more than one source shall not be allowed.

401.03.11 ROLLING AND COMPACTION

A. The initial or breakdown rolling shall consist of one complete coverage of the bituminous mixture with a steel-wheeled roller.

1. Initial rolling shall commence at the lower edge and shall progress toward the highest portion of the roadbed.

2. Under no circumstances shall the center be rolled first.

B. The initial or breakdown rolling shall be followed by rolling such that uniform density is obtained throughout the depth of the layer of the material being compacted.

1. At least two rollers, one steel-wheeled, the other pneumatic-tired, shall be used.

2. The total number of rollers used shall be sufficient to obtain the required compaction while the mixture is in a workable condition.

C. The final rolling of the bituminous mixture shall be performed with the same type of roller used for breakdown rolling.

D. Rolling shall be performed in such a manner that cracking, shoving, or displacement will be avoided.

1. All rollers shall be in good condition and the reversing mechanism maintained so that the roller is capable of changing directions smoothly.

2. The roller shall be kept in continuous motion while rolling so that all parts of the pavement receive equal compression.

3. The motion of the roller shall be slow enough at all times to avoid displacement of the pavement.

4. 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.

E. To prevent adhesion of the mixture to the roller, the wheels shall be kept properly maintained.

1. The use of diesel oil on pneumatic-tired rollers shall be kept to a minimum as determined by the Engineer.

2. Preferably, a water soluble oil or an asphalt release agent shall be used.

401.03.12 ACCEPTANCE SAMPLING AND TESTING OF BITUMINOUS MIXTURE

A. At no cost to the Contracting Agency, field thickness and density determinations of the bituminous mixture shall be made in lots, each lot representing one day's placement.

1. A lot shall be divided into 5 equal sublots, and 1 test shall be made for each sublot.

2. The location of the field tests may be chosen on a random basis using ASTM D3665, Section 4.3, except that any random location given shall be set back 2 feet from a curb or 3 feet from an edge, joint, or seam.

3. A summary of the random number chart used and the lot description shall be completed and approved by the Engineer prior to sampling and shall be included in the finished test results.

B. Determination of the field thickness of the compacted bituminous mixture, as required by the Engineer, shall be accomplished by ASTM D3549, "Standard Test Method for Thickness or Height of Compacted Bituminous Paving Mixture Specimens."

C. Determination of the field density of the compacted bituminous mixture shall be accomplished by either of the methods listed below. In case of dispute, ASTM D1188 as modified shall govern.

1. ASTM D2950, "Density of Bituminous Concrete in Place by Nuclear Method." When this method is used, the nuclear device shall first be correlated with the density of core samples.

2. ASTM D1188, "Bulk Specific Gravity of Compacted Bituminous Mixtures Using Paraffin-Coated Specimens." When this method is used, the procedure shall be modified to require the use of “Coated Specimens” (Parafilm or Paraffin) only. The use of Bulk Specific Gravity determinations by SSD (surface saturated dry) method are prohibited.

D. The use of ASTM D2950 shall include correlation of test results to drilled cores.

1. A minimum of 1 lot (one full day’s production), and not less than 5 sublots, shall be used for this correlation.

2. Should any nuclear test density in the first lot differ from its corresponding drilled core density by more than 3.00 percent relative compaction, a second lot shall be correlated and the average of all sublots in the first and second lots, but not less than 10 sublots, shall be used for the correlation. The 4-inch cores shall be transferred to the Engineer along with the random number generator listing station/offset locations.

E. The theoretical maximum density of the bituminous mixture shall be determined by taking random samples of the mixture delivered to the job site and testing in accordance with ASTM D2041, "Theoretical Maximum Specific Gravity of Bituminous Paving Mixtures."

1. At least 2 theoretical maximum density determinations shall be made for each day's production of bituminous mixture used in the work.

2. If the day's production is less than 500 tons, then only 1 theoretical maximum density determination is required.

F. As a quality control measure, the Contractor shall, at no cost to the Contracting Agency, make periodic checks of the field density of the compacted bituminous mixture at any time during paving operations. The testing performed by the Contractor may be used by the Engineer in part or in whole as the basis of acceptance in addition to the Quality Assurance testing to be done by the Engineer.

G. The pavement thickness acceptance criteria are as listed below:

1. If the average of all measurements meets or exceeds the design thickness, with no core more than 10 percent less than the design thickness, the placement is acceptable.

2. If there is only an isolated thin area, the limits of the area should be identified to determine if a construction resolution is necessary.

3. If the core results indicate a consistently thin section, with no core more than 15 percent less than the design thickness and with the approval of the Engineer, the Contractor has the option of proposing a construction resolution or contributing an amount equivalent to the reduction in the asset value. Calculation of the lost asset value is accomplished with the following steps:

a. Determine the annual numbers of 18-kip equivalent single axle loads (ESAL), based upon the design traffic index (TI), a 20-year design life and an assumed traffic growth rate.

b. Calculate the composite structural number of the designed road section (i.e., the AC and aggregate base sections).

c. Using the average AC thickness, calculate the structural number of the constructed road section.

d. Determine the ESAL value that correlates with the reduced structural number.

e. Based upon the annual ESAL counts, determine the corresponding design life of the reduced section.

f. Using a 3 percent inflation factor and the unit cost of the AC (on a $/square yard basis) determine the equivalent uniform annual cost (EUAC) of each section.

g. Multiply the reduction in design life by the EUAC to determine the reduced value of the pavement, on a unit cost basis.

h. Multiply the unit cost by the pavement area.

i. As an alternative, use the following unit cost values for the 4 road classifications (dollars per square yard per inch deviation from design thickness): Residential = $6.97, Minor Collector = $7.10, Major Collector = $6.14, and Arterial = $7.20.

4. If the core results yield an average thickness greater than the design thickness, but are alternately very high and very low (more than 10 percent out), the Engineer may reject the placement.

H. The pavement density acceptance criteria for production placements shall be as listed below, otherwise specified in the project plans or contract documents:

1. The average density for Residential roadway pavement shall be 92 percent ± 2.0 percent (90.0 percent - 94.0 percent), with no single density deviating more than 4 percentage points (all measurements between 88 percent - 96 percent). If the average is between 2.0 percent - 4.0 percent out (88 percent - 90.0 percent or 94.0 percent - 96 percent), with no density more than 5.0 percent out (all measurements between 87 percent - 97 percent), the Contractor has the option of contributing the lost asset value of $1.22 per square yard per percentage point deviation from the acceptance range.

2. The average density for Minor Collector roadway pavement shall be 93.0 percent ± 2.0 percent (91.0 percent - 95.0 percent), with no single density deviating more than 4 percentage points (all measurements between 89 percent - 97 percent). If the average is between 2.0 percent - 4.0 percent out (89 percent - 91.0 percent or 95 percent - 97 percent), with no density more than 5.0 percent out (all measurements between 88 percent - 98 percent), the Contractor has the option of contributing the lost asset value of $1.22 per square yard per percentage point deviation from the acceptance range.

3. The average density for Major Collector roadway pavement shall be 93.0 percent ± 1.5 percent (91.5 percent - 94.5 percent), with no single density deviating more than 4 percentage points (all measurements between 89 percent - 97 percent). If the average is between 1.5 percent - 4.0 percent out (89 percent - 91.5 percent or 94.5 percent - 97 percent), with no density more than 5.0 percent out (all measurements between 88 percent - 98 percent), the Contractor has the option of contributing the lost asset value of $0.81 per square yard per percentage point deviation from the acceptance range.

4. The average density for Arterial roadway pavement shall be 93.0 percent ± 1.5 percent (91.5 percent - 94.5 percent), with no single density deviating more than 4 percentage points (all measurements between 89 percent - 97 percent). If the average is between 1.5 percent - 4.0 percent out (89 percent - 91.5 percent or 94.5 percent - 97 percent), with no density more than 5.0 percent out (all measurements between 88 percent - 98 percent), the Contractor has the option of contributing the lost asset value of $0.81 per square yard per percentage point deviation from the acceptance range.

401.03.13 MAINTAINING TRAFFIC

A. Traffic shall not be allowed on newly placed pavement for at least 24 hours or until the bituminous paving mix in-place temperature has dropped below 104 degrees F.

B. Exceptions shall be made at the discretion of the Engineer. Artificial means to reduce the pavement temperature may be used as approved by the Engineer.

401.03.14 JOINTS

A. Placing of the bituminous paving shall be as continuous as possible.

1. Rollers shall not pass over the unprotected end of the freshly laid mixture unless authorized by the Engineer.

2. Transverse joints shall be conformed by cutting back on the previous run to expose the full depth of the course.

3. A brush coat of asphalt emulsion shall be used on contact surface of transverse joints just before additional mixture is placed against the previously rolled material.

B. Longitudinal joints shall be spaced so that joints in succeeding courses will be at least 6 inches horizontally from joints in any preceding course. Lanes will be evened up each day to eliminate cold longitudinal joints insofar as practicable.

C. Transverse joints shall be spaced so that joints in succeeding courses will be a minimum of 5 feet horizontally from joints in any adjacent course. Lanes shall be evened up each day to eliminate cold transverse joints insofar as practicable.

D. Comply with Subsection 401.03.10, "Spreading and Finishing."

401.03.15 SURFACE TOLERANCES

A. Surface tolerances will be specified under the respective sections of bituminous pavement.

401.03.16 SURFACING MISCELLANEOUS AREAS

A. Surfacing of road approaches and connections, street intersection areas, frontage roads, island areas, sidewalks, dikes, curbs, gutters, gutter flares, ditches, downdrains, spillways, aprons at the ends of drainage structures, and other designated areas outside the travelled way shall conform to the provisions specified in these specifications.

B. The combined aggregate grading for bituminous mixtures placed on miscellaneous areas shall conform to that specified for the bituminous mixture placed on the travelled way, except the aggregates used in the construction of island areas and dikes shall be constructed of aggregate conforming to the requirements of Plantmix Surface Aggregate, Type 3.

1. 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 travelled ways shall be increased not less than 1 percent by weight of the aggregate over the amount of bituminous material used in the bituminous mixture placed on the travelled way.

2. Submittal of a revised job-mix formula will not be necessary.

C. The bituminous mixture placed in island areas, sidewalks, dikes, gutters, gutter flares, ditches, downdrains, spillways, aprons at the end of drainage structures, and other designated areas outside the travelled way may be spread in 1 layer. The material shall be compacted to the required lines, grades, cross section, and density requirements for Category II pavements in accordance with Subsection 401.03.12, “Acceptance Sampling and Testing of Bituminous Material.”

D. Dikes shall be shaped and compacted with an extrusion machine or other equipment capable of shaping and compacting the material to the required correct grade and cross section.

METHOD OF MEASUREMENT

401.04.01 MEASUREMENT

A. The quantity of bituminous plantmix to be measured for payment shall be the number of tons used in the accepted work, and will be determined by weighing the completed mixture of aggregate, mineral filler if required, and bituminous material.

B. The quantity of shoulder dikes constructed of bituminous plantmix to be measured for payment shall be the number of linear feet and will be determined from measurement taken along the top of the completed dikes to the nearest 1-foot length.

C. 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.D.1, "Plant Scales," are met, in which case the cumulative weight of all the acceptable batches will be used for payment.

D. Due to possible variations in the specific gravity and voids of the payment, 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

A. All accepted work and materials measured as prescribed above will be paid for as provided in the representative sections for each type specified.

B. Full compensation for furnishing and applying bituminous material or asphaltic emulsion as provided for in Subsection 401.03.06, "Preparation of Existing Surface," including tack coat, and Subsection 401.03.14, "Joints," shall be considered as included in the contract price paid for the principal items involved and no further compensation will be allowed.

C. When bituminous plantmix, Type III, is used in the construction of island areas or dikes, and there is no separate payment for said mixture, this bituminous plantmix shall be included in the payment for plantmix bituminous surface of the major type shown in the list of bid items and the proposal.

SECTION 402

PLANTMIX BITUMINOUS SURFACE

DESCRIPTION

402.01.01 GENERAL

A. This work shall consist of constructing 1 or more courses of bituminous pavement on a prepared base in accordance with these specifications, and in conformity with the lines, grades, thickness, and typical cross sections shown on the plans or established by the Engineer.

1. The prepared base shall be prime coated or tack coated as specified in Section 405, "Tack Coat," and Section 406, "Prime Coat," prior to the placement of any plantmix bituminous surface.

2. The cured prime coat shall have no raw asphalt exposed and shall be cleaned of all loose material.

B. The requirements of Section 401, "Plantmix Bituminous Pavements – General" shall be applicable to this work, except as hereinafter specified.

MATERIAL

402.02.01 GENERAL

A. The material shall conform to Subsection 401.02.01, "Composition of Mixtures," through Subsection 401.02.04, "Bituminous Materials."

CONSTRUCTION

402.03.01 GENERAL

A. Construction shall conform to Subsection 401.03.01, "Bituminous Mixing Plant," through Subsection 401.03.16, "Surfacing Miscellaneous Areas," with the exceptions below.

402.03.02 SPREADING AND FINISHING

A. Unless otherwise specified, bituminous plantmix surface shall be placed in courses not exceeding 4 inches in compacted thickness. When more than 1 course is placed, the courses shall be of approximately equal thickness.

B. Bituminous plantmix surface to be placed on shoulders and other areas of the travelled way having a width of 8 feet or more shall be spread as specified in Subsection 401.03.10, "Spreading and Finishing."

1. When the areas are less than 8 feet in width, the material may be deposited and spread in 1 or more layers by other mechanical means that will provide a uniform smoothness and texture.

2. Stockpiling bituminous mixture on contiguous pavement that might be stained thereby will not be permitted.

402.03.03 SURFACE TOLERANCES

A. The completed surfacing shall be smooth and free from ruts, humps, depressions, or irregularities.

1. Any ridges, indentations, or other objectionable marks left in the surface by rolling or other means shall be eliminated.

2. The use of any equipment that leaves ridges, indentations, or other objectionable marks in the bituminous surface, or does not consistently produce a surface meeting the profile index requirements, shall be discontinued.

B. After final rolling, the smoothness of the final dense-graded surface course shall be measured by the following methods:

C. **Straightedge Measurement:**

1. The completed surfacing shall be thoroughly compacted, smooth, and free from ruts, humps, depressions, or irregularities. When a straightedge 10 feet long is laid on the finished surface and parallel with the centerline of the highway, the surface shall not vary more than 1/4 inch from the lower edge of the straightedge.

2. The transverse slope of the finished surface shall be uniform to a degree such that no depressions greater than 1/4 inch are present when tested with a straightedge 12 feet long laid in a direction transverse to the centerline and extending from edge to edge of a 12-foot traffic lane.

D. **Profilograph Measurement (When specified in the Contract Special Provisions):**

1. The Contractor shall provide the profilograph and measurements under the direction of the Engineer.

   a. The profiles shall be measured 3 feet from and parallel to either traffic lane line.

   b. The profiles shall be measured for the entire length of each traffic lane within 48 hours after each day's placement of plantmix bituminous mixture.

   c. Profile measurements will not be required on roadway segments less than 0.1 mile in length, single lane utility construction less than 0.25 mile in length, or in multiple lane utility construction 0.125 mile in length.

2. Profile measurements on pavement along horizontal curves having a centerline radius less than 1,000 feet will not be required.

   a. Pavement within 30 feet of a concrete bridge deck (including approach slabs) shall not be measured unless the bridge deck also is to be overlaid with plantmix bituminous surface.

   b. At locations that tie into existing pavements, the profile shall begin 50 feet before the starting joint and end 50 feet after the ending joint.

   c. Intersections where there is a grade break, valley gutters, and 50 feet before and after swales will not be included in the measurements.

3. Initial runs of the profilograph shall be completed before opening the new pavement to public traffic whenever practical.

   a. The profilographs shall be submitted immediately thereafter for evaluation.

   b. A profile index will be calculated for each 0.1 mile of traffic lane measured according to Nev. Test Method No. T446.

   c. All costs for traffic control required for running of the profilograph shall be included in the cost of traffic control.

4. The pavement smoothness type (Type A, B, or C) and the maximum allowable profile index for each mile section and 0.1 mile section for the specified pavement type shall be in accordance with the following table:

Profile Index

Pavement Smoothness Type		Max. per lane mile	Max. per 0.1 lane mile
Type A	New Arterial and Major Collector	5 inches	0.5 inches
Type B	Removal and Replacement in 80-foot and greater (arterial and collector) with new curb construction	7 inches	0.7 inches
Type C	Right-of-way less than 80-foot (collector) or on arterial and collector asphalt removal and replacement projects that contain existing curb	10 inches	1.0 inches

5. Pavement on horizontal curves having a centerline radius of 1,000 feet or more, but less than 2,000 feet, and within the superelevation transition of such curves will be evaluated as pavement smoothness Type C.

6. Areas that exceed the profile index requirements and areas representing high points on the profiles having deviations in excess of 0.3 inches as measured according to Test Method No. Nev. T446 shall be ground to conform to requirements. Ground areas shall be remeasured for conformance with the profile index to confirm no high points in excess of 0.3 inches exist.

7. Additional grinding shall be performed as necessary to extend the ground area laterally to the nearest lane line or edge of pavement and longitudinally to lines normal to the pavement centerline.

8. Deviations in excess of 0.3 inches that cannot be brought into specified surface tolerances shall be corrected by abrasive grinding, by either removal or replacement, or by placing an overlay of hot mix asphalt. The Contractor shall obtain approval for the exact method of correction from the Engineer.

9. Seal coat shall be applied to the ground areas after the surface tolerance specifications have been met. The seal coat shall be Emulsified Asphalt, Type SS-1h (Diluted), applied as directed.

10. The grinding machine for correcting pavement exceeding the profile requirements shall meet the following criteria:

    a. Power driven, self-propelled, and specifically designed to remove, profile, smooth, and texture hot mix asphalt.

    b. Wheel base of not less than 12 feet.

    c. Equipped with a rotating powered mandrel drum studded with diamond blades with a cutting head not less than 3 feet wide.

    d. Equipped with an effective means for controlling dust and other particulate matter.

    e. The grinding machine shall not cause strain or damage to the underlying surface of the pavement.

    f. Grinding and texturing equipment that causes ravels, aggregate fractures, spalls, or disturbance of joints shall not be used.

11. Grinding shall be performed in a longitudinal direction.
    a. Grinding shall result in a uniform textured surface over the designated surface areas.
    b. The surface of the ground pavement shall have parallel corduroy-type texture consisting of grooves between 0.1 inch and 0.13 inch wide.
    c. The peaks of the ridges shall be approximately 0.06 inch higher than the bottom of the grooves with approximately 52 to 57 evenly-spaced grooves per foot.
12. The ground material, including water used for the grinding operation, shall be picked up and disposed of outside the right-of-way according to Subsection 107.14, "Disposal of Material Outside Project Right-of-Way."

402.03.04 PROFILOGRAPH EQUIPMENT

A. The Contractor shall furnish and operate a California-type profilograph for checking riding tolerances at the time and date ordered.

B. The profilograph shall be equipped with a 25-foot wheel base and the following features:
    1. 3-Unit Frame Assembly:
        a. All welded construction of lightweight aluminum square tubing.
        b. Index frame connections by 4 steel locating pins and secured by 4 quick-acting clamps.
    2. Multiple Wheel Assemblies:
        a. Wheel supports of square steel tubing and all-welded construction.
        b. Secure connections by quick-acting clamps.
        c. Wheels with cast aluminum hubs, ball bearings, and cushion rubber tires.
        d. Bearing support caster wheel assemblies.
        e. Steerable front wheels from the center of the machine.
        f. Rear wheels with a quick-setting manual adjustment for turning in a short radius, moving sideways, and to prevent rear-end crabbing on superelevations.
    3. Recording Wheel Assembly:
        a. Frame of all-welded construction of lightweight rectangular aluminum tubing.
        b. Lightweight 24-inch minimum diameter recording wheel with heavy duty spokes for maximum rigidity, with a pneumatic tire maintained at 25 psi air pressure unless otherwise specified by the manufacturer.
    4. Recorders (if computerized):
        a. A high-resolution printer capable of printing the profile trace to the specified scale and automatic positioning and marking of the specified "blanking band" and "must grind" bumps. It shall also be capable of printing station numbers, distances, and comments entered by the operator via keypad while measuring the profiles.
        b. Calculate the profile index in inches per mile per each 0.1 mile section without hand calculations or data reduction.

c. A display screen for instant visual observation of the road profile and “must grind” areas while measurements are being taken.

d. The horizontal chart scale shall be 1 inch equals 25 feet and the vertical scale shall be 1 inch equals 1 inch.

1) The recorder shall have an adjustment feature to calibrate the scales to these parameters.

2) Calibrate the profilograph before usage to be accurate within 0.1 foot in 100 feet longitudinally.

e. Battery backed-up memory shall retain control parameters when the system is powered down.

f. Capable of accurate operation in ambient temperatures from 45 degrees F to 120 degrees F.

5. Recorders (if not computerized):

a. Use sealed ball bearings throughout.

b. A low inertia recording pen assembly shall run on hardened and ground guide rods for both sensitive and smooth trace response.

c. The recording pen travel shall be 7 inches in 1 setting.

d. The recorder reversing mechanism shall be fully automatic and the paper shall reverse direction without manual adjustment of drag clutches.

e. The drag clutches shall be preset, sealed from dust, and self-compensating for wear.

f. Integral aluminum case with formed plexiglas viewing windows.

g. The horizontal chart scale shall be 1 inch equals 25 feet and the vertical scale shall be 1 inch equals 1 inch.

h. A variable roller disc integrator shall be incorporated into the drive system to permit accurate calibration of horizontal chart speed.

i. The profilograph shall be calibrated before usage to be accurate within 0.1 feet in 100 feet horizontally.

METHOD OF MEASUREMENT

402.04.01 MEASUREMENT

A. Plantmix bituminous surface will be measured as specified in Subsection 401.04.01, "Measurement."

BASIS OF PAYMENT

402.05.01 PAYMENT

A. The accepted quantity of plantmix bituminous surface will be paid for at the contract unit price bid per ton of plantmix bituminous surface, which price 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.

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

C. Partial payments for plantmix bituminous surface may be made as set forth under Subsection 109.06, "Partial Payments."

D. Payment will be made under:

PAY ITEM	PAY UNIT
Plantmix Bituminous Surface	Ton
Plantmix Bituminous Shoulder Dikes	Linear Foot

SECTION 403

PLANTMIX BITUMINOUS OPEN-GRADED SURFACE

DESCRIPTION

403.01.01 GENERAL

A. This work shall consist of placing plantmix bituminous open-graded surface in one course in accordance with these specifications and in conformity with the lines, grades, thickness, and the typical cross sections shown on the plans or established by the Engineer.

B. Work shall not be started until the Contractor has completed all motor patrol and power loader equipment work or any other work that could scar or mar the finished open-graded surface.

C. The requirements of Section 401, "Plantmix Bituminous Pavements – General," shall be applicable to this work, except as hereinafter specified.

MATERIALS

403.02.01 GENERAL

A. Materials shall conform to Subsection 401.02.02, "Aggregates," and Subsection 401.02.04, "Bituminous Materials."

403.02.02 COMPOSITION OF MIXTURE

A. The plantmix open-graded mixture shall be composed of aggregates and bituminous material as described in these specifications.

B. Before starting work, the Contractor shall submit a proposed job-mix formula in writing for use by the Engineer in setting the job-mix formula to be used.

1. The proposed job-mix formula shall be determined by a testing laboratory, under the direction and control of a registered professional engineer, based on tests required to determine the gradation and surface capacity for coarse aggregate.

2. The initial design asphalt content for open-graded mixes shall be determined in accordance with the following:

a. Applicable sections of California Testing Method 303, latest edition (State of California, Department of Transportation, Manual of Test Volume 2).

b. However, the formula shall be: Asphalt content, percent by weight of total mix = 2.0(Kc)+4.

C. Modifications in the asphalt content will be made by the Engineer as necessary based on field observations made during construction.

D. Test reports for determination of the job-mix formula shall include the following information:

1. Aggregate Gradation.

2. Surface Capacity, Kc.

E. The grade of asphalt to be used for all mixes shall be AC-30 or AC-20P as specified in Subsection 703.03.02, "Asphalt Cements," unless otherwise stipulated in the Special Provisions.

F. The formula submitted shall propose definite single values for:

1. The percentage of aggregate passing each specified sieve.
2. The percentage of bitumen to be added (to 0.1 percent)
3. The temperature of the mixture leaving the mixer.

G. The temperature of the open-graded mixture at the hopper of the paver shall conform to the following table, except the temperature shall not be more than 20 degrees F lower than the temperature of the completed mixture leaving the plant.

TEMPERATURES OF PLANTMIX BITUMINOUS OPEN-GRADED MIXTURES AT THE PAVER		
Grade of Asphalt Cement	**Minimum**	**Maximum**
AC-30	225ºF	275ºF
AC-20P	280ºF	350ºF

H. The mixture furnished shall conform to the job-mix formula within the following range of tolerances:

1. Aggregate passing the No. 4 and larger sieves: ±7 percent.
2. Aggregate passing the No. 8 sieve: ±4 percent.
3. Aggregate passing the No. 200 sieve, not to exceed: 3 percent.
4. Bitumen Content:: ±0.3 percent of volume or batch weight of aggregate.

I. Should there be a change in sources of materials, a new job-mix formula shall be established before the new mix is used.

J. The temperature of the bituminous material just prior to mixing shall conform to the requirements of Subsection 401.02.01, "Composition of Mixtures."

CONSTRUCTION

403.03.01 GENERAL

A. The construction shall conform to Subsection 401.03.01, "Bituminous Mixing Plant," through Subsection 401.03.16, "Surfacing Miscellaneous Areas," with the exceptions below.

403.03.02 ROLLERS

A. There shall be operating with each paver, 2 tandem rollers weighing not less than 8 nor more than 10 tons.

B. When 2 pavers are paving in echelon within 400 feet of each other, no additional rollers will be required, and generally not over 2 passes will be required.

403.03.03 JOINTS

A. Longitudinal joints shall be constructed only on the shoulders or at the edge of travel lanes.

403.03.04 SURFACE TOLERANCES

A. **Straightedge Measurement:**

1. The completed surfacing shall be thoroughly compacted, smooth, and free from ruts, humps, depressions, or irregularities.
2. When a straightedge 10 feet long is laid on the finished surface and parallel with the centerline of the highway, the surface shall not vary more than 1/4 inch from the lower edge of the straightedge.
3. The transverse slope of the finished surface shall be uniform to a degree such that no depressions greater than 1/4 inch are present when tested with a straightedge 12 feet long laid in a direction transverse to the centerline and extending from edge to edge of a 12-foot traffic lane.
4. 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.
5. 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.

B. **Profilograph Measurement (When specified in the Contract Special Provisions):**

1. The Contractor shall produce completed surfacing which meets the requirements of Subsection 402.03.03.D, "Profilograph Measurement," with the following additions and exceptions to the profilograph measurement.
2. The Contractor shall furnish and operate a profilograph, as specified in Subsection 402.03.04, "Profilograph Equipment," at the time and date ordered.
3. The Contractor shall repair, or remove and replace, all areas exceeding the profile index requirements and areas representing high points on the profiles having deviations in excess of 0.4 inches as measured according to Nev. Test Method No. T446.
4. The Contractor shall remeasure repaired or replaced areas for conformance with the profile index and for no high points in excess of 0.4 inches.
5. High points in excess of 0.4 inches may be allowed to remain in place, if requested and approved.
   a. Liquidated damages of $500.00 will be assessed for each such high point that is allowed to remain in place.
   b. Grinding may be utilized for repair to the open-graded surface when approved.
   c. Limit grind areas to 25 feet in length.
   d. The grinder and grinding operations shall conform to Subsection 402.03.03, "Surface Tolerances."

METHOD OF MEASUREMENT

403.04.01 MEASUREMENT

A. Plantmix bituminous open-graded surface will be measured as specified in Subsection 401.04.01, "Measurement," or if the contract documents specify payment by area, the quantity of Plantmix Bituminous Surface to be measured for payment shall be the number of square yards, including the asphalt cement, used in the accepted work.

BASIS OF PAYMENT

403.05.01 PAYMENT

A. The accepted quantity of plantmix bituminous open-graded surface will be paid for at the contract price bid per square yard of plantmix bituminous open-graded surface thickness, which shall include the bituminous material (asphalt cement) or it will be paid for at the contract unit price bid per ton which shall include the cost of all 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.

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

C. Partial payments for plantmix bituminous open-graded surface may be made as set forth under Subsection 109.06, "Partial Payment."

D. Payment will be made under:

PAY ITEM	PAY UNIT
Plantmix Bituminous Open-Graded Surface (Thickness)	Square Yard
Plantmix Bituminous Open-Graded Surface	Ton

SECTION 404

HOT PLANTMIX RECYCLED BITUMINOUS PAVEMENT

DESCRIPTION

404.01.01 GENERAL

A. This work shall consist of recycling a bituminous pavement in a central plant and re-laying the reprocessed bituminous mixture on a prepared surface in accordance with the line, grades, thicknesses, and typical cross sections shown on the plans or established by the Engineer.

B. Recycled hot plantmix bituminous pavement, conforming to the requirements specified herein, may be substituted at the Contractor's option for conventional base course or surface course mixtures (Section 303, "Plantmix Bituminous Base," and Section 402, "Plantmix Bituminous Surface"). Comply with Section 401, "Plantmix Bituminous Pavements - General," except as herein specified.

MATERIALS

404.02.01 COMPOSITION OF MIXTURES

A. The recycled bituminous plantmix shall be composed of a mixture of reclaimed bituminous pavements, additional virgin aggregate, mineral filler, if required, recycling agent, and/or additional bituminous material.

1. 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.

2. Unless otherwise specified in the Special Provisions, the proportion of reclaimed bituminous pavement used in the mix shall not exceed 15 percent.

3. A greater percentage (more than 15 percent) of the reclaimed bituminous pavement material may be used in the recycling process if the Engineer determines that the resultant mixture satisfies the requirements specified for the mix design.

4. A new job-mix formula shall be established should there be a change in source of materials or a change in the percentage of reclaimed material used in the mix.

B. Before starting work, the Contractor shall submit a proposed job-mix formula in writing, for use by the Engineer in setting the job-mix formula to be used. The proposed job-mix formula shall be determined by a testing laboratory under the direction and control of a registered professional engineer, in accordance with Subsection 401.02.01, "Composition of Mixtures."

C. The formula submitted for the combined mix shall also indicate the recommended grade and amount of recycling agent and/or additional bituminous material to be used in the mix.

1. This shall be determined by recovering the asphalt cement from representative samples of the pavement to be recycled and testing the properties of the asphalt cement after adding various amounts of the recycling agent and/or additional bituminous material.

2. The test report shall show the curves for the following properties of the recycled asphalt cement after adding various amounts of recycling agent and/or bituminous material:

a. Penetration at 77 degrees F (before and after RTFC test).

b. Absolute Viscosity at 140 degrees F (before and after RTFC test).

D. The grade and amount of recycling agent and/or additional bituminous material to be used will be that which will produce a paving grade asphalt cement conforming to Section 703, "Bituminous Materials."

1. For Traffic Category I pavements, the combined bituminous materials shall meet all of the requirements of an AC-30 or AC-20 grade.

2. For Traffic Category II pavements, the combined bituminous material shall meet all the requirements of an AC-20 or AC-10 grade.

3. All properties specified for a paving grade asphalt cement shall be tested on the combined bituminous material, and the results shall be submitted with the proposed job-mix formula.

404.02.02 AGGREGATES

A. **Reclaimed Bituminous Pavement Aggregate.** The aggregate shall be the product of crushed, milled, or planed bituminous pavement.

B. **Virgin Aggregates.** Virgin aggregates shall meet the requirements of Section 705, "Aggregates for Bituminous Courses."

404.02.03 BITUMINOUS MATERIAL

A. The bituminous material shall be an asphalt cement and shall comply with Section 703, "Bituminous Materials."

B. The grade shall be determined by the job-mix formula.

404.02.04 RECYCLING AGENT

A. The recycling agent shall conform to the requirements in the following table.

B. The grade shall be determined by the job-mix formula.

SPECIFICATIONS FOR HOT-MIX RECYCLING AGENT[1]

TEST	ASTM Test Method	RA-5		RA-25		RA-75		RA-250		RA-500	
		min	max	min	max	min	max	min	max	min	max
Viscosity @ (140°F), cSt	D2170	200	800	1,000	4,000	5,000	10,000	15,000	35,000	40,000	60,000
Flash Point COC, °F	D92	400	--	425	--	450	--	450	--	450	--
Saturates, wt. %	D2007	--	30	--	30	--	30	--	30	--	30
Viscosity Ratio[3]	--	--	3	--	3	--	3	--	3	--	3
RTFC Oven Weight Change ±%	D2872[2]	--	4	--	3	--	2	--	2	--	2
Specific Gravity	D70 or D1298	Report		Report		Report		Report		Report	

[1] The final acceptance of recycling agents meeting this specification is subject to the compliance of the reconstituted asphalt blends with current asphalt specifications.

[2] The use of ASTM D1754 has not been studied in the context of this specification; however, it may be applicable. In cases of dispute, the reference method shall be ASTM D2872.

[3] Viscosity Ratio = $\frac{\text{RTFC Viscosity at 140°F cSt}}{\text{Original Viscosity at 140°F cSt}}$

CONSTRUCTION

404.03.01 GENERAL

A. Construction shall conform to the Subsection 401.03.01, "Bituminous Mixing Plant," through Subsection 401.03.15, "Surface Tolerances," with the exceptions below.

404.03.02 BITUMINOUS MIXING PLANT

A. The plant shall comply with Subsection 401.03.01, "Bituminous Mixing Plant." In addition, the control and handling of the recycling agent shall be in a manner similar to that specified for the bituminous material.

B. If a batch plant is used, the plant shall be modified so that:

1. Virgin aggregate can be superheated to a temperature required to produce a resultant mix temperature as specified in Subsection 401.02.01, "Composition of Mixtures," after adding the ambient temperature reclaimed bituminous pavement aggregate.

2. Reclaimed aggregate shall be fed to the aggregate weigh hopper in a manner to ensure uniform proportioning.

C. If a drier drum plant is used, the plant shall be modified so that:

1. Either the virgin aggregate can be superheated to a temperature required to produce the required resultant mix temperature, or the combination of reclaimed bituminous pavement aggregate and virgin aggregate can be heated to a temperature needed for a resultant mix temperature as specified in Subsection 401.02.01, "Composition of Mixtures."

2. The reclaimed aggregate shall be introduced into the plant in such a manner to ensure uniform proportioning and to protect the material from direct contact with the burner flame.

D. Regardless of the type of bituminous mixing plant used, the air pollution requirements as set forth by the Clark County Air Pollution Control Division and state law shall apply to the manufacture of recycled bituminous pavement.

404.03.03 PREPARATION OF AGGREGATES

A. Virgin aggregates shall be prepared as specified in Subsection 401.03.08, "Preparation of Aggregates."

B. Reclaimed bituminous pavement aggregates shall be prepared so that 100 percent will pass a 1-1/2-inch sieve. The moisture content of the reclaimed bituminous pavement aggregate at the time of introduction into the mixer shall not exceed 3 percent as determined by Test Method ASTM D2216.

C. The stockpiling area for the reclaimed bituminous pavement aggregate shall be graded and compacted so a firm level base can be maintained at all times.

1. Layer placing or alternate approved methods shall be used to prevent coning or segregation of component sizes.

2. The stockpile will be limited to 10 feet in height and no equipment of any type will be allowed on top of the stockpile.

3. The stockpile shall be maintained in a loose and uncompacted state.

4. To prevent premature consolidation, reclaimed bituminous pavement aggregate shall not be stored in confined metal bins or hoppers unless slated for immediate processing.

D. Immediately prior to feeding the reclaimed bituminous pavement aggregate into the mixing plant, the material shall first pass through a grizzly with bars spaced 2 inches apart.

METHOD OF MEASUREMENT

404.04.01 MEASUREMENT

A. Hot plantmix recycled bituminous pavement shall be measured as specified in Subsection 401.04.01, "Measurement."

BASIS OF PAYMENT

404.05.01 PAYMENT

A. The accepted quantity of hot plantmix recycled bituminous pavement will be paid for at the contract unit price bid per ton, which shall include all asphalt cement and recycling agent.

B. The above price shall be full compensation for furnishing all the material, mixing, loading, hauling, placing, compacting, and incidentals necessary for doing the work involved in constructing hot plantmix recycled bituminous pavement as shown on the plans or established by the Engineer.

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

D. Partial payments for hot plantmix recycled bituminous pavement may be made as set forth under Subsection 109.06, "Partial Payment."

E. Payment will be made under:

PAY ITEM	PAY UNIT
Hot Plantmix Recycled Bituminous Pavement	Ton

SECTION 405

TACK COAT

DESCRIPTION

405.01.01 GENERAL

A. This work shall consist of preparing and treating an existing bituminous or concrete surface with asphaltic emulsion in accordance with these specifications and in conformity with the lines shown on the plans or established by the Engineer.

MATERIAL

405.02.01 BITUMINOUS MATERIAL

A. The type and grade of bituminous material shall be SS-1h or CSS-1h asphalt emulsion unless otherwise specified in the Special Provisions.

1. The grade may be changed by the Engineer during construction.
2. The bituminous material shall comply with Section 703, "Bituminous Materials."
3. The bituminous material may be conditionally accepted at the source.

B. 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:

1. The emulsion shall be cut back by warm water.
2. Water shall be added to the emulsion in the quantity of 50 percent of the emulsion by weight.

CONSTRUCTION

405.03.01 EQUIPMENT

A. The Contractor shall provide equipment for heating and applying the bituminous material.

B. The distributor shall be so designed, equipped, maintained, and operated that bituminous material at even heat may be applied:

1. Uniformly on variable widths of surface up to 14 feet.
2. At readily determined and controlled rates from 0.05 to 2.0 gallons per square yard with uniform pressure.
3. With an allowable variation from any specified rate not to exceed 0.02 gallon per square yard.

C. Distributor equipment shall include a tachometer, pressure gauges, accurate volume measurement devices or a calibrated tank, and thermometer for measuring temperatures of tank contents.

D. Distributors shall be equipped with a power unit for the pump and full circulation spray bars adjustable laterally and vertically.

405.03.02 WEATHER LIMITATIONS

A. Application of bituminous material will not be permitted:

1. When the surface to be treated is damp or wet.
2. When weather conditions are unsuitable.
3. When the surface temperature is below 50 degrees F.

405.03.03 PREPARATION OF SURFACE

A. The existing surface shall be patched and cleaned and be free of irregularities to provide a smooth and uniform surface to receive the treatment.

B. The edges of existing pavements that will be adjacent to new pavement shall be cleaned to permit the adhesion of bituminous materials.

C. Where the Contractor is applying tack upon a previously constructed course under the contract, patching, cleaning, repairing, and so forth will be at no additional cost to the Contracting Agency, unless otherwise provided. Comply with Subsection 104.04, "Maintenance of Traffic," and Subsection 105.14, "Maintenance During Construction."

D. 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."

405.03.04 APPLICATION OF ASPHALTIC EMULSION

A. The asphaltic emulsion shall be uniformly applied at the rate called for on the plans or ordered by the Engineer.

B. The temperature of the material to be spread at the time of application shall conform to Table 1 of Subsection 406.03.04, "Application of Bituminous Material."

C. The tack coat shall be applied so as to offer the least inconvenience to traffic and to permit one-way traffic without pickup or tracking of the bituminous material.

1. Tack coat shall be applied only so far in advance that it will be covered during the following 36 hours.
2. The tack coat shall be completely "broke" prior to being covered.

METHOD OF MEASUREMENT

405.04.01 MEASUREMENT

A. 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.

B. Bituminous material diluted as prescribed shall be measured in square yard, or tons of the diluted mixture acceptably applied to the surface.

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

BASIS OF PAYMENT

405.05.01 PAYMENT

A. 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 square yard or ton.

B. The unit bid price 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."

C. The Contracting Agency reserves the right to increase or to omit all or any part of the estimated amount of bituminous material to be used and no adjustment in unit price shall be allowed by reason of such increase or decrease.

D. When an item for Tack Coat does not appear in the proposal, tack coat will be considered as incidental to the subsequent paving and compensation shall be included in the contract prices for other items of work.

E. Payment will be made under:

PAY ITEM	PAY UNIT
Emulsified Asphalt Tack Coat (Type) (diluted)	Ton, Square Yard

SECTION 406

PRIME COAT

DESCRIPTION

406.01.01 GENERAL

A. This work shall consist of preparing and treating an existing aggregate base with bituminous material, and blotter material, if required, in accordance with these specifications and in conformity with the lines shown on the plans or established by the Engineer.

MATERIAL

406.02.01 BITUMINOUS MATERIAL

A. The type and grade of bituminous material shall be MC-70 liquid asphalt unless otherwise specified in the Special Provisions. The grade may be changed 1 step by the Engineer during construction.

B. The bituminous material shall meet the applicable requirements of Section 703, "Bituminous Material." The bituminous material may be conditionally accepted at the source.

406.02.02 SAND BLOTTER

A. Sand blotter shall meet the requirements of Subsection 705.03.06, "Sand Blotter." The material may be accepted in the stockpile at the source.

CONSTRUCTION

406.03.01 EQUIPMENT

A. The Contractor shall provide equipment for heating and applying the bituminous material and for applying blotter material.

B. The equipment shall meet the requirements of Subsection 405.03.01, "Equipment."

406.03.02 WEATHER LIMITATIONS

A. Bituminous material shall not be applied:

1. On a wet surface that has free-standing water.
2. When the atmospheric temperature is below 50 degrees F .
3. When weather conditions, in the opinion of the Engineer, would prevent the proper construction of the prime coat.

406.03.03 PREPARATION OF SURFACE

A. The surface upon which the bituminous prime coat is to be placed shall conform to the established lines and grades, shall be smooth and uniform, and shall be compacted to the required density.

B. If the required density deteriorates between 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 no additional cost to the Contracting Agency.

C. When required by the Engineer, an application of water shall be applied immediately before bituminous application.

406.03.04 APPLICATION OF BITUMINOUS MATERIAL

A. 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.

1. When traffic is maintained, not more than 1/2 of the width of the section shall be treated in one application.
2. Care shall be taken that the application of bituminous material at the junctions of spreads is not in excess of the specified amount.
3. Excess bituminous material shall be squeegeed from the surface.
4. Skipped areas or deficiencies shall be corrected.

B. When traffic is maintained, 1-way traffic shall be permitted on the untreated portion of the roadbed.

C. 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.

D. Application rate shall be between 0.10 and 0.25 gallon per square yard.

E. The temperature requirements pertaining to the application of liquid asphalts and asphaltic emulsions shall conform to the requirements of the following Table 1:

TABLE 1
SPRAYING TEMPERATURES OF LIQUID ASPHALTS AND ASPHALTIC EMULSIONS

Grade & Type	Distributor Spraying Temperatures	
	Minimum	Maximum
RC, MC, & SC	°F	°F
70	120	180
255	165	220
800	200	255
3000	235	290
Grade of Asphalt Emulsion		
RS-1, CRS -1	75	130
RS-2, CRS-2	110	160
SS-1, CSS-1	75	130
SS-1h, CSS-1h	75	130
CMS-2S	100	160

406.03.05 APPLICATION OF BLOTTER MATERIAL

A. If, after the application of the prime coat, the bituminous material fails to penetrate within 24 hours, blotter material may be spread in the amounts required to absorb any excess bituminous material.

B. Excess sand blotter shall be removed prior to the placement of the subsequent courses.

406.03.06 MAINTENANCE

A. All loose sand shall be completely removed from the treated areas before placing any pavement or surfacing material thereon.

B. Immediately in advance of placing asphalt concrete or asphalt concrete base, additional prime coat shall be applied as directed by the Engineer to areas where the prime coat has been damaged, and loose or extraneous material shall be removed, and no additional compensation will be allowed therefor.

METHOD OF MEASUREMENT

406.04.01 MEASUREMENT

A. The quantity of bituminous material to be measured for payment will be the number of square yards or the number of tons conforming to all the requirements in the completed work.

B. The quantity of sand blotter measured for payment will be the number of tons conforming to all the requirements in the completed work.

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

BASIS OF PAYMENT

406.05.01 PAYMENT

A. 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 or square yard for bituminous material and per ton for sand blotter.

B. When sand blotter is not included in the proposal and it is needed to protect the work or public traffic, sand blotter shall be considered subsidiary to other items of work and no additional compensation will be allowed.

C. The above prices shall be full compensation for furnishing the material, mixing, loading, hauling, placing, and incidentals necessary for doing all of the work involved in placing prime coat and sand blotter as shown on the plans or established by the Engineer.

D. The Contracting Agency 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 adjustment in unit price will be allowed by reason of such increase or decrease.

E. When an item for prime coat does not appear in the proposals, but is shown on the plans or Standard Drawings, prime coat will be considered as incidental to the subsequent paving and compensation shall be included in the contract prices for other items of work.

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

G. Payment will be made under:

PAY ITEM	PAY UNIT
Liquid Asphalt Prime Coat (Type)	Ton, Square Yard
Sand Blotter	Ton

SECTION 407

SEAL COAT

DESCRIPTION

407.01.01 GENERAL

A. This work shall consist of an application of bituminous material on a compacted and bonded bituminous surface and blotter sand, if required, in accordance with these specifications and in conformity with the lines shown on the plans or established by the Engineer.

MATERIAL

407.02.01 BITUMINOUS MATERIAL

A. Unless otherwise specified in the Special Provisions, the type and grade of bituminous material shall be SS-1h or CSS-1h asphalt emulsion. The grade may be changed by the Engineer during construction.

B. The bituminous material shall meet the applicable requirements of Section 703, "Bituminous Materials." The bituminous material may be conditionally accepted at the source.

C. The emulsion shall be cut back by warm water. Water shall be added to the emulsion in the quantity of 50 percent of the emulsion by weight.

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

A. 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 405.03.01, "Equipment."

407.03.02 WEATHER LIMITATIONS

A. Bituminous material shall not be applied:

1. On a wet surface.
2. When the surface temperature is below 50 degrees F.
3. When weather conditions, in the opinion of the Engineer, would prevent the proper construction of the seal coat.

407.03.03 PREPARATION OF SURFACE

A. 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.

B. The process of cleaning shall continue until dirt and loose material are removed from the entire width of the surfacing.

407.03.04 APPLICATION OF BITUMINOUS MATERIAL

A. Bituminous material shall not be spread later in the day than will permit the stopping of traffic control prior to darkness.

B. 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.

C. The bituminous material shall be uniformly applied at the rate called for on the plans or ordered by the Engineer.

D. The temperature of the bituminous material shall conform to the applicable requirements of Subsection 406.03.04, "Application of Bituminous Material."

E. The seal coat shall be applied in a manner to offer the least inconvenience to traffic and to permit 1-way traffic without pickup or tracking of the bituminous material.

F. When seal and screenings are to be applied to the central portion of the pavement, the shoulder seal coat shall be applied at least 4 days in advance of the application of the adjacent surface treatment requiring screenings, and the seal coats shall be applied so that the joints between the 2 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

A. The applicable requirements of Section 406, "Prime Coat," shall apply to this section when sand blotter is required.

METHOD OF MEASUREMENT

407.04.01 MEASUREMENT

A. The quantity of bituminous material to be measured for payment will be the number of tons or square yards conforming to all the requirements in the completed work.

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

BASIS OF PAYMENT

407.05.01 PAYMENT

A. The accepted quantity of material measured as provided in Subsection 407.04.01, "Measurement," will be paid for at the contract unit price bid per ton or square yard for bituminous material.

B. The above price shall be full compensation for furnishing the material, 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.

C. The Contracting Agency reserves the right to increase or to omit all or any part of the estimated amount of bituminous material to be used and no adjustment in unit price shall be allowed by reason of such increase or decrease.

D. Sand blotter will be paid for in accordance with Section 406, "Prime Coat."

A. When an item for seal coat does not appear in the proposal, but it is shown on the plans or Standard Drawings, seal coat will be considered as incidental to the subsequent paving and compensation be included in the contract prices for other items of work.

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

C. Payment will be made under:

PAY ITEM	PAY UNIT
Emulsified Asphalt Seal Coat (Type)	Ton, Square Yard

SECTION 408

PAVEMENT SURFACE TREATMENTS - CHIP SEAL

DESCRIPTION

408.01.01 GENERAL

A. This work shall consist of an application of bituminous material and cover of screenings applied on a previously compacted and bonded bituminous surface, in accordance with these specifications and in conformity with the lines shown on the plans or established by the Engineer.

MATERIAL

408.02.01 BITUMINOUS MATERIAL

A. The type and grade of bituminous material will be specified in the contract. The grade may be changed by the Engineer during construction.

B. The bituminous material shall comply with Section 703, "Bituminous Materials." The bituminous material may be conditionally accepted at the source.

408.02.02 SCREENINGS

A. Screenings shall comply with Subsection 705.03.05, "Screenings" for the size specified. Comply with Subsection 106.04, "Samples and Tests."

CONSTRUCTION

408.03.01 DISTRIBUTORS

A. The distributor shall comply with Subsection 405.03.01, "Equipment."

408.03.02 AGGREGATE SPREADER

A. The aggregate spreader shall be self-propelled and supported by at least 4 wheels equipped with pneumatic tires on 2 axles.

B. 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 ROLLING AND COMPACTION

A. There shall be operating with each aggregate spreader at least 1 pneumatic-tired roller.

B. Rollers shall meet the following requirements:

1. The rollers shall be pneumatic-tired rollers and shall consist of not less than 9 wheels equipped with pneumatic tires of equal size and diameter mounted on 2 axles.

2. Axles shall be 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 1,000 and 2,000 pounds.

3. The tire treads, rear tire spacing, tire inflation, and tire size shall be approved by the Engineer.

C. Rolling with a pneumatic-tired roller shall begin immediately after the distribution of the screenings and continue until the aggregate is properly sealed in the binder.

1. As soon as the asphalt has achieved a definite set, rolling shall be discontinued unless otherwise directed by the Engineer.

2. Rollers shall begin at the outer edge of the treatment and proceed in a longitudinal direction, working toward the center of the road.

3. Each pass shall overlap the previous pass by about 1/2 the width of the front wheels.

4. All rollers shall be in good condition and the reversing mechanism so maintained that the roller is capable of changing directions smoothly.

408.03.04 WEATHER LIMITATIONS

A. Bituminous material shall not be spread when:

1. Weather conditions are unsuitable.

2. The atmospheric temperature is below 65 degrees F.

3. The pavement temperature is below 80 degrees F.

408.03.05 MAINTAINING TRAFFIC

A. 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 1/2 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.

B. 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.

C. 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 6 hours or for such time as deemed necessary by the Engineer as follows:

1. 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.

2. 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

A. 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.

B. 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

A. Bituminous material shall be applied by means of a pressure distributor in a uniform, continuous spread over the section to be treated.

1. The temperature of the bituminous material shall conform to Subsection 406.03.04, "Application of Bituminous Material."

2. The quantity of bituminous material to be used per square yard shall be as directed.

3. 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.

4. A strip of building paper at least 3 feet in width and with a length equal to that of the spray bar of the distributor plus 1 foot shall be used at the beginning of each spread.

5. If the cutoff is not positive, the use of paper may be required at the end of each spread.

6. The paper shall be removed and disposed of in a satisfactory manner.

B. The distributor shall be moving forward at proper application speed at the time the spray bar is opened.

1. Any skipped areas or deficiencies shall be corrected.

2. Junctions of spread shall be carefully made to ensure a smooth riding surface.

C. The length of spread of bituminous material shall not be in excess of that which trucks loaded with screenings can immediately cover.

D. The spread of bituminous material shall not be more than 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.

E. 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

A. Immediately following the application of the bituminous material, screenings shall be spread at the required rate per square yard.

B. To avoid building a longitudinal joint when spreading screenings on the first width of bituminous material, no screenings shall be applied within 6 inches of the edge adjacent to the next application of bituminous material.

C. To eliminate dust film, screenings shall be moistened with water before 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.

D. Asphaltic emulsion applied to the road surface shall be covered with screenings before setting or breaking occurs.

1. 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 ensure against permanent ridges or bumps in the completed surface.

2. Additional screenings shall be spread by hand in whatever quantities required to prevent picking up by the rollers or traffic.

E. After the application of the screenings, the surface, where specified, shall be lightly broomed or otherwise maintained as directed for a period of 4 days or as directed.

1. 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.

2. The maintenance shall be conducted so as not to displace embedded material. Excess material shall be swept off and removed at the time determined by the Engineer.

METHOD OF MEASUREMENT

408.04.01 MEASUREMENT

A. The quantity of bituminous material to be measured for payment will be the number of tons or the number of square yards conforming to all the requirements in the completed work.

B. The quantity of screenings measured for payment will be the number of tons or square yards conforming to all the requirements in the completed work.

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

BASIS OF PAYMENT

408.05.01 PAYMENT

A. 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 or square yard for bituminous material and per ton or square yard for screenings.

B. 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.

C. The Contracting Agency reserves the right to increase or to omit all or any part of the estimated amount of screening or bituminous material to be used, and no adjustment in unit price shall be allowed for such increase or decrease.

D. Flagmen and pilot cars will be paid for in accordance with Section 624, "Accommodations for Public Traffic."

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

F. Payment will be made under:

PAY ITEM	PAY UNIT
Emulsified Asphalt (Type)	Ton, Square Yard
Screenings	Ton, Square Yard

SECTION 409

PORTLAND CEMENT CONCRETE PAVEMENT

DESCRIPTION

409.01.01 GENERAL

A. 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 conformity with the lines, grades, thicknesses, and typical cross sections shown on the plans or established by the Engineer.

B. 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 MATERIALS

A. Materials shall conform to the requirements of the following sections and subsections:

Materials	Section/Subsection
Fine Aggregate	706.03.03
Coarse Aggregate	706.03.01
Portland Cement	701
Water	722
Air Entraining Admixtures	702.03.02
Joint Filler	707.03.04
Curing Materials	702.03.01
Reinforcement	713

B. An inadequate water supply shall be considered 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

A. Gradation shall comply with Subsection 501.02.02, "Gradation Requirements."

409.02.03 CONCRETE PROPERTIES AND TESTS

A. Portland cement concrete pavement shall be subject to the following requirements and test methods:

Test	Test Designation	Requirements
Flexural Strength of Concrete	ASTM C293	Minimum Modulus of Rupture: 450 psi

CONSTRUCTION

409.03.01 CLASSIFICATION AND PROPORTIONS

A. The Contractor shall notify the Engineer not less than 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.

1. 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 year.
2. Samples shall not exceed 500 pounds for each separate grading.
3. 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 saturated surface dry (SSD) condition; and the percentage of air in the concrete proposed for use in the work.
4. If the Contractor proposes to use an admixture other than an air-entraining agent, the Contractor shall state admixture's complete brand name and the quantity proposed to be used per sack of cement.
5. The Engineer, after making such tests as the Engineer deems advisable, will either accept the proposed materials and proportions or suggest modifications needed for acceptance.
6. After acceptance by the Engineer of batch proportions and materials, batch proportions and materials 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.

B. Portland cement concrete shall be proportioned using the aggregates tested such that the requirements in Table 1 of this subsection will be satisfied without falling below the minimum or exceeding the maximum values given.

1. 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).
2. Aggregates shall be batched and reported to the Engineer.
3. The weights used may be varied as necessary to comply with the above tolerances in cement factor and unit weight.
4. 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-inch	100
1-1/2-inch	90-100
1-inch	50-86
3/4-inch	45-75
3/8-inch	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 1 - CONCRETE PROPORTIONS

Class of Concrete	Sacks of Cement Per Cubic Yard		Coarse Aggregate Size No.	Maximum Water Gallons Per Sack Cement*	Slump Range Inches	Air Range %	Unit Weight Variation Pounds
	Min.	Max.					
P.C.A.	5.5	7	467	5.5	0-3**	4±1	±3
P.C.A.A.	6	7.5	467	5.5	0-3**	5±1	±3

*Based on aggregate in a saturated surface dry condition (SSD).

**The nominal slump in inches shall be 3 inches, the maximum slump shall be 3-1/2 inches. 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 specified range. Four slump tests will be considered sufficient to determine nominal slump. The difference in slump, determined by comparing slump tests on 2 samples of mixed concrete for each individual batch tested, shall not exceed 1 inch. When the difference in slump does exceed 1 inch, procedure and equipment used in producing the concrete shall be adjusted to reduce the difference in slump to not more than 1 inch.

409.03.02 EQUIPMENT

A. **General:**

1. Equipment and tools necessary for handling materials and performing all parts of the work shall meet the approval of the Engineer as to design, capacity, and mechanical condition.

   a. This equipment shall be on the site and available for inspection, testing, and approval before paving operations are started.

   b. All equipment, tools, and machinery shall be maintained in a satisfactory working condition.

2. 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.

3. 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.

4. Aggregates and cement shall be proportioned by weight, except that when the amount of concrete required for any 1 contract is 10 cubic yards or less, the materials may be measured by volume. Materials that are proportioned by volume shall be measured in containers of known capacity.

5. Proportioning shall consist of combining the aggregates, each stored in a separate bin in the various gradations prescribed in Subsection 706.03.01, “Coarse Aggregate,” with cement and water.

   a. Weigh hoppers shall be charged from bins located directly over the hoppers or from conveyor belts.

   b. When conveyor belts are used, there shall be a separate belt for each size aggregate.

   c. There shall be an approved moisture meter installed to indicate the moisture in the sand.

6. Bulk cement shall be weighed in an individual hopper and shall be kept separate from the aggregates until the ingredients are released for discharge. The cement hopper shall be attached to a separate scale for individual weighing.

7. The amount of water to be added to the mixture shall be measured and discharged rapidly into the mixing drum through a valve with a positive cut-off. When water is measured by weight, the water shall be weighed on a separate scale.

8. All weighing or metering devices, except moisture meters used for proportioning materials, shall be accurate to within 1 percent.

   a. The devices shall be sealed and certified by the Nevada State Department of Weights and Measures.

   b. These certifications shall be dated within the past 12 months and shall be renewed whenever required by the Engineer.

   c. The moisture meter shall be accurate to within 1/2 of 1 percent.

   d. Whenever portable bunkers are set up at a new location, the scale assemblies shall be inspected and certified regardless of the date the scales were last tested.

9. Scales used in proportioning shall be either springless dial or multiple beam type.

   a. Scale gradations shall be no greater than the following:

      1) Aggregate Scales: 25 pounds

      2) Cement Scales: 5 pounds

      3) Water Scales: 5 pounds

   b. All scales shall be of such size and so arranged that the scales may be read easily from the operator's platform.

   c. If a multiple beam type scale is used, the scale shall be provided with an indicator operated by the main beam that will give positive visible evidence of over or under weight.

   d. The indicator shall be designed to operate during the addition of the last 400 pounds of any weighing.

   e. The over travel of the indicator hand shall be at least 1/3 of the loading travel.

   f. Indicators shall be enclosed against moisture and dust.

10. Weighing equipment shall be insulated against vibration and movement of other operating equipment in the plant. When the entire plant is running, the scale reading at cut-off shall not vary from the weight designated by the Engineer by more than 1 percent for cement, 1 percent for water, 1-1/2 percent for any size of aggregate, or 1 percent for the total aggregate in any batch.

11. Machine mixing will be required in all cases other than those in which the mixing would obviously prove to be impractical, in which event hand mixing will be permitted. Mixing shall be commenced as soon as possible after the cement is placed in contact with the aggregates, but in no event shall the intervening period exceed 30 minutes.

12. All concrete mixers shall be of such design and construction and so operated as to provide a thoroughly and properly mixed concrete in which the ingredients are uniformly distributed.

a. Mixers shall be maintained in proper and serviceable working condition and any part or portion thereof that is out of order, or becomes worn to such extent as to detrimentally affect the quality of mixing, shall be promptly repaired or replaced.

b. Mixers shall not have any aluminum parts which will have direct contact with concrete.

B. **Concrete Consistency:**

1. The amount of water added at the mixer shall be regulated to take into account the free water in the aggregates. Free water is defined as the total water minus the water absorbed by the aggregate in a saturated surface dry condition.

2. The amount of water used in the mixture shall not exceed the minimum amount necessary to permit practical placement and consolidation of the concrete, and unless otherwise authorized by the Engineer, shall be that required to produce concrete with a slump within the range shown as nominal in the following table:

Type of Work	Nominal Slump Inches	Maximum Slump Inches
Concrete Pavement	0-3	3.5

3. The concrete used in the work shall not have a slump greater than that shown as maximum above, nor a free water content greater than 312 pounds per cubic yard of concrete.

4. The consistency of concrete shall be determined in accordance with ASTM C143.

5. If slump tests of individual samples taken at approximately the 1/4 and 3/4 points of the discharge differ by more than 2 inches, the mixer will not be acceptable for further use until the condition is corrected.

C. **Paving and Stationary Mixers:**

1. Paving and stationary mixers shall be equipped with an accurate automatic timing device so designed and constructed as to lock the discharge lever before aggregate and cement enter the drum, and release the lever only after the specified mixing time has elapsed. The regulation of the setting of the device shall be under the supervision of the Engineer. Water control equipment shall also be provided with each concrete mixer.

2. The proper proportions of aggregate, cement, and water for each batch of concrete shall be placed in the mixer, and shall be mixed for a period of not less than 1 minute after all materials are in the drum. The minimum mixing time, however, shall not be less than 1-1/2 minutes.

3. The rotating speed at which the mixer shall be operated shall conform to that recommended by the manufacturer.

4. The total volume of materials mixed in any 1 batch shall exceed neither the water level capacity of the mixer nor the manufacturer's guaranteed capacity of the mixer.

D. **Transit Mixers:**

1. The type, capacity, and manner of operation of the mixing and transporting equipment for ready-mix concrete shall conform to the current "Standards for Operation of Truck Mixers and Agitators of the National Ready-Mixed Concrete

Association" and the "Truck Mixer and Agitator Standards of the Truck Mixer Manufacturers Bureau."

a. Transit mix concrete trucks shall be equipped with an automatic device for recording the number of revolutions of the drum during the mixing period.

b. Each mixer and agitator shall have attached thereto, in a prominent place, a metal plate or plates installed by the manufacturer on which is plainly marked the capacity of the drum in terms of the volume of mixed concrete and the speed of rotation for the agitating and mixing speeds of the mixing drum or blades.

2. Each mixer shall have an identification number painted in a location on the truck that can be easily read from the batching platform.

3. The total volume of materials introduced into the mixer shall not exceed the manufacturer's guaranteed mixing capacity.

a. If the concrete so mixed does not meet the uniformity requirements of this subsection, the amount of materials charged into the mixer shall be reduced.

b. The drum of the mixer shall be completely emptied of previously mixed load.

c. The proper proportions of aggregate, cement, and water for each load of concrete shall be placed in the mixer and shall be mixed therein for not less than 70 nor more than 100 revolutions of the drum or blades at the speed designated by the manufacturer of the equipment as mixing speed.

d. Additional revolutions of the drum shall be at the speed designated by the manufacturer of the equipment as agitating speed.

e. The revolving of the drum shall be continuous until the concrete is completely emptied from the drum.

4. When concrete is being placed for pavement structures, all wash water shall be emptied from the mixer before any portion of the succeeding load is placed therein. For all other work, the mixer shall be empty or may carry 10 gallons of water in the drum.

a. Adequate control of ready-mixed concrete will normally require that additional water be added and mixed into the batch at the point of discharge.

b. Water so added shall be mixed into the load for a minimum mixing time of 3 minutes.

c. Water shall not be added to the load during transit.

d. The total elapsed time between the addition of water at the batch plant and discharging the completed mix shall not exceed 60 minutes. Under conditions contributing to quick setting, the total elapsed time permitted may be reduced by the Engineer.

5. The Engineer shall be provided with a legible certified weighmaster's certificate at the job site for each load which shall contain the following information:

a. Name of Vendor

b. Name of Contractor

c. Number of Cubic Yards in the Load

d. Actual Weights of Cement and of Each Size of Aggregate

e. Amount of Water Added at the Plant

f. Amount of Water in the Aggregate

g. Brand and Type of Cement

h. Brand and Amount of Admixture

i. Time and Date of Batching

6. When mix proportions have been designated for a project and are identified by number, the Engineer may waive the foregoing and accept a legible certified weighmaster's certificate which shall contain the following information:

a. Name of Vendor

b. Name of Contractor

c. Number of Cubic Yards in the Load

d. Mix Designation Number

e. Amount of Water Added at the Plant (including Water in Aggregate)

f. Time and Date of Batching

7. Space shall be provided on the certificate so that amount of water added on the job may be indicated.

E. **Forms and Headers:**

1. Forms and headers shall be either wood or metal, and shall be:

a. Set plumb and true to line and grade, with the upper edge thereof set to the grade of the pavement to be constructed.

b. Rigidly installed on a true alignment and so maintained for a distance in advance of placing the pavement to provide for at least a 1-day run of concrete.

2. Headers shall rest firmly on the subgrade or base. They shall be oiled immediately prior to the placing of the concrete and shall remain in place at least 12 hours after concrete has been placed.

3. Forms and headers shall be removed before the work will be accepted.

F. **Wooden Forms:**

1. Wooden forms shall be constructed of 3-inch nominal lumber in pieces not less than 16 feet long except where changes in alignment or grade necessitate the use of material of smaller dimensions. The lumber used shall:

a. Be free from warp and other imperfections that would impair the strength for the use intended.

b. Have square edges (which may be slightly beveled) and square ends.

c. Be surfaced on the upper edge.

d. Not be more than 1/2 inch less in depth than the specified thickness of the edge of the pavement.

2. Wooden forms shall be secured by nailing to side stakes spaced not more than 4 feet apart, driven into the subgrade vertically to a depth not less than 12 inches, and so that the tops will be below the upper edge of the header. The stakes shall be sufficient length and cross-sectional area to adequately resist lateral displacement of the headers during the paving operations.

3. Wooden headers shall be spliced by nailing a board to the outside of the headers. The board shall be at least 4 feet long, 1 inch thick, and at least 6 inches wide (or the depth of the header, whichever is less), and shall be centered on the joint.

G. **Metal Forms:**

1. Metal forms shall be free from warp, have sufficient rigidity to resist springing during the paving operations, and shall be not less in depth than the specified thickness of the edge of the pavement being constructed.

2. The forms shall be secured with metal stakes spaced not more than 5 feet apart and driven below the top of the forms.

3. The stakes shall be designed so as to be driven through openings in the forms to lock the forms in position.

H. **Slip Form Construction:**

1. At the option of the Contractor, and with the approval of the Engineer, concrete pavement may be constructed by the use of slip form paving equipment.

2. Slip form paving equipment shall be provided 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, and the equipment shall spread, consolidate, screed, and float-finish the freshly placed concrete to provide a dense and homogenous pavement.

3. The concrete shall be distributed uniformly into final position by the slip form paver and the horizontal deviation in alignment of the edges shall not exceed 1-1/4 inches from the alignment established by the Engineer.

4. The concrete, for the full paving width, shall be effectively consolidated by internal vibration, with transverse vibrating units, or with a series of longitudinal vibrating units. Internal vibration shall mean vibration by means of vibrating units located within the specified thickness of pavement section and at a minimum distance ahead of the screed equal to the pavement thickness.

5. 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, offset to run a sufficient distance from the edge of the pavement to avoid breaking or cracking the pavement edge.

6. After the concrete has been given a preliminary finish by finishing devices incorporated in the slip form paving equipment, the surface of the fresh concrete shall be checked by the Contractor with a straightedge to the tolerance and finish required in Subsection 409.03.08, "Spreading, Compacting, and Shaping."

7. The subgrade shall be moist at the time of placing concrete.

   a. The subgrade shall be thoroughly wet the night before or at least 6 hours prior to placing the concrete, and again sprinkled immediately before the concrete is placed on it.

   b. Sprinkling shall be such that mud and pools of water will not be formed.

   c. At the time of placing the concrete, the grade shall not be muddy, soft, or frozen.

409.03.03 BLANK

409.03.04 BLANK

409.03.05 REINFORCEMENT

A. 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.

B. Bar reinforcement shall conform to the provisions in Section 505, "Reinforcing Steel."

C. 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.

D. The supports shall be specially manufactured for the purpose and each support shall be capable of supporting a vertical load of 200 pounds.

409.03.06 BLANK

409.03.07 PLACING CONCRETE

A. The Contractor shall make adequate advance arrangements for preventing delay in delivery and placing of the concrete.

1. An interval of more than 45 minutes between placing of any 2 consecutive batches or loads shall constitute cause for stopping paving operations.

2. The Contractor shall make a contact joint, at no additional cost to the Contracting Agency, at the location and of the type directed by the Engineer, in the concrete already placed.

B. Unless otherwise specified, concrete pavement shall be placed in 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 monolithically 2 or more lanes wide without a contact joint, but with a longitudinal weakened plane joint at each traffic lane line.

C. All concrete shall be used while fresh. The use of water for retempering any concrete will not be permitted.

D. Any concrete showing improper proportions 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 no additional cost to the Contracting Agency.

E. The Contractor shall protect freshly placed concrete from damage by any cause and any damage shall be repaired by the Contractor at no additional cost to the Contracting Agency.

F. Expansion joint material shall be protected while depositing fresh concrete adjacent thereto.

G. Concrete work shall be adequately barricaded in all directions to protect the work.

409.03.08 SPREADING, COMPACTING, AND SHAPING

A. The concrete shall be consolidated and the surface finished true to grade and cross section.

1. Upon completion, the surface shall be free of any unevenness greater than 1/8 inch when checked with a 10-foot straightedge placed on the surface of the pavement.

2. The 10-foot straightedge shall be furnished by the Contractor and shall be at the site of the work prior to commencing concrete placement.

B. **Tamping:**

1. The concrete shall be distributed uniformly between the side forms as soon as the concrete is placed, after which the concrete shall be struck off and tamped with a mechanical tamper.

2. The tamper shall be operated at right angles to the centerline of the pavement, and tamping continued until the concrete is thoroughly consolidated to the specified cross section and sufficient mortar for finishing purposes has been brought to the surface.

3. Steel-shod hand tampers or vibrating bars may be substituted in those cases where the use of mechanical spreader and tamper would be obviously impracticable.

4. Approved concrete vibrating equipment shall be used in conjunction with the mechanical tamper to consolidate the concrete adjacent to the forms or existing pavement.

C. **Floating:**

1. After tamping, the surface of the concrete shall be floated by either the finishing machine method or the transverse float method described below.

2. Bridge decks may be floated by the longitudinal float method.

3. **Finishing Machine Method:** The concrete shall be floated smooth and true to grade with an approved finishing machine.

4. **Transverse Float Method:**

a. The concrete shall be floated at least twice with a long-handled float at least 5 feet wide, after which the surface of the concrete shall be finished smooth and true to grade with a wooden float 16 feet long, 2 inches thick, and 6 inches wide.

b. The float shall be rigidly ribbed and with adjustable screws between the rib and float board to ensure a true and flat surface on the underside at all times.

c. The float shall be operated from the side of the pavement, and parallel with the centerline.

d. 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.

e. Each successive pass of the float shall halflap the previous pass.

f. The float shall be operated as far behind the tamping machine as the workability of the concrete will permit before its initial set.

5. **Longitudinal Float Method:**

a. The concrete shall first be floated with a double-handled longitudinal float not less than 16 feet nor more than 20 feet in length, having a trowelling surface not less than 8 inches nor more than 10 inches wide.

b. The float shall be operated from bridges over the pavement with its length parallel to the centerline of the improvement, and shall be worked back and forth transversely across the slab, planing off high spots and filling depressions.

c. Floating shall continue until the surface is reasonably smooth, after which the bridges may be advanced not to exceed 2/3 the length of the surface so floated, and the operation continued.

D. After being finished by one of the above methods, the outside edges of pavement shall be rounded to a 1/2-inch radius; and transverse contact joints, expansion joints, and joints adjacent to an existing pavement shall be rounded to a 1/4-inch radius.

E. A strip of wetted burlap shall be provided, of a length not less than the width of the pavement slab.

1. The burlap shall be attached by 1 edge to a rigid frame supported over the pavement so that the free edge of the burlap will rest or drag on the surface of the concrete.

2. The burlap shall be dragged back and forth longitudinally along the pavement until the surface of the slab is of uniform texture appearance throughout its entire length.

409.03.09 JOINTS

A. Joints in concrete pavement will be designated as longitudinal and transverse contact joints, transverse expansion joints, and longitudinal and transverse weakened plane joints. Unless otherwise specified:

1. Transverse joints shall be constructed perpendicular to the centerline of the pavement.

2. Longitudinal joints shall be constructed parallel to the centerline of the pavement.

3. The faces of all joints shall be perpendicular to the finished surface of the pavement.

B. Joint filler, when required, will be as designated on the plans or in the Special Provisions.

C. **Contact Joints:**

1. Contact joints are those made by placing fresh concrete against hardened concrete at planned locations. Contact joints shall be constructed at the locations and in the manner shown on the plans.

2. Longitudinal contact joints shall be constructed by one of the following methods: A plain face, the use of tie bars, or the construction of keyways. Tie bars or keyways will be as designated on the plans or in the Special Provisions.

D. **Transverse Expansion Joints:**

1. Transverse expansion joints shall be installed at locations shown on the plans.

2. Expansion joint filler material shall have a minimum thickness of 1/2 inch, a maximum thickness of 3/4 inch, and a depth equal to the thickness of the pavement, and shall be composed of materials as specified in the Special Provisions or approved by the Engineer.

3. After the concrete has been finished, an edger of 1/4-inch radius shall be used on each side of the expansion joint filler. The expansion joint filler shall be cleaned of all concrete mortar.

E. **Weakened Plane Joints:**

1. Weakened plane joints shall be constructed at the locations shown on the plans and shall be formed by cutting a groove in the pavement with a power driven saw.

a. The groove for a transverse joint shall be cut to a minimum depth of 1-1/2 inches or 1/6 of the pavement thickness, whichever is greater; the groove for a

longitudinal joint shall be cut to a depth of 1/4 of the pavement thickness; and the width shall be a minimum width possible with the saw being used, but in no case shall the width exceed 1/4 inch.

b. Any portion of the sealing compound which has been disturbed by sawing operations shall be restored by spraying the areas with additional sealing compound.

c. In the initial lane of concrete, the first transverse weakened plane joint immediately following a transverse contact joint, and every fourth weakened plane joint thereafter, shall be sawed within 10 to 24 hours after the concrete has been placed.

d. The time lapse will be subject to the approval of the Engineer.

e. Every second transverse weakened plane joint shall be sawed within 24 hours after the concrete is placed, and the remaining weakened plane joints may be sawed at such time as the Contractor may elect; except that in any lane, all weakened plane joints shall be sawed before concrete is placed in succeeding adjacent lanes and before any traffic whatsoever is permitted to use the pavement.

2. In succeeding adjacent lanes of concrete pavement, transverse weakened plane joints opposite those which have been sawed in the initial lane shall be sawed within 10 to 24 hours after the concrete has been placed.

a. The time lapse will be subject to the approval of the Engineer.

b. In all cases, no more than three consecutive transverse weakened plane joints shall be bypassed.

3. At the option of the Contractor, longitudinal weakened plane joints may be used at traffic lane lines in multi-lane monolithic concrete pavement in lieu of longitudinal contact joints. Dowel requirements will be as designated on the plans or in the Special Provisions.

409.03.10 CURING

A. **General:**

1. All Portland cement concrete pavement shall be cured for 72 hours by the methods specified in this section, subject to the conditions set forth in Subsection 501.03.09.A.1, "General."

2. 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:**

1. Curing by use of curing compound shall be as specified in Subsection 501.03.09.A.3, "Curing Compound Method." The curing compound shall not be applied until all patching and surface finishing, except grinding, have been completed.

2. 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 or until the Engineer determines that a cooling effect is no longer required.

C. **Waterproof Membrane Method:** Curing by use of waterproof membrane material shall be as specified in Subsection 501.03.09.A.4, "Waterproof Membrane."

409.03.11 PROTECTION OF PAVEMENT

A. Concrete shall not be placed on frozen ground nor shall concrete be mixed or placed while the atmospheric temperature is below 35 degrees F unless adequate means are employed to heat the aggregates and water, and provision satisfactory to the Engineer has been made for protecting the work.

B. Placing the concrete shall be stopped before rainfall is sufficient to cause a flow or wash the surface.

C. Upon written notice from the Engineer, all concrete which has been damaged shall be replaced by the Contractor at no additional cost to the Contracting Agency.

D. All concrete in pavement shall be protected from freezing or frost for a period of 5 days after placing. The temperature of the surface of the concrete shall not be allowed to drop below 40 degrees F for this period of 5 days.

E. When ordered by the Engineer or shown in the contract documents, pavement crossings shall be constructed for the convenience of public traffic.

1. The material and work necessary for the construction of these ramps, and subsequent removal and disposal of the ramps, will be paid for at the contract unit prices for the items of work involved.

2. 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."

3. Where public traffic will be required to cross over the new pavement, Type III Portland cement shall be used in concrete.

4. 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 450 psi.

F. No traffic or Contractor's equipment, except for subgrading equipment, will be permitted on the pavement before a period of 10 calendar days has elapsed after the concrete has been placed, nor before the concrete has developed a modulus of rupture of at least 450 psi, as determined by Test Method ASTM C293. Concrete that fails to attain a modulus of rupture of 450 psi within 10 days shall not be opened to traffic until directed by the Engineer.

G. Equipment used to prepare subgrade may be permitted to ride upon one edge of the previously placed concrete at the end of 72 hours, provided, however, that no damage is done to the pavement edge by reason of such operation. Any damage to the pavement resulting from such operations shall be repaired by the Contractor at no additional cost to the Contracting Agency prior to placing the adjacent lane.

METHOD OF MEASUREMENT

409.04.01 MEASUREMENT

A. 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.

B. Preformed joint sealer in weakened plane joints will be measured by the linear foot of the sealed joint. Preformed joint filler in transverse expansion joints and preformed polyethylene joint filler in 4-inch joints will be measured by the linear foot of joint filler complete in place.

C. Tie bars will not be measured for payment.

D. The length of sawed joint for preformed polyethylene joint sealer shall be the length in feet of the joint.

E. 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.E, "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.

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

BASIS OF PAYMENT

409.05.01 PAYMENT

A. The accepted quantities measured as provided in Subsection 409.04.01, "Measurement," will be paid for at the contract unit price bid per square yard for Portland cement concrete pavement.

B. 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.

C. Payment for reconstructing or adjusting manholes to grade will be made as a separate item as provided in Subsection 609.05.01, "Payment." If no such item is provided, payment will be deemed included in the other items of work.

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

E. Partial payments for Portland cement concrete payment may be made as set forth under Subsection 109.06, "Partial Payment."

F. 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	Linear Foot
Reinforcing Steel	Pound

SECTION 412

PAVEMENT SURFACE TREATMENTS - SLURRY SEAL/MICROSURFACING

DESCRIPTION

412.01.01 GENERAL

A. This work shall consist of the application of a mixture of mineral aggregate, emulsified asphalt, water, and additives on a previously compacted and bonded bituminous surface, in accordance with these specifications and in conformity with the lines shown on the plans or established by the Engineer.

MATERIALS

412.02.01 ASPHALT EMULSION

A. The asphalt emulsion shall be LMCQS-1h.

B. Each shipment of emulsified asphalt shall be accompanied with a certificate of analysis/ compliance from the manufacturer.

C. When the daily high ambient temperature is below 80 degrees F, the Contractor shall chemically modify the emulsion to accelerate the break and set times.

D. The emulsion modifier shall be adjusted at the emulsion manufacturer's facility.

E. The asphalt emulsion shall comply with Section 703, "Bituminous Materials."

412.02.02 POLYMER MODIFIERS

A. The polymer modifier shall be either a solid synthetic rubber or latex material.

B. The polymer modifier shall be combined with the emulsion by co-milling with the manufacture of the asphalt emulsion at a minimum rate of 3 percent polymer solids by weight of the base asphalt in the emulsion prior to loading at the emulsion plant.

C. If the contract includes quantities for conventional slurry seal, the polymer modified emulsion shall be compatible with the mix design developed for the conventional slurry seal.

412.02.03 COMMERCIAL MINERAL FILLER

A. The mineral filler shall be considered a part of the mineral aggregate and shall comply with Section 705, "Aggregates for Bituminous Courses."

B. The quantity of filler shall be determined by the job mix design. Filler shall be used for one or more of the following reasons only:

1. To improve the gradation of the aggregate.
2. To provide improved stability and workability of the slurry.
3. To increase the durability of the cured slurry.

412.02.04 CARBON BLACK

A. If specified, carbon black shall be added to the slurry seal mixture at a minimum 2 percent to maximum 3 percent based on the weight of the emulsion.

B. The product shall be MonoChem perma-black 115A, 2847A, or equal as approved by the Engineer:

Specifications	**Tolerances**
Total Solids	40-44
Percent Black by Weight	35-37
Type Black	Medium furnace color

412.02.05 SET CONTROL ADDITIVE

A. The set control additive shall be aluminum sulfate, or Portland Type I/II cement, or other approved additive previously included in the mix design.

B. The quantity of set control additive shall be field adjusted to provide the specified mix properties.

412.02.06 WATER

A. Water for the slurry mixture shall conform to Section 722, "Water," and be clear, potable, free from harmful soluble salts, and compatible with the slurry mixture.

412.02.07 MINERAL AGGREGATE

A. The mineral aggregate shall conform to the specified contract gradations for ISSA Type I, Type II, or Type III.

B. Mineral aggregate shall be 100 percent manufactured crushed stone that is free from dirt, organic matter, clay balls, adherent films of clay, dust, or other objectionable matter.

C. The parent rock used in the manufacturing shall have a normal size greater than 1/2 inch and shall comply with Section 705, “Aggregates for Bituminous Courses.”

D. Aggregate sources may be required to be evaluated for use based upon petrographic examination in accordance with ASTM C295. Such tests shall be at no additional cost to the Contracting Agency.

CONSTRUCTION

412.03.01 SLURRY SEAL/MICROSURFACING MIXTURES

A. Slurry Seal Mixtures:

1. The slurry seal shall consist of a mixture of emulsified asphalt; mineral aggregate; mineral filler and carbon black, if required; set control additive; and water.
2. The mixture shall conform to ISSA Type I, Type II, and Type III gradations.
3. The mix shall be in accordance with this section and in accordance with Section 703, ”Bituminous Materials,” Section 705, ”Aggregates for Bituminous Courses,” and Section 722, “Water.”
4. The mixture shall be proportioned, mixed, and spread evenly on a prepared surface in accordance with these specifications or as directed by the Engineer.
5. The completed slurry seal shall leave a homogeneous mat, adhere firmly to the prepared surface, and have a friction-resistant surface texture throughout its service life.

B. Microsurfacing Mixtures:

1. Mixtures shall be capable of being spread in varying cross sections (wedges, wheel path depressions, leveling courses, and surfaces) which, after curing and initial

traffic consolidation, resist compaction throughout the entire design tolerance range of bitumen content and the various thicknesses encountered.

2. The blended mixture shall have proper workability during lay-down and shall permit traffic loading within 1 hour after placement, without the occurrence of bleeding, raveling, separation, or other distresses.

C. Prior to the start of work, the Contractor shall place 2 test sections of at least 1,500 square yards each, for each mix to be used, in an area designated by the Engineer.

1. The test section shall be placed using the same equipment, methods, and mixes as scheduled for use on the Contract.

2. At these test sections, the Contractor shall also satisfactorily demonstrate the equipment and procedure intended for the removal of oil deposits from the pavement surface.

3. The test sections will be evaluated for a minimum of 3 days after placement under traffic and normal usage.

4. If a test section proves to be unsatisfactory, the necessary adjustments to the mix design, equipment, and placement methods shall be made.

5. Additional test sections, as required, shall be constructed and evaluated for conformance to the specifications.

6. The 2 initial test sections, if acceptable, will be paid for at the contract unit price.

D. When the test sections do not conform to the specification requirements, the slurry seal shall be removed at no additional cost to the Contracting Agency.

1. No compensation will be made for reapplication or additional test sections required due to unsatisfactory work or material.

2. Initiation of work on the project streets shall not begin without the Engineer's approval of test sections.

E. The equipment, tools, and machines needed in the performance of the work shall be provided by the Contractor, shall be subject to the approval of the Engineer, and shall be maintained in a satisfactory working condition at all times.

F. **Job Mix Design:**

1. No slurry or microsurfacing mixture shall be placed until mix design(s) submitted by the Contractor have been approved by the Engineer.

2. Sources of all materials shall be selected prior to the time when the mix design is prepared and the materials are required to be used in the work.

3. The exact proportions used in the preparation of the slurry seal or microsurfacing shall be determined by a testing laboratory, experienced in slurry seal and microsurfacing mix design procedures, and approved by the Engineer.

4. Mix design preparation shall conform to Section 703, "Bituminous Materials," and shall be at no additional cost to the Contracting Agency.

5. The approved mixture shall be homogenous and sufficiently stable during the entire mixing and spreading period so that:

a. The emulsion does not break prematurely.

b. There is no segregation of the fines from the coarser aggregate.

c. The liquid portion of the mix does not float to the surface.

6. The amount and type of asphalt emulsion to be blended with aggregate shall be determined by the laboratory mix design.

7. The set control additive shall be introduced into the slurry mix by an approved method that will ensure uniform distribution and proper control. The exact amount shall be determined by conditions in the field and indicated in the mix design.

8. A minimum amount of water, added as specified by the Engineer, shall be used as necessary to obtain a workable and homogeneous mixture.

9. The slurry mixture shall show no signs of uncoated aggregate or premature breaking of emulsion when applied to the pavement surface.

G. **Sampling and Testing:**

1. Suitably sized samples of aggregate, bituminous material, and mineral filler shall be submitted, when required by the Engineer, for approval not less than 10 days before the work starts. All samples of materials shall be supplied by the Contractor at no additional cost to the Contracting Agency.

2. All tests deemed necessary by the Contracting Agency to determine conformance with requirements specified shall be performed without cost to the Contractor.

3. Additional samples of materials shall be furnished as directed by the Engineer during progress of the work.

4. The aggregate manufacturer shall produce and stockpile each specified gradation of aggregate in 500-ton lots. The first lot of material shall be sampled and tested by the Engineer.

5. Certification of Lot 1 shall be based upon the averaged test values from 5 samples.

   a. The approved gradation of Lot 1 shall be the “job target gradation.”

   b. The stockpile tolerance identified in Section 705, “Aggregates for Bituminous Courses,” shall be applied to this gradation.

6. Each successive lot of 500 tons shall be sampled and tested once.

   a. When the “job target gradation” has been tested and accepted, the Contractor shall continuously manufacture the aggregate until the total estimated quantity is produced, tested, and accepted.

   b. The Contractor shall not receive compensation for unused aggregate.

   c. The approved lots of aggregate shall be stockpiled in a secured area, protected from contamination, and reserved for use on this contract.

7. If it is established that a satisfactory mixture meeting the requirements specified herein cannot be produced from the materials furnished, the materials shall be rejected and the Contractor shall submit new samples.

412.03.02 PREPARATION OF SURFACE

A. At least two weeks prior to cleaning and slurry sealing the streets, an application of Pramitol 25E herbicide as distributed by Universal Cooperatives, Inc., Minneapolis, MN 55440, or an equal product as approved by the Engineer, shall be applied to all vegetation within the limits of curb flow line to curb flow line.

1. At the direction of the Engineer, multiple applications of herbicide may be required to ensure complete kill of vegetation.
2. No additional compensation will be made for multiple applications of herbicide.
3. Extreme care shall be used when placing the herbicide to ensure that it is not allowed to go beyond the intended limits.
4. The Contractor shall be responsible for licenses required and for damage to any plant or animal caused by the Contractor's operations.

B. Immediately prior to applying the slurry seal, the existing pavement surface shall be cleaned of all silt deposits, oil spots, vegetation, and all loose or objectionable material.

C. At the direction of the Engineer, if the pavement cracks have not been previously sealed, the loose material in cracks shall be removed as follows:

1. Compressed Air: 90 psi at the nozzle immediately before sweeping or vacuuming operations.
2. Pressurized Water: Not greater than 1,000 psi at the nozzle prior to sweeping or vacuuming operations. The cracks may be damp but shall not have freestanding water in the crack.
3. All surface debris from the crack cleaning process shall be thoroughly cleaned prior to placement of slurry seal. Payment for crack cleaning shall be by force account.
4. In urban areas, the surface shall be cleaned with a self-propelled pick-up sweeper. In rural areas, power brooms may be used.
5. Water flushing will be permitted by approval of the Engineer when normal sweeping will not adequately remove debris from the surface. If water flushing is approved, the pavement shall be dry before the slurry seal is applied.

D. Areas impregnated with grease, oil, or fuel shall be cleaned by grinding.

1. Traffic paint not tightly bonded to the surface and any thermoplastic markings shall also be removed.
2. The grinding machine used to remove the existing bituminous surface, paint, and pavement markings shall meet the following requirements:
   a. Be a hydrostatically powered mandrel type device.
   b. The mandrel shall be studded with a minimum of 72 cutter bits to provide a pavement texture acceptable to the Engineer.
   c. Bits shall have tungsten carbide tips in forged steel holders and be conical in shape.
   d. The mandrel device shall have a minimum cutting width of 24 inches and a variable cutting depth of zero to 4 inches.
3. Areas inaccessible to the grinder shall be treated and prepared with an alternate method approved by the Engineer.
4. The debris produced by the grinding machine or other method shall be immediately removed from the pavement surface and disposed of at an acceptable location.
5. The Contractor shall protect existing facilities (i.e., concrete, valve boxes, manholes, and so forth).
6. Damaged facilities shall be replaced at the direction of the Engineer and at no additional cost to the Contracting Agency.

E. The Engineer shall give final approval that the surface has been properly prepared prior to the application of the slurry. This approval shall not relieve the Contractor from responsibility as outlined above.

F. Prior to application of the slurry or microsurfacing, manholes, valve boxes, drop inlets, and other service entrances shall be protected by covering with paper, plastic, or other suitable material approved by the Engineer. The paper shall be held in place with spray glue or tape and removed within 24 hours after slurry seal has cured.

G. Raised pavement markers not scheduled for reinstallation shall be covered, washed off, or protected from the slurry by a method approved by the Engineer.

412.03.03 MIXING UNIT

A. The slurry seal or microsurfacing shall be mixed and applied with a machine designed and manufactured to lay the mixture.

B. Self-loading mixing units shall not be used on roadway right-of-way widths of 60 feet or less.

C. The mixing machine shall meet the following requirements:

1. A continuous flow mixing unit, automatically sequenced.
2. Capable of delivering accurately predetermined proportions of aggregate, water, and asphalt emulsion to a revolving multi-blade, double-shafted, spiraled mixer tank.
3. Capable of discharging the thoroughly mixed product on a continuous basis.
4. Equipped with a hydraulically controlled steel pugmill gate for positive discharge operations. Discharge from the pugmill shall be controlled by a chute or other suitable mechanical device.
5. Equipped with a metering system to accurately meter all liquids by volume by the use of flow meters reading gallons per minute. The flow of the liquids shall be consistent and precise and feed into the pugmill in the proportions outlined in the mix design.
6. Equipped with a temperature-indicating device installed in the emulsion tank at the emulsion pump suction line level.
7. Capable of thoroughly blending all ingredients together without violent action.
8. Equipped with an approved fines feeder that provides an accurate metering device or method of introducing a predetermined proportion of mineral filler into the mixer as the aggregate is fed in. The fines feeder shall be used when mineral filler is part of the aggregate blend.
9. Equipped with a water pressure system and fog type spray bar.
10. Capable of mixing materials at preset proportions regardless of the speed of machine and without changing machine settings.

D. Each mixing unit to be used in performance of the work shall be calibrated prior to construction.

1. Previous calibration documentation covering the exact materials to be used may be accepted provided they were made during the current calendar year.
2. The documentation shall include an individual calibration for each type of material to be used on the project.

E. The Contractor shall ensure that all equipment used to transport materials and mixing units on public roadways comply with Nevada Revised Statutes Sections 484.764 through 484.771. If special use permits are required, the Contractor shall provide the Engineer with copies.

F. **Slurry Seal Spreader Box:**

1. The slurry seal shall be spread with a box specifically designed to place slurry seal.
2. The mixture shall be spread uniformly by means of a conventional slurry seal surfacing spreader box attached to the mixer.
3. Front, rear, and side seals shall be provided to ensure no loss of the mixture at the pavement contact point. The rear seal shall be provided to act as a final strike-off and shall be adjustable.
4. The spreader box and rear strike-off shall be so designed and operated that a uniform consistency is achieved to produce a free flow of material to the rear strike-off.
5. Augers within the box may be required due the consistency of the material and the pavement slope. The spreader box shall have suitable means provided to side shift the box to compensate for variations in the pavement geometry.
6. A burlap drag or other approved material shall be attached to the rear of the spreader box to provide a uniform, highly textured mat. If used, the burlap drag shall be clean, flexible, and not leave drag or scour marks in the finished slurry seal surface.
7. The spreader box shall be kept clean and buildup of asphalt and aggregate on the box shall not be permitted.

G. **Microsurfacing Spreader Box:**

1. The microsurfacing shall be placed with a spreader box specifically designed to place microsurfacing. Conventional slurry seal boxes will not be allowed to spread microsurfacing.
2. Attached to the mixer machine shall be a mechanical spreader box capable of placing the microsurfacing at a minimum width of 12 feet and preventing the loss of microsurfacing materials from the box.
3. The spreader box shall have baffles, reversible hydraulic motor driven augers, or paddles to ensure uniform application on superelevated sections and shoulder slopes.
4. The mixture shall be agitated and spread uniformly within the spreader box by means of twin shafted paddles or spiral augers fixed within the spreader box.
5. Spreader box skids shall be a minimum of 6 feet in length and maintained in such a manner as to prevent chatter (washboarding of the surface) in the finished mat.
6. The spreader box shall have suitable means provided to side shift the box to compensate for variations in the pavement geometry.
7. The spreader box shall have a series of strike-off devices at the rear of the box:
   a. The leading strike-off device shall meet the following requirements:
      1) Fabricated of steel, stiff rubber, or other suitable material.
      2) Designed to maintain close contact with the pavement during spreading operations.
      3) Shall obtain the uniform thickness required.

4) Shall be capable of being adjusted to the various pavement cross sections for the application of a uniform microsurfacing finished surface.

b. The final strike-off device shall meet the following requirements:

1) Fabricated of flexible material suitable for the intended use.

2) Shall be designed and operated to ensure that a uniform texture is achieved in the finished surface of the microsurfacing.

3) Shall have the same type of adjustments as the spreader box.

8. The final strike-off shall be cleaned daily and changed if problems with longitudinal drag marks or scouring occur.

9. The spreader box shall be kept clean and buildup of asphalt and aggregate on the box shall not be permitted.

H. **Rut Filling Box:**

1. When required in the specifications, before the final surface course is placed with the spreader box, preliminary microsurfacing may be required to fill ruts, utility cuts, depressions in the existing surface, and so forth.

2. Ruts of 1/2 inch or greater in depth shall be filled independently with a rut-filling spreader box, either 5 feet or 6 feet in width.

3. For irregular or shallow rutting of less than 1/2 inch in depth, a full-width scratch-coat pass may be used as directed by the Engineer.

4. Ruts that are in excess of 1-1/2 inches in depth may require multiple placements with the rut-filling spreader box to restore the cross-section.

5. All rut-filling level-up material shall cure under traffic for at least a 24-hour period before additional material is placed on top of the level-up course.

6. The spreader box shall be kept clean and buildup of asphalt and aggregate on the box shall not be permitted.

412.03.04 MIX PREPARATION

A. The Contractor shall ensure that all oversized aggregate particles and other objectionable matter is removed from the mineral aggregate utilized in the slurry mix.

B. At the direction of the Engineer, the aggregate shall be screened prior to loading into the mixing unit.

1. Type I and II gradations shall be screened through a 3/8-inch screen.

2. Type III gradation shall be screened through a 1/2-inch screen.

3. With the approval of the Engineer, temporary use of screens attached to the distributor box will be permitted.

C. The aggregate shall be moistened immediately prior to mixing with the emulsion.

412.03.05 WATER FOG

A. Immediately prior to application of the slurry seal, the surface of the pavement and all crack faces shall be moistened with a fog spray of water, applied at the rate of 0.02 to 0.05 gallon per square yard from the spray bar on the slurry seal machine.

B. No free water shall be on the surface of the pavement following the fog spray.

C. Rate of application of the fog spray shall be adjusted during the day to suit pavement temperatures, surface texture, humidity, and dryness of pavement surface.

412.03.06 APPLICATION

A. Sufficient quantities of the slurry seal or microsurfacing mixture shall be fed into the spreader box so that uniform and complete coverage of the pavement is obtained.

B. The mixing machine shall be operated at such a speed that the mixture in the spreader box shall not exceed a total mixing time of 4 minutes and the volume shall remain essentially constant.

C. The slurry seal shall be placed in accordance with the following:

Aggregate	Application Rate (pounds per square yard)
Type I	8-12
Type II	12-20
Type III	18-30

D. The application rate shall be adjusted for the surface texture of the pavement to ensure effective embedment of the aggregate and the durability of the surface treatment.

E. The Contractor shall submit the following signed, written reports to the Engineer each working day:

1. A report indicating the amount of aggregate and emulsion delivered, aggregate and emulsion used on the project, and the amount of area in square yards completed.

2. A report indicating the percentage of emulsion used to aggregate used and the application rate in pounds of aggregate applied per square yard of area covered. This report will verify compliance with the mixture of materials to the mix design and the specified aggregate application rate.

F. The Contractor shall submit to the Engineer from the aggregate and emulsion suppliers an original copy of the bill of lading daily for each delivery of material to be used on the project. The Contractor shall submit with each emulsion bill of lading a certificate of compliance from the emulsion supplier verifying that each delivery of emulsion is in compliance with the contract requirements.

G. If uniform thickness cannot be met with one application due to irregularities in pavement surface, multiple applications shall be made.

1. Where multiple applications are required, as determined by the Engineer, each application shall be thoroughly cured before another application is placed.

2. Any additional applications will be paid at the unit price bid.

H. No streaks caused by oversized aggregate particles or buildup of slurry mix on squeegees shall be left in the finished surface.

412.03.07 JOINTS

A. The longitudinal joint between adjacent lanes shall have no visible lap, pinholes, or uncovered areas.

B. Thick spots caused by overlapping shall be smoothed immediately with hand squeegees before the emulsion breaks.

C. Overlaps that occur at transverse joints shall also be smoothed before the emulsion breaks, to obtain a uniform surface with no discontinuities.

412.03.08 PRODUCTION

A. The Contractor shall average a minimum of 20,000 square yards of material, in place, per working day for work within the public right-of-way.

B. At the direction of the Engineer, parking lot applications, heavy application rates, and areas not feasible to close entirely are excluded from the required production rate.

412.03.09 LINES

A. Care shall be taken to ensure straight lines along curbs and shoulders.

B. No runoff on these areas will be permitted.

C. Lines at intersections shall be kept straight to provide a good appearance.

412.03.10 HANDWORK

A. Approved hand squeegees, with burlap drags, shall be used to spread slurry in areas not accessible to the slurry spreader box.

B. Care shall be exercised in leaving no unsightly appearance from handwork.

412.03.11 CURING

A. Areas receiving slurry seal will be allowed to cure from 4 to 24 hours or until the treated pavement will not be damaged by traffic.

B. Areas receiving microsurfacing shall be sufficiently cured to be open to traffic within 1 hour.

C. The Contractor shall protect the area for the full curing period with suitable barricades or markers.

D. Areas that are damaged within 24 hours of application of slurry or prior to moving to new work locations shall be repaired by the Contractor at no additional cost to the Contracting Agency.

412.03.12 ROLLING

A. Slurry seal placed on parking lots, alleys, or low traffic volume areas as determined by the Engineer shall be compacted with a smooth pneumatic tire roller with a minimum weight of 4 tons.

B. The roller shall be equipped with a water tank and a sprinkler apparatus which shall be used to keep the wheels damp and to prevent the adherence of slurry seal on the wheels during the rolling process.

C. Steel wheel rollers may be used in a supplementary capacity when approved by the Engineer.

D. Rolling shall start when the slurry seal/microsurfacing has set sufficiently to prevent any pickup of material and rolled a minimum of 3 coverages by the roller or until a uniform surface is obtained.

412.03.13 WEATHER LIMITATIONS

A. Slurry seal or microsurfacing shall be applied only when the atmospheric temperature is 65 degrees F and rising and when the temperature is not expected to fall below 60 degrees F during working hours.

B. Application of slurry seal or microsurfacing when the atmospheric temperatures are expected to exceed 105 degrees F will not be allowed.

C. The maximum and minimum temperatures may be adjusted by the Engineer.

D. High relative humidity or overcast conditions causing prolonged cure times or undesirable color shall be cause for stopping the work.

412.03.14 MAINTAINING TRAFFIC

A. The seal coat shall be applied to alternating streets to provide sufficient public parking for those residents living on streets that have been closed.

   1. Traffic will not be allowed on the newly placed bituminous material until, in the opinion of the Engineer, the bituminous material has sufficiently set and bonded to prevent damage by vehicular traffic.

   2. Areas that are subject to an increased rate of sharp turning vehicles may require additional time to allow for a more complete cure of the slurry seal mat to prevent damage.

   3. Street closures shall be opened as soon as the material has sufficiently set and bonded.

B. The Contractor shall cooperate with and give written notice to all emergency agencies, public entities, each home, homeowners' association, business, and school that will be affected by any part of the construction process, particularly concerning temporary interruptions to vehicular access. To accomplish the notification process, the Contractor shall provide a minimum of 2 notifications:

   1. The first written notice of the approximate schedule and explanation of the work process shall be distributed at least 7 days prior to the commencement of work in the area.

   2. A second written notice shall be distributed at least 24 hours prior to construction to remind all affected parties of the construction to take place.

C. The Contractor shall employ a qualified traffic control supervisor to be on-site locally at all times when traffic control devices are being used or when notifications have been sent out.

412.03.15 TRAFFIC MARKINGS

A. Prior to removal of street closure barricading, all raised pavement markers shall be exposed.

B. Temporary reflective polyurethane plastic marker tabs shall be installed prior to the application of slurry seal on streets where permanent markings are scheduled for replacement.

C. Temporary traffic markings shall comply with Section 6, “Temporary Traffic Control," of the MUTCD.

412.03.16 STORAGE OF EQUIPMENT AND MATERIALS

A. Materials shall be stored in an area to prevent water saturation and contamination of stockpiled aggregates.

B. Written authorization to use private property to store equipment and materials shall be obtained from the property owner and submitted prior to mobilization and use. The Contractor shall also submit a letter of indemnification to the Contracting Agency and the property owner.

412.03.17 CLEANUP

A. All material swept or blown onto the sidewalks, all trash, all discarded slurry seal material, and other refuse shall be collected on a daily basis, removed from the site, and disposed of to a site approved by the Engineer.

B. All applied slurry seal/microsurfacing surfaces shall be swept by the Contractor with an approved sweeper to remove any excess raveled material that becomes dislodged from the street surface after 5 days.

1. Dislodged material from the street shall be disposed of to a site approved by the Engineer.

2. Sweeping required beyond the initial 5-day cure due to normal raveling shall be paid for under the appropriate bid item for sweeping.

412.03.18 CONTRACTOR'S RESPONSIBILITY TO THE PUBLIC

A. The Contractor shall be responsible for answering and resolving any conflicts that may arise between a homeowner or business owner and the Contractor during the construction process.

METHOD OF MEASUREMENT

412.04.01 MEASUREMENT

A. The quantity of slurry seal or microsurfacing measured for payment will be the number of square yards of Type I, Type II, or Type III material applied and conforming to all the requirements of the completed work.

B. Surface preparation prior to the application of slurry seal or microsurfacing shall be the number of hours spent performing grinding operations.

C. Ravel sweeping, including disposal of excess material, shall be based on the number of hours spent sweeping at the direction of the Engineer.

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

BASIS OF PAYMENT

412.05.01 PAYMENT

A. Payment at the unit price bid for the accepted quantity of slurry seal or microsurfacing measured as provided in Subsection 412.04.01, “Measurement,” shall be full compensation for developing the mix design, furnishing the material, mixing, hauling, loading, placing, rolling, and any incidentals for doing all the work involved in placing the material.

B. Payment at the unit prices bid for surface preparation and ravel sweeping shall be full compensation for all work involved to complete the items.

C. Payment at the unit price bid for the addition of carbon black to the slurry seal or microsurfacing mixture shall be full compensation for all work involved in its use.

D. All payments will be made in accordance with Subsection 109.02, “Scope of Payment.”

E. Payment will be made under:

PAY ITEM	PAY UNIT
Application of Polymer Modified Type I, II, or III Slurry Seal	Square Yard
Application of Type III Microsurfacing	Square Yard
Surface Grinding	Hour
Ravel Sweeping	Hour
Carbon Black Additive (optional)	Gallon

SECTION 413

PLANTMIX BITUMINOUS GAP-GRADED SURFACE

DESCRIPTION

413.01.01 GENERAL

A. This work shall consist of placing a gap-graded wearing course, bonded to the surface, in accordance with these specifications and in conformity with the lines, grades, thickness, and the typical cross sections shown on the plans or established by the Engineer.

B. The bonded wearing course shall consist of an application of a warm polymer modified asphalt emulsion to create a polymer modified membrane (PMM) followed immediately with a hot gap-graded ultra-thin asphalt concrete surface course (UTACS).

C. This work shall not be started until the Contractor has completed all heavy equipment work or any other work that could scar or mar the finished gap-graded surface.

D. The requirements of Section 401, "Plantmix Bituminous Pavements – General," shall be applicable to this work, except as hereinafter specified.

413.01.02 REFERENCE CODES AND STANDARDS

A. Related Interagency Quality Assurance Committee (IQAC) procedures at:

http://www.accessclarkcounty.com/depts/public_works/Pages/iqac.aspx

413.01.03 REQUIREMENTS

A. Persons involved with the placement of UTACS shall be trained by the manufacturer and/or the Nevada T2 Program.

MATERIALS

413.02.01 GENERAL MATERIALS

A. The materials shall conform to Subsection 401.02.01, "Composition of Mixtures," with the following exceptions:

1. Prior to starting work, the Contractor shall submit a proposed job-mix formula in writing for review and approval by the Engineer.
2. The proposed job-mix formula shall be determined by an AASHTO certified testing laboratory, using Nevada Alliance for Quality Transportation Construction (NAQTC) certified technicians, based on the tests required to determine the gradation and surface capacity for coarse aggregate.
3. The gradation shall be Type S1, S2, or S3 in accordance with Subsection 705.03.08, "Plantmix and Roadmix Asphalt Concrete Surface Course UTACS Type S1 through S3," and the contract Special Provisions.
4. The bituminous materials shall be PG76-22CC in accordance with Section 703.03.02, "Asphalt Cements."

413.02.02 COMPOSITION OF GAP-GRADED (UTACS) MIXTURE

A. The plantmix gap-graded Ultra-Thin Asphalt Concrete Surface (UTACS) mixture shall be composed of aggregates and bituminous materials as described in these specifications. The criteria for the design is based on Subsection 413.02.01, “General Materials,” above and the following:

1. Film Thickness (µm):

   a. Gradation surface area factor using the film thickness calculation based on effective asphalt content and aggregate surface area according to Asphalt Institute MS-2 Table 6.1.

   b. The minimum film thickness shall be 10 µm.

2. Specimens for AASHTO T283 testing shall be compacted using the Superpave gyratory compactor applying 100 gyrations or using the Marshall compactor applying 50 blows on each side of the 4-inch diameter sample.

   a. Use mix quantity necessary to obtain compacted samples 2.5 inches ±0.05 inch in height.

   b. Further test compacted samples regardless of air void levels achieved after 100 gyrations or 50 blows on each side.

   c. Apply vacuum to samples to be conditioned for 20 seconds and proceed without calculating percent saturation.

   d. Mixing and compaction temperatures are to be recommended by the binder supplier.

   e. The minimum moisture susceptibility shall be 80 percent retained strength.

3. The minimum air voids shall be 4 percent and the maximum aggregate surface shall be 26 square feet per pound.

4. Marshall stabilities are not required.

5. Gradation shall be in accordance with Subsection 705.03.08, "Plantmix and Roadmix Asphalt Concrete Surface Course UTACS Type S1 through S3" of Section 705, "Aggregates for Bituminous Courses."

6. The binder type shall be PG76-22CC as described in Section 703, "Bituminous Materials."

413.02.03 POLYMER MODIFIED MEMBRANE

A. The UTACS pavement shall consist of an application of a warm polymer modified membrane (PMM) asphalt emulsion, as specified under Section 703, "Bituminous Materials," followed immediately with an ultra-thin surface course of quality hot mix asphalt concrete.

B. The PMM emulsion shall be sprayed immediately prior to the application of the surface course so that no wheel or other part of the paving machine comes in contact with the PMM before the surface course is applied.

C. The process of applying the PMM, placement of the surface course, and screed compacting shall be performed in under 5 seconds during normal paving speeds, resulting in a homogeneous surface that can be opened to traffic immediately upon sufficient cooling to 160 degrees F or below.

D. The PMM target design application rate shall be in accordance with Table 1. The PMM application rates shall be adjusted in the field to account for the texture of the existing pavement, traffic, and project uniqueness.

TABLE 1 – PMM APPLICATION RATES

Gradation Type	Application Rate
S1	0.13 gal/sq yd
S2	0.15 gal/sq yd
S3	0.17 gal/sq yd

CONSTRUCTION

413.03.01 GENERAL CONSTRUCTION

A. The construction shall conform to Subsection 401.03.01, "Bituminous Mixing Plant," through Subsection 401.03.16, "Surfacing Miscellaneous Areas," with the exceptions below.

413.03.02 GAP-GRADED UTACS PAVING EQUIPMENT

A. The Contractor shall use a self-priming paver, designed and built for the purpose of applying the PMM bond and the UTACS pavement.

1. All other equipment and tools shall be approved by the Engineer.
2. All equipment and tools shall be maintained in satisfactory working condition at all times.

B. The self-priming machine shall meet the following requirements:

1. Be capable of spraying the PMM emulsion, applying the surface course overlay, and providing a smooth surface to the mat in 1 pass at the rate of 35.5 to 92 feet/minute.
2. Shall incorporate a receiving hopper, feed conveyor, insulated storage tank for PMM emulsion, electronic device to determine rate of emulsion application, metered PMM emulsion system, spray bar, and variable width.
3. The integrated distributor-paver shall be equipped with a full-width, heated vibratory screed that can spread and finish the bonded wearing course to the required cross section and grade that produces a uniformly finished surface free from tearing or other blemishes.

C. At all times during paving, the sump pump for excess spray bar emulsion shall be operating as indicated by the required warning light to prevent overflow of the tray. The screed shall have the ability to be crowned at the center, both positively and negatively, and have vertically adjustable extensions to accommodate the desired pavement profile.

D. The PMM shall be applied in accordance with the following:

1. With a mechanical pressure spray bar.
2. Within a tolerance of 0.018 gallon per square yard of the application rate.
3. At a uniform rate for the full paving width.

E. Rollers:

1. Rolling of the wearing course shall consist of a minimum of 2 passes with a steel double drum asphalt roller of minimum weight of 10 tons, before the material temperature has fallen below 185 degrees F.

2. At no time shall the roller or rollers be allowed to remain stationary on the freshly placed asphalt concrete.
3. Rolling shall immediately follow the placement of the UTACS with approved asphalt rollers.
4. Rollers shall be monitored to ensure the rollers are not picking up material and that the setting process is completed while the mat is above 185 degrees F.
5. Rollers shall be well maintained in reliable operating condition and be equipped with functioning water system and scrapers to prevent adhesion of the fresh mix onto the roller drums.
6. Adequate roller units shall be supplied so the rolling will be accomplished promptly following the placement of the material.
7. A release agent (added to the water system) may be required to prevent adhesion of the fresh mix to the roller drum and wheels.
8. Rolling shall normally be done in the static mode.

F. Sweepers: The Contractor shall have a minimum of 1 approved sweeper available at all times during the construction of the surface course to pick up loose material.

G. Material Transfer Vehicle (MTV): An MTV shall be used when placing UTACS, and shall meet the following requirements:

1. Able to remix the UTACS mixture to eliminate truck end segregation, minimize material temperature loss, and deliver a uniform mixture to the paver.
2. Self-propelled machine totally independent of the paver.
3. High-capacity truck unloading system to receive UTACS mix from the haul units.
4. Minimum 25-ton surge capacity to minimize paver start/stops and maximize trucking efficiency.
5. Equipped with a pivoting paver loading conveyor able to swing 55 degrees to either side to allow off-lane paving.

413.03.03 APPLICATION OF GAP-GRADED UTACS SURFACE

A. The UTACS pavement shall not be placed on wet pavement. The pavement surface temperature shall not be less than 50 degrees F and the ambient temperature shall not be less than 50 degrees F and rising.

B. The PMM shall be sprayed by a metered mechanical pressure spray bar at a temperature of 140 degrees F –180 degrees F.

1. The sprayer shall accurately and continuously monitor the rate of spray and provide a uniform application across the entire width to be overlaid.
2. The machine will be equipped with an electronic device by which the rate of emulsion application can be determined while the paver is in operation.
3. The PMM shall be applied manually where the screed extension or handwork is required outside the range of the machine mounted spray bar.
4. Over-application or double application of emulsion on the existing base shall not be permitted.

5. The mix design target PMM shot rate shall be adjusted based upon the existing pavement surface conditions, traffic, and project uniqueness, with the approval of the Engineer.

6. The PMM field-adjusted shot rate shall be reduced by 0.03 gallon/square yard within 150 feet of the intersection, to minimize the risk of flushing under the action of standing and slow moving traffic, unless a full-width mill transition has been specified in the plans.

7. The Contractor and Engineer shall establish an acceptable range for the spray rate.

8. The PMM shall have a minimum of 2 daily yield verifications to be reported to the Engineer, 1 at midway production and 1 at the end of production.

9. These reports shall be the sum of the rates documented each 100 linear foot by the Contractor QC Inspector.

C. The PMM application rate may be adjusted as directed by the Engineer based on the texture depth of the existing pavement measured according to ASTM E965, "Measuring Pavement Macrotexture Depth Using a Volumetric Technique." Suggestions to adjust the PMM application rate as a function of texture depth of the existing pavement are shown in Table 2.

D. No wheel or other part of the paving machine shall come in contact with the PMM before the surface course is applied. Contractor shall use placement operations and equipment that:

1. Keep surfaces clean and free of contamination and debris prior to placement of the polymer modified asphalt emulsion membrane.

2. Prevent tracking through the polymer modified asphalt emulsion membrane prior to placement of the gap-graded polymer modified asphalt concrete.

E. The surface course shall be applied at a temperature of 302 degrees F – 330 degrees F and shall be spread over the PMM less than 5 seconds after the application of the PMM during normal paving speeds.

TABLE 2 – PMM RATE ADJUSTMENTS DUE TO PAVEMENT TEXTURE

Pavement Type - Texture Description	Texture Depth Range (mm)	PMM Rate Correction	
		l/m2	gal/yd2
Flushed asphalt	<0.5	-0.04 to -0.27	-0.01 to -0.06
Black asphalt	0.5 to 1.0	0	0
Smooth asphalt, non-porous	1.0 to 1.2	0	0
Absorbent asphalt, slightly porous, oxidized	1.2 to 1.7	0.09	0.02
Slightly pocked asphalt, porous, oxidized	1.7 to 2.0	0.18	0.04
Badly pocked asphalt, porous, oxidized	>2.0	0.27	0.06
Asphalt milled surface	N/A	0	0
Asphalt within 150 ft of intersection without mill	N/A	-0.13	-0.03
Asphalt within 150 ft of intersection with mill	N/A	0	0

F. When filling the emulsion tank, no emulsion shall overflow into the paver hopper.

1. Should emulsion be spilled into the paver hopper, paving shall stop and all contaminated material shall be removed from the paver hopper.

2. Under no circumstances shall the contaminated material be placed on the roadway.

G. Overlapping or hot lapping of the bonded wearing course shall not be permitted when paving miscellaneous areas in order to achieve project layout requirements.

H. Material that has been placed through the paving screed or over the polymer modified asphalt emulsion membrane shall not be reintroduced into the paving process.

I. UTACS shall be applied at a thickness such that no aggregate is fractured.

1. The S3 mix shall be applied at a minimum 3/4-inch thickness.
2. The S2 mix shall be applied at a minimum 5/8-inch thickness.
3. The S1 mix shall be applied at a minimum of 9/16-inch thickness.

413.03.04 SURFACE PREPARATION FOR UTACS

A. The following items shall be performed prior to the commencement of paving operations and paid for under the appropriate bid item numbers:

1. Manhole covers, drains, grates, catch basins, and similar utility structures shall be protected and covered with building felt prior to paving, and shall also be clearly referenced for location and adjustment after paving.
2. Thermoplastic traffic markings shall be removed.
3. Pavement cracks and joints greater than 0.25 inches wide shall be cleaned and filled using an approved material and method.
   a. There shall be no over-banding of cracks which will be covered by UTACS.
   b. Crack sealing shall be completed at least 7 days prior to paving.
4. Surface irregularities greater than 1 inch deep shall be milled and/or filled with a material approved by the Engineer. All repairs shall be completed 1 week prior to paving or as recommended by the sealant manufacturer or the Engineer.
5. The entire pavement surface to be overlaid shall be thoroughly cleaned, giving special attention to accumulated mud and debris. Pressurized water and/or vacuum systems may be required to ensure a clean surface.
6. Cold planing shall be completed as specified herein.

413.03.05 JOINTS

A. Longitudinal joints shall be constructed only on the shoulders or at the edge of the travel lanes.

413.03.06 QUALITY CONTROL ASPECTS

A. PMM application rate shall be checked twice per day using random sample location techniques.

B. Determination of the application rate of the PMM shall be as follows:

1. At the location to be sampled, immediately adjacent to the paving area, use 2 pads approximately 3.3 feet wide by 3.3 feet long to determine the PMM application rate based on the average of 2 application rate measurements.
2. Capture the tare weight of each pad to be used prior to capturing the PMM sample.
3. Place the first pad 5 feet in front of spray bar on the spray paver.
4. Place the second pad in front of the first pad farther away in the travel direction.

5. Set the machine in automatic mode; do not use manual mode when calibrating emulsion application rate.
6. Circulate the emulsion through the spray bars for approximately 5 minutes before spray calibration in order to purge the system.
7. Select the machine ground speed/production rate to be no less than 30 feet per minute.
8. Select the desired emulsion application rate and take a sample at this setting.
9. Weigh each pad that has been sprayed with the PMM.
10. Calculate the net weight of emulsion and convert it into gallons using the PMM weight-per-gallon information provided by the emulsion manufacturer.
11. Divide the gallons of PMM by the pad area and compare with the target application rate in gallon per square yard.

C. A minimum of 3 daily samples of the bituminous wearing course shall be tested for asphalt content and gradation.

1. If the average of the daily test results vary from the job-mix formula by more than the tolerance indicated in Subsection 705.03.08, "Plantmix and Roadmix Asphalt Concrete Surface Course UTACS Type S1 through Type S3," production shall stop.
2. The Contractor shall identify the cause and document what corrective action will be taken.
3. The job-mix formula may be adjusted only as approved by the Engineer.

D. A minimum of 2 daily UTACS mixture yield checks shall be completed, 1 at midday during production and 1 at the end of the day's production, to ensure that mixture application rate requirements defined in Subsection 413.03.03, "Application of Gap-Graded UTACS Surface," are met.

E. Placement Limitations: The UTACS and/or PMM shall not be placed on pavement that has visible surface moisture.

F. The Contractor shall immediately cease operations if any precipitation occurs. If any material is placed during the precipitation event, such material shall be removed and replaced, as directed by the Engineer, at no additional cost to the Contracting Agency.

G. Place UTACS and/or PMM only when the pavement surface temperature is 50º F and rising and the ambient temperature is 50 degrees F and rising.

H. The UTACS shall not be placed if the forecast low from the National Weather Service is 32 degrees F or lower for the night following any single day's paving operation.

I. Because of the minimal depth of the surface course being placed, the course may be damaged if opened to traffic too quickly. Therefore, the new UTACS pavement shall not be opened to traffic until the rolling operation is complete and the material has cooled sufficiently to resist damage (approximately 160 degrees F).

J. No more than 15 minutes shall be allowed to elapse between the delivery trucks carrying the UTACS mix to the paver or 3 cold joints per 1/2 mile. Cold joints are defined as when the last delivery truck leaves the paver, the paver has stopped more than 15 minutes before the next delivery truck is brought to the paver.

413.03.07 SURFACE TOLERANCES FOR UTACS

A. The completed surfacing shall be thoroughly compacted, smooth, and free from ruts, humps, depressions, or irregularities.

1. Any ridges, indentations, or other objectionable marks left in the surface of the bituminous mixture by blading or other equipment shall be removed by rolling or other means.

2. The use of 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.

B. The Contractor shall produce completed surfacing which meets the requirements of Subsection 402.03.03.D, "Profilograph Measurement," when required by the Contracting Agency, with the following additions and exceptions to the profilograph measurement:

1. The Contractor shall furnish and operate a profilograph as specified in the subsection noted above at the time and date ordered by the Engineer.

2. Any requirement for grinding shall have a depth selected so that at least 80 percent of the original UTACS thickness is preserved in order to minimize the risk of localized bleeding.

3. Liquidated damages may be assessed, as required by the Contracting Agency, for each such high point that is allowed to remain in place.

4. The profile index requirements herein shall not apply to the pavement within 30 feet of either end of a concrete bridge deck (including approach slabs). The finished surface of such pavement shall, however, meet all other requirements of this section.

413.03.08 UTACS PAVEMENT REPAIRS

A. The Contactor shall pay all costs of UTACS pavement repair activities and implementation, except as otherwise provided herein.

B. The Contractor shall have the right to use such pavement repairs deemed necessary to bring the UTACS pavement up to the performance criteria established in Subsection 413.03.07, "Surface Tolerances for UTACS."

METHOD OF MEASUREMENT

413.04.01 MEASUREMENT

A. UTACS Pavement will be measured as specified in Subsection 401.04.01, "Measurement," or if the Contract Documents specify payment by area, the quantity of Plantmix Bituminous Surface to be measured for payment shall be the number of square yards, including the asphalt cement, used in the accepted work.

BASIS OF PAYMENT

413.05.01 PAYMENT

A. The Ultra-Thin Asphalt Concrete Surface (UTACS) bonded with a polymer modified membrane (PMM) will be paid at the Contract price bid per square yard, which shall include all material, mixing, loading, hauling, placing, compacting, incidentals, and for all labor, tools, and equipment necessary to complete the work as shown on the plans, as specified herein, and as directed by the Engineer.

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

C. Partial payments for UTACS may be made as set forth under Subsection 109.06, "Partial Payment."

D. Payment will be made under:

Pay Item	Pay Unit
UTACS Bonded with a PMM, S1 Gradation	Square Yard
UTACS Bonded with a PMM, S2 Gradation	Square Yard
UTACS Bonded with a PMM, S3 Gradation	Square Yard

SECTION 495

PRESTRESSING CAST-IN-PLACE CONCRETE

DESCRIPTION

495.01.01 GENERAL

A. 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.

B. This work shall include the furnishing and installation of 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.

C. For prestressed cast-in-place concrete, the term "member" as used in this section shall be considered to mean the concrete that is to be prestressed.

MATERIALS

495.02.01 GENERAL

A. Prestressing steel shall conform to Section 713, "Reinforcement."

B. Wires shall be straightened, if necessary, to produce equal stress in all wires or wire groups or parallel lay cables that are to be stressed simultaneously or when necessary to ensure proper positioning in the ducts.

C. Where wires are to be button headed, the buttons shall be cold formed symmetrically about the axis of the wires.

1. The buttons shall develop the minimum guaranteed ultimate tensile strength of the wire.

2. No cold forming process shall be used that causes indentations in the wire.

D. 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.

1. Prestressing steel that has sustained physical damage at any time shall be rejected.

2. The development of visible rust or other results of corrosion shall be cause for rejection, when ordered by the Engineer.

E. 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.

1. A corrosion inhibitor that prevents rust or other results of corrosion shall be placed in the package or form, or incorporated in a corrosion inhibitor carrier type packaging material, or when permitted by the Engineer, applied directly to the steel.

2. The corrosion inhibitor shall have no deleterious effect on the steel or concrete or bond strength of steel to concrete.

3. Packaging or forms damaged from any cause shall be immediately replaced or restored to original condition.

F. The shipping package or form shall be clearly marked with a statement that the package contains high strength prestressing steel; the care to be used in hauling; the type, kind,

and amount of corrosion inhibitor used, including the date when placed; safety orders; and instructions for use.

G. If ordered by the Engineer, the Contractor shall submit the following for the corrosion inhibitor:

1. A sample, a list of chemicals and their proportions, and instructions for use.

2. Evidence that the prestressing steel will be protected from rust and other results of corrosion.

3. A Certificate of Compliance in accordance with Subsection 106.05, "Certificate of Compliance."

H. Prestressing steel for post tensioning that is installed in members prior to placing and curing of the concrete shall be continuously protected against rust or other corrosion, until grouting, with 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.

I. All water used for flushing ducts shall contain either quicklime (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.

J. 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 10 calendar days after the installation of the prestressing steel, rust that may form during the 10 days will not be cause for rejection of the steel.

1. Prestressing steel installed, tensioned, and grouted in this manner, all within 10 calendar days, will not require the use of corrosion inhibitor in the duct following installation of the prestressing steel.

2. Prestressing steel installed as above but not grouted within 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

A. Prestressing shall be performed by post tensioning methods. The method of prestressing to be used shall at the Contractor's option, subject to the requirements specified herein.

B. The Contractor shall submit to the Engineer for review complete details and substantiating calculations of the method, materials, and equipment the Contractor proposes to use in the prestressing operations, including any additions or rearrangements of reinforcing steel from that shown on the plans. Such details shall:

1. Outline the method and sequence of stressing.

2. Include complete specifications and details of the prestressing steel, anchoring devices, working stresses, anchoring stresses, type of ducts, and all other data pertaining to the prestressing operations.

3. Include the proposed arrangement of the prestressing steel in the members, pressure grouting materials, and equipment.

C. The Contractor shall not cast any member to be prestressed before review of the shop detail drawings is complete.

D. Three sets of all shop detail drawings prepared specifically for the contract shall be submitted to the Engineer for review.

1. After review, 5 sets shall be submitted to the Engineer for use during construction.

2. Shop detail drawings shall be 24 inches by 36 inches in size and each drawing shall include the job site, name of structure as shown on the contract plans, the contract entity, bridge number, and contract number.

E. At the completion of the contract, 1 set of full size drawings on mylar or other approved material of all shop detail drawings for railroad bridges shall be furnished and delivered to the Engineer by the Contractor at no additional cost to the Contracting Agency.

495.03.02 ANCHORAGES AND DISTRIBUTION

A. All post tensioned prestressing steel shall be secured at the ends with approved permanent type anchoring devices.

B. All anchorage devices for post tensioning shall hold the prestressing steel at a load producing a stress of not less than 95 percent of the specified minimum tensile strength of the prestressing steel.

C. 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 1/4 inch from the root of the thread of the washer or from the edge of the ring or plate.

D. The load from the anchoring device shall be distributed to the concrete with approved devices that will effectively distribute the load to the concrete. Such approved devices shall conform to the following requirements:

1. The final unit compressive stress on the concrete directly underneath the plate or assembly shall not exceed 3,000 psi.

2. 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 100 percent of the ultimate load is applied as determined by the Engineer.

3. Materials and workmanship shall conform to Section 506, "Steel Structures."

E. Should the Contractor elect to furnish anchoring devices of a type that are sufficiently large and 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.

F. 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 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

A. 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.

B. All ducts or anchorage assemblies shall be provided with pipes or other suitable connections for the injection of grout after prestressing.

C. Ducts for prestressing steel when bars are used shall have a minimum inside diameter 3/8 inch larger than the diameter of the bars to be used.

D. Ducts for prestressing steel shall be securely fastened in place to prevent movement.

E. 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, ducts shall be blown out or flushed and blown out immediately prior to installation of the steel.

F. Rigid ducts may be fabricated with either welded or interlocked seams. Galvanizing of the welded seam will not be required.

1. Rigid ducts shall have sufficient strength to maintain their correct alignment during placing of concrete.

2. Joints between sections of rigid duct shall be positive metallic connections that do not result in angle changes at the joints.

3. Waterproof tape shall be used at the connections.

4. Ducts shall be bent without crimping or flattening.

5. Transition couplings connecting the ducts to anchoring devices need not be galvanized.

G. All ducts for continuous structures shall be vented within 3 feet of the high points of the cable path.

1. Vents shall be 1/2-inch minimum diameter standard pipe.

2. Connections to ducts shall be made with metallic structural fasteners.

3. The vents shall be mortar tight, taped as necessary, and provide means of injection of grout through the vents and for sealing the vents.

4. Ends of vents shall be removed 1 inch below the top of top slab after grouting has been complete.

495.03.04 PRESTRESSING

A. All prestressing steel shall be tensioned with hydraulic jacks so that the force in the prestressing steel shall not be less than the value shown on the plans.

1. Unless otherwise specified or shown on the plans, the average working stress in the prestressing steel shall not exceed 60 percent of the specified minimum ultimate tensile strength of the prestressing steel.

2. The maximum temporary tensile stress (jacking stress) in prestressing steel shall not exceed 75 percent of the specified minimum ultimate tensile strength of the prestressing steel.

3. 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 70 percent of the specified minimum ultimate tensile strength of the prestressing steel.

B. 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 anchorage, and all other losses peculiar to the method or system of prestressing have taken place or have been provided for.

C. 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.

D. The following formula and friction coefficients shall be used in calculating friction losses in tendons:

$$T° = TX^{e} (Ua + KL)$$

T° = Steel stress at jacking end
T = Steel stress at any point X
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

E. Each jack used to stress tendons shall be equipped with either a pressure gauge or a load cell for determining the jacking stress, at the option of the Contractor.

1. The pressure gauge, if used, shall have an accurate reading dial at least 6 inches in diameter and each jack. The gauge 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.

2. The load cell, if used, shall be calibrated and provided with an indicator that will determine the prestressing force in the tendon.

3. The range of the load cell shall be such that the lower 10 percent of the manufacturer's rated capacity will not be used in determining the jacking stress.

F. The certified calibration charts for the hydraulic jacks, pressure gauges, or load cells used for tensioning prestressing steel may be checked before and during tensioning operations with agency-furnished load cells.

1. The Contractor shall provide, at no additional cost to the Contracting Agency, 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.

2. The checking operations, except as provided above, will be conducted by the Contracting Agency.

G. 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.

H. 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.

I. Except as herein provided, cast-in-place concrete shall not be prestressed until at least 10 days after the last concrete has been placed in the member to be prestressed and until the compressive strength of the last placed concrete has reached the strength specified for the concrete at the time of stressing.

J. 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.

K. 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 gauge pressures and elongations at all times and shall be submitted to the Engineer for approval.

L. Prestressing tendons in continuous post tensioned members shall be tensioned by jacking from both ends of the tendon.

495.03.05 BONDING AND GROUTING

A. 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.

B. Grout shall consist of Portland cement, water, and an expansive admixture approved by the Engineer.

C. Portland cement shall conform to Section 701, "Hydraulic Cement."

D. Water shall comply with Section 722, "Water."

E. The use of admixtures shall comply with Subsection 501.02.03, "Admixtures," 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.

F. Water shall be added first to the mixer, followed by cement and admixtures.

1. The grout shall be mixed in mechanical mixing equipment of a type that will produce uniform and thoroughly mixed grout.

2. The water content shall be not more than 5 gallons per sack of cement.

3. Retempering of grout will not be permitted.

4. Grout shall be continuously agitated until it is pumped.

G. The pumpability of the grout shall be determined by the Engineer in accordance with the U.S. Corps of Engineers Test Method CRD C-79. The efflux time of a grout sample immediately after mixing shall not be less than 11 seconds.

H. Grouting equipment shall be capable of grouting at a pressure of at least 100 psi.

I. Grouting equipment shall be furnished with a pressure gauge having a full scale reading of not more than 300 psi.

J. Standby flushing equipment capable of developing a pumping pressure of 250 psi and of sufficient capacity to flush out any partially grouted ducts shall be provided.

K. All ducts shall be clean and free of deleterious materials that would impair bonding of the grout or interfere with grouting procedures.

L. All grout shall pass through a screen with 0.07-inch maximum clear openings prior to being introduced into the grout pump.

M. 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.

N. Grout injection pipes shall be fitted with positive mechanical shutoff valves.

1. Vent and ejection pipes shall be fitted with valves, caps, or other devices capable of withstanding the pumping pressures.

2. Valves and caps shall not be removed or opened until the grout has set.

3. Leakage of grout through the anchorage assembly shall be prevented by positive mechanical means.

O. 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 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.

P. 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

A. Sampling and testing shall conform to ASTM A416, ASTM A421, and as specified below.

B. Samples from each size and each mill 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.

C. 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.

D. All materials for testing shall be furnished by the Contractor at no additional cost to the Contracting Agency. The Contractor shall have no claim for additional compensation in the event Contractor's work is delayed awaiting approval of the materials furnished for testing.

E. 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 so that each lot can be accurately identified at the job site.

1. Each lot of anchorage assemblies and bar couplers to be installed at the site shall be likewise identified.

2. All unidentified prestressing steel, anchorage assemblies, or bar couplers received at the site will be rejected.

F. The following samples of materials and tendons, selected by the Engineer from the prestressing steel at the plant or job site, shall be furnished by the Contractor to the Engineer well in advance of anticipated use:

1. For wire, strands, or bars, one 7-foot long sample of each size shall be furnished for each heat or reel.

2. If the prestressing tendons are to be prefabricated, 1 completely fabricated prestressing tendon 5 feet in length for each size of tendon shall be furnished, including anchorage assemblies.

3. If the prestressing tendon is to be assembled at the job site, sufficient wire or strand and end fittings to make up 1 complete prestressing tendon 5 feet in length for each size of tendon shall be furnished, including anchorage assemblies.

4. If the prestressing tendon is a bar, one 7-foot length complete with 1 end anchorage shall be furnished and in addition, if couplers are to be used with the bar, two 4-foot lengths of bar equipped with 1 coupler and fabricated to fit the coupler shall be furnished.

G. When prestressing systems have been previously tested and approved for Contracting Agency's 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.

H. For prefabricated tendons, the Contractor shall give the Engineer at least 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 fabrication is in progress at the plant and will arrange for the required testing of the material to be shipped to the site.

I. 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.

J. Job site or site as referred to herein shall be considered to mean the structure site.

K. 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.

METHOD OF MEASUREMENT

495.04.01 MEASUREMENT

A. The unit of measurement for Prestressing Cast-in-Place Concrete shall be lump sum.

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

BASIS OF PAYMENT

495.05.01 PAYMENT

A. 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, and as directed by the Engineer.

B. 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 for 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.

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

D. Payment will be made under:

PAY ITEM	PAY UNIT
Prestressing Cast-in-Place	Lump Sum

SECTION 501

PORTLAND CEMENT CONCRETE

DESCRIPTION

501.01.01 GENERAL

A. This work shall consist of Portland cement, fine aggregate, coarse aggregate, water and when specified, an air entraining admixture, proportioned, mixed, placed, and cured as herein specified. All concrete shall meet the most current requirements of American Concrete Institute (ACI) with the following additions and/or exceptions indicated in this specification.

B. As used in this section, the term Portland Cement shall be considered synonymous with the term Hydraulic Cement.

501.01.02 QUALITY CONTROL TESTING AND INSPECTION

A. The testing and inspection of Portland cement concrete shall comply with this specification. The inspection of the mixing plant shall comply with the ACI 311, Chapter 2. In Clark County unincorporated areas and if required by other Contracting Agencies, all field and laboratory sampling and testing for project control shall be performed by NAQTC or ACI certified technicians in an AASHTO or A2LA accredited laboratory. The concrete designs shall comply with Tables 1 and 2 and the IQAC website http://www.accessclarkcounty.com/depts/public_works/pages/iqac.aspx or comply with Contracting Agency requirements.

MATERIALS

501.02.01 GENERAL

A. Materials shall meet the requirements of the following sections and subsections:

Materials	Section
Aggregate for Portland Cement Products	706
Concrete Curing Materials and Admixtures	702
Portland Cement	701
Water	722

501.02.02 GRADATION REQUIREMENTS

A. Refer to ACI 304 Chapters 2.1 and 2.2, and comply with the gradation requirements specified in Section 706, "Aggregates for Portland Cement Products," and the following:

1. 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 "Base Fineness Modulus."

   a. The "Base Fineness Modulus" shall be the average of the most recent 10 fineness modulus values (or the average of all preceding values if less than 10 have been completed) from any one source.

b. Fine aggregate from any one source having a variation in fineness modulus exceeding ±0.2 as prescribed above will be rejected, or at the discretion of the Engineer, may be accepted subject to approved changes.

c. 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 No. 4, No. 8, No. 16, No. 30, No. 50, and No. 100, and dividing by 100.

2. Fine aggregates from different sources of supply shall not be mixed or stored in the same stockpile and shall not be used alternately in the same class of construction or job mix without written permission. Such permission will be contingent on amending the job mix and batch masses as necessary to protect the quality of the concrete produced.

3. If the fine aggregate for a job mix is to be a composite material from 2 or more sources, material from respective sources shall be blended by methods that will maintain the degree of uniformity of gradation required by these specifications.

4. Adequate supplies of aggregate shall be produced and stockpiled sufficiently in advance of construction operations to permit sampling and testing before use.

5. Coarse aggregates which vary in gradation shall be placed in separate stockpiles or bins and recombined in approved proportions. Different sizes of aggregates shall be stored in stockpiles sufficiently removed from each other to prevent the materials from becoming intermixed.

6. If the Contractor changes the source of any size of aggregate, a new mix design shall be submitted to the Engineer for approval.

501.02.03 ADMIXTURES

A. Refer to ACI 212. Air-entraining admixtures and water reducers and retarders shall conform to the requirements of Subsection 702.03.02, "Air-Entraining Admixtures," and Subsection 702.03.03, "Admixtures Other Than Air-Entraining."

B. Admixtures that are not listed in the mix design shall not be used without written permission from the Engineer, except as otherwise provided in these specifications or in the Special Provisions.

C. Admixtures used in Class EA Concrete, Modified shall be an approved chemical admixture for concrete, meeting the requirements of ASTM C494. Use Type “A” admixture when the anticipated high temperature for the day is 80 degrees F or below. Type “D” admixture shall be used when the anticipated high temperature is above 80 degrees F. The water-cement ratio shall not be adjusted once the chemical admixture has been incorporated into the mix.

D. Admixtures shall not be used to replace cement. Admixtures containing chlorides as Cl^- in excess of 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, the admixtures shall be used at the dosage specified in the mix design, or in the contract documents, or as provided by the Engineer.

E. When the use of an air-entraining agent is specified, it shall be added in a quantity conforming to Table 2 in Subsection 501.03.04, "Classifications and Proportions." It shall be measured 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.

F. When a High Range Water Reducing admixture is used, the initial slump is waived and the slump of the concrete after the admixture is added shall not exceed 8 inches.

G. Admixtures shall be measured accurately into each batch by methods approved by the Engineer.

H. 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 to permit tests to be made to determine compliance with claimed properties.

I. Any type of admixture shall be uniform throughout its use in the work. Should it be found that the admixture as furnished is not uniform, its use shall be discontinued.

J. Admixtures shall be dispensed in liquid form. Dispensers for admixtures shall have sufficient capacity to measure at one time the full quantity required for each batch. Unless 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 admixtures shall not vary from the dosage indicated in the mix design or as approved by the Engineer by more than 5 percent, with the exception of air entraining admixtures where the dosage is required to achieve the specified range. Equipment for measurement shall be designed for convenient confirmation of the accuracy of measurement. If more than one admixture is used, each shall be dispensed by separate equipment unless otherwise permitted in writing by the Engineer.

K. 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 of 20 percent when used in precast, prestressed concrete; 10 percent when used in cast-in-place prestressed concrete; 10 percent when used in cast-in-place reinforced concrete; or 3 percent when used in non-reinforced concrete pavements.

L. Water reducers shall reduce the water demand of concrete for a given slump at least 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 48 hours and longer, be not less than that of similar concrete without the admixture.

M. When the Contractor proposes to use an air-entraining admixture which has been previously approved, the Contractor shall submit a certification stating that the admixture is the same as that previously approved.

N. 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.

O. Before or during construction, the Engineer may require that the admixture selected be further tested to determine its effect upon the strength of the concrete. The 7-day compressive strength of concrete containing the admixture under test shall not be less than 88 percent of the strength of concrete made with the same materials, the same cement content, and consistency, but without the admixtures.

P. Subject to the following conditions, pozzolan conforming to Subsection 702.03.04, "Pozzolans (Fly Ash)," shall be used to a minimum of 20 percent and a maximum of 35 percent, by weight, of the required Portland cement in concrete, or as required by the Engineer.

1. The replacement of cement with pozzolan shall be at a rate of 1 pound of pozzolan for each pound of Portland cement.
2. Silica fume may be used to replace 3 percent to 7 percent, by weight, of the total cementitious material.
3. Store pozzolan in separate weather-tight facilities.

501.02.04 CONCRETE MAKING PROPERTIES

A. The mix design procedure shall comply with the method indicated on the IQAC website (see Subsection 501.01.02, "Quality Control Testing and Inspection"). The type of cement permitted, the minimum sacks of cement required, and the maximum water/cement ratio shall be as shown in Table 1.

Table 1 - Cements Permitted, Sack Requirements, and W/C Ratio

Type of Cement Permitted	Minimum Sacks of Cement Per Cubic Yard [3]	Maximum Water/Cement Ratio
Type II & Fly Ash	6.5 [2, 3]	0.45
Type MS & Fly Ash	6.5 [1, 2]	0.45
Type 1-P (MS)	6.5	0.45
Type V	6.5 [3]	0.45
Type HS	6.5 [2]	0.45
Type V & Fly Ash	6.0 [2, 3]	0.45
Type HS & Fly Ash	6.0 [1, 3]	0.45

B. The testing frequency shall comply with the Contracting Agency requirements or the Special Provisions.

C. Prior to mix design approval, the Contracting Agency reserves the right to verify the mix design test results, using the sources and proportions of materials as indicated by the mix design.

D. The mix design submittal shall include the information indicated in the concrete design report form on the IQAC website.

501.02.05 ZERO SLUMP CONCRETE FOR THE MANUFACTURING OF PRECAST CONCRETE PRODUCTS

A. Concrete products manufactured by the zero slump method shall comply with Subsection 501.02.03, “Admixtures” and Subsection 501.02.04, “Concrete Making Properties.” Zero slump concrete shall also exhibit design and performance requirements meeting IQAC and relevant ASTM specifications. Air entrainment is not required in a dry cast manufacturing process.

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[1] Maximum of 8 sacks.
[2] Sacks per cubic yard before replacement with fly ash.
[3] 5.0 sacks per cubic yard for precast products, pipe and box, with zero slump mix design.

B. For zero slump concrete, all other parts of this section do not apply.

501.02.06 LOW SLUMP CONCRETE FOR THE MANUFACTURING OF EXTRUDED SLIP FORM CONCRETE

A. Extruded slip form concrete shall comply with material requirements contained in Table 1, above, and with design and performance requirements meeting IQAC and relevant ACI specifications. The plastic properties may be adjusted on-site with an appropriate type admixture to ensure compliance with Subsection 501.03.04, "Classification and Proportions," and to aid Contractor in placement and finishing of low slump slip form concrete.

501.02.07 SELF-CONSOLIDATING CONCRETE

A. The Contractor's use of self-consolidating concrete shall require the approval of the Engineer and shall be subject to the following requirements:

1. Substitutions. Class S concrete may be substituted for selected applications for classes A, D, Modified A, and Modified D; and Class SA concrete may be substituted for selected applications for classes AA, DA, PAA, Modified AA, and Modified DA, as approved by the Engineer.

2. Trial Placement.

   a. The Contractor shall submit details of a representative test section (mockup) for approval.

   b. Produce a trial batch of classes S and SA concrete, conforming to the proposed mix design.

   c. As part of the concrete placement demonstration, provide the labor, equipment, and materials to test the concrete. Evaluate the mixture for strength, air content, slump flow, visual stability index, J-ring value, and hardened visual stability index.

   d. Place a test section when the atmospheric conditions approximate the conditions anticipated for placing the final work. Finish and cure the mockup according to this section.

   e. If it is determined that the trial batch is not workable or not able to be properly placed or finished, modify the mix design or batching sequence. Submit the revised mix design and batching sequence to the Engineer, and place another test section. Repeat the submittal and trial pour process until a workable and finished trial batch is produced.

   f. Do not place any Class S and SA concrete until the Engineer accepts the mockup pour.

   g. A new mix design and a new trial pour will be required whenever there is a change in the source of any component material.

   h. Segregated concrete, as determined by NV Test Method SCC-2, shall not be incorporated into any component of the anticipated concrete work.

   i. When a truck mixer or agitator is used for transporting concrete, deliver the concrete to the site of the work and complete discharge within 60 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, a mixing and

delivery time of less than 60 minutes may be required. A mixing and delivery time exceeding 60 minutes may be approved by the Engineer if a trial pour is performed with satisfactory results.

j. Place each successive batch within a maximum time interval of 20 minutes. Place the concrete in continuous layers. When it is necessary by reason of emergency or other delay, to place less than a complete horizontal layer in one operation, terminate each layer by using a vertical bulkhead. Do not rod or vibrate the concrete to attempt restoring the fluidity to the mix. Plan and regulate the delivery of concrete so that minor interruptions due to form repair, material testing, etc. will not impact the required 20-minute time interval between successive placements.

3. Concrete Slump Requirements. Except for concrete used in drilled shafts, the requirements of NV Test Method T438 will be performed at 2 hours, 3 hours, or for extended times depending on the concrete placement duration.

4. Drilled Shafts. Use Class S or SA concrete for drilled shaft construction. Upper portions of drilled shafts (top of shaft down to bottom of embedded vertical column reinforcing) may be constructed using the column concrete mix.

CONSTRUCTION

501.03.01 EQUIPMENT

A. With the exception of items indicated in Subsection 501.03.05, "Proportioning Methods," and Subsection 501.03.06, "Machine Mixing," the measurement of materials and batching shall comply to the ACI 304, Chapters 3 and 4 recommendations and those in this section or as approved by the Engineer.

1. Certify concrete production facilities and delivery equipment by complying with National Ready-Mix Concrete Association certification requirements.

2. 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.

3. All equipment necessary shall be on hand and approved before concrete operations are begun by the Contractor.

B. Provide adequate internal vibrating equipment, including power, to enable the Engineer to fabricate concrete cylinders for testing purposes.

C. Furnish internal vibrators with rigid or flexible shafts, preferably powered by electric motors, capable of operating at a frequency of 7,000 vibrations per minute or greater.

1. The outside diameter or the side dimensions of the vibrating element shall be at least 3/4 inch and not greater than 1-1/2 inches.

2. The length of the shaft shall be at least 24 inches.

D. The Contractor shall maintain the equipment in good condition and adjustment. Concrete mixers and other 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

A. 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.

B. Different brands of cement shall not be mixed during use or in storage, nor shall different brands 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. A change in brand of cement will require a new mix design.

C. The sacked cement shall be so piled as to permit access for tally, inspection, and identification of each shipment.

D. 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, with tests pertaining to the delivered lot. The certificate shall be dated, signed, and indicate the quantity of shipment. Two copies shall be delivered directly to the Engineer.

E. Upon receipt of the certificate of compliance, the Engineer may permit the use of the cement. When a certificate of compliance is not furnished to the Engineer, the cement shall not be used in the work until a release for its use has been received by the Contractor from the Engineer.

F. Whenever it is determined by a laboratory test of mill or field samples that the cement does not comply with the specifications, the use of that cement will be suspended until tests by a third party paid for by the Contractor can be made and the test results are approved by the Engineer.

G. 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

A. Refer to ACI 304, Chapter 2.2.3. The handling and storage of aggregates shall be such as to prevent segregation or contamination by foreign materials.

B. Maintain aggregate stockpiles in saturated surface dry condition.

C. In placing materials in storage or in moving materials 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 material failing to meet specified requirements shall be discontinued and the materials shall be reprocessed or wasted.

501.03.04 CLASSIFICATION AND PROPORTIONS

A. For non-commercial sources, the Contractor shall notify the Engineer not less than 30 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.

1. The sources of materials to be used on a project shall not be changed during the job except with the written consent of the Engineer.

2. If permission to change sources of material is granted, a new job mix formula shall be required.

3. Samples shall not exceed 500 pounds for each separate grading.

B. When requested by the Contractor, exceptions to the above requirement may be granted in writing by the Engineer under either of the following conditions:

1. The concrete structures on the project are minor in nature, such as culvert headwalls, manholes, small boxes, sidewalks, etc., generally, when less than 100 cubic yards of concrete are called for on the project.

2. When the aggregate source has been previously tested within the past 1 year and accepted by the Contracting Agency.

C. The Contractor shall give the Engineer advance notice in writing when any changes are to be made in the batch proportions. In the case of Class EA concrete, no changes will be allowed without new laboratory trial testing and subsequent approval.

D. Batches of concrete shall not vary more than ±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 14 pounds per cubic yard less, nor more than 23 pounds per cubic yard greater than the designated cement factor. Batch aggregates and report by weight to the Engineer. The weights used may be varied as necessary to comply with the above tolerances in cement factor and unit weight.

E. For Class EA Concrete, Modified, perform laboratory trial tests to determine strength and compatibility of all materials (as specified in Table 2 of this subsection and in Subsection 501.02.03, "Admixtures") to be used. Contractor shall have an approved laboratory perform the tests and furnish documentation of such tests. Laboratory trial batches may be observed by the Engineer.

Table 2 - Concrete Mix Designation[4, 5]

Class of Concrete	Cementitious Range lb/yd^3	Max. Nom. Coarse Aggregate Size inches	Min. 28-Day Compressive Strength[6] psi	Slump Range inches	Entrained Air Range %	Unit Weight Variation lb/ft^3	Use
A	564-705	1-1/2	3000	1-4	4-7	± 3	General use and reinforced structures
AA	564-705						
B	517-705	2	3000	1-5	4-7	± 3	Massive or lightly reinforced sections
BA				1-4			
C	470-611	2-1/2	2500	1-5	4-7	± 3	Massive unreinforced and backfill
CA	517-658						
D	564-705	3/4	3000	1-4	4-7	± 3	Thin reinforced sections, hand rails, etc.
DA	564-752						
PA A	564-752	3/4	Specified on Plans	1-4	Specified on Plans	± 3	Prestressed members

[4] Blend the coarse aggregate gradation from stockpiles conforming to the requirements of Subsection 706.03.01, "Coarse Aggregate," and the stated nominal maximum size. Submit test reports for trial batches showing each stockpile sieve size and the proportions used for blending. Adhere to Subsection 706.02.01, "General," for the combined gradation regardless of coarse aggregate gradation. If approved, coarse aggregate nominal maximum size of 1 inch may be used in lieu of 3/4 inch.

[5] Air entrainment on mixes placed above 6000 feet elevation

[6] Comply with Subsection 501.02.04, "Concrete Making Properties," of the NDOT Standard Specifications for the moving average method of evaluating concrete specified under Statistical Evaluation of Concrete Strength.

Table 2 - Concrete Mix Designation[4, 5]							
Class of Concrete	**Cementitious Range lb/yd^3**	**Max. Nom. Coarse Aggregate Size inches**	**Min. 28-Day Compressive Strength[6] psi**	**Slump Range inches**	**Entrained Air Range %**	**Unit Weight Variation lb/ft^3**	**Use**
Modified A and AA	564-752	1-1/2	Specified on Plans	1-4	4-7 (AA only)	± 3	Where specified on plans
Modified D and DA	564-752	3/4	Specified on Plans	1-4[7]	4-7 (DA only)	± 3	Where specified on plans
Modified EA[8]	564-752	3/4	Specified on Plans	1/2 -4	4-7	± 3	High Performance Concrete
S and SA	639-925[9]	3/4[10]	Specified on Plans	N/A	4-7 (SA only)[11]	± 3	Self Consolidating Concrete

501.03.05 PROPORTIONING METHODS

A. Except as hereinafter noted, aggregate bins shall conform to either 1 or 2 as follows:

1. Each specified size of aggregates 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.

2. 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.

B. Conformance to 1 and 2 above will not be required when batching for culvert headwalls, manholes, small boxes, sidewalks, etc., and the total quantity of concrete called for on the project does not exceed 300 cubic yards.

C. All aggregates for use in Portland cement concrete shall be proportioned by weight, with the exception that aggregates for culvert headwalls, short pieces of curb 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.

D. Water shall be proportioned to maintain batching consistency with regard to stockpile moisture contents and varying absorption values for both coarse and fine aggregates. The Engineer may request the Contractor to submit a new mix design if either the coarse or fine aggregate absorption values vary from the approved mix design by more than 1 percent.

E. Bulk cement shall be weighed separately when the batch is 1 cubic yard or more.

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[7] For extruding barrier or bridge rail, slump range is 0.5-4 inches.

[8] Aggregates shall consist of a blend of coarse, intermediate, and fine aggregates in order to produce a dense grading. Consideration of the grading, workability factor, and coarseness factor, as outlined in ACI 302 shall be utilized. The aggregate maximum nominal size shall consist of at least a nominal 3/4 inch stone size.

[9] The maximum shrinkage requirement of 0.06% in 28 days air dry after 28-day wet cure, ASTM C157, shall apply if the total cementitious material exceeds 752 pounds per cubic yard.

[10] If approved, 1/2 inch or 3/8 inch may be used in lieu of 3/4 inch.

[11] Air content shall be as follows: For 1/2 inch max. aggregate size, 4.5% - 7.5%, and for 3/8 inch max. aggregate size, 5% - 8%.

1. The scale and weigh hopper for the cement shall be separate and 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 underweight by more than 1 percent of the amount specified.

2. An interlock system will not be required on projects having less than 300 cubic yards in the bid schedule.

F. Scales utilized in the proportioning device may be of the springless dial type or of the multiple beam type.

G. 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.

H. 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.

1. The indicator shall be so designed that it will operate during the addition of the last 400 pounds of any weighing.

2. The over travel of the indicator hand shall be at least 1/3 of the loading travel.

3. The indicator shall be enclosed against moisture and dust.

I. 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 1 percent for cement and 1-1/2 percent for any size aggregate, nor 1-1/2 percent for the total aggregate in any batch.

J. Scales shall be approved with a certificate of inspection as required by Subsection 109.01, "Measurement of Quantities."

K. When the entire plant is running, the scale reading and cutoff weights shall not vary from the mix design by more than 1 percent for cement, fly ash, and silica fume, 1.5 percent for any individual size aggregate, and 1 percent for the total combined aggregate in any batch. The total water shall not exceed the maximum water specified in the mix design.

L. 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.

M. Stockpiled aggregates shall be in a saturated surface dry condition just prior to batching.

1. 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.

2. Aggregate containing excess moisture shall be stockpiled prior to use until sufficiently dried to meet the above requirements.

N. Batches with cement in contact with damp aggregates shall be mixed within 30 minutes after being proportioned. Batch trucks hauling more than 1 batch of cement and aggregate shall be so constructed that materials do not flow from one compartment to another during haul or discharge.

O. Coarse and fine aggregate shall be handled and measured separately. Cement shall be emptied directly into the charging skip of the mixer. Water shall be measured either by volume or by weight.

P. 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 in one operation into the mixing drum without dribbling.

1. 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.

2. 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 1 percent from the required quantity of water for any position of the mixer with respect to a level plane.

3. 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. Concrete manufactured by any procedure which results in any unmixed lumps of cement in the mixed product shall be rejected. The preparation of the mix shall be in accordance to ACI 318, Section 5.8, “Mixing,” and this section. The Cement and Concrete terminology is defined in ACI 116.

B. The Engineer shall be provided with a legible ticket with each load of concrete delivered to the project site which shall contain the following information:

1. Name of Vendor.

2. Name of Contractor.

3. Number of Cubic Yards in the Load.

4. Actual Weights of Cement and of each Size of Aggregate.

5. Amount of Water Added at the Plant.

6. Amount of Water in the Aggregate.

7. Brand and Type of Cement.

8. Brand and Amount of Admixture.

9. Time and Date of Batching.

C. Space shall be provided on the ticket so the amount of water added on the job may be indicated.

D. All concrete shall be mixed in mechanical mixers, except that when permitted by the Engineer, batches not exceeding 1/3 cubic yard may be mixed by hand methods in accordance with the provisions of Subsection 501.03.07, "Hand Mixing."

1. Mixers shall have legible permanently attached plates showing manufacturer's rated capacity, mixing speeds, and serial number.

2. Mixers may be stationary mixers or truck mixers.

a. Agitators may be truck mixers operating at agitating speed or truck agitators.

b. 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.

3. The Contractor, at no additional cost to the Contracting Agency, shall furnish samples of the fresh concrete and provide safe and satisfactory facilities for obtaining the samples.

4. 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.

5. 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 50 degrees F nor more than 90 degrees F as specified in Subsection 501.03.10.B, "Cold Weather – General," and Subsection 501.03.10.C, "Low Temperature Protection." Aggregates and water used for mixing shall not exceed 150 degrees F.

6. Concrete for structures shall be mixed for a period of not less than 60 seconds nor more than 5 minutes after all materials, including water, are in the mixer.

7. 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 an accumulation of cement on surfaces of conveyors or hoppers, or in other conditions which may vary the required quantity of cement in the concrete mixture.

8. Stationary mixers having a capacity of 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.

9. The total elapsed time between the intermingling of damp aggregates and cement and the start of mixing shall not exceed 30 minutes.

10. Mixers and agitators which have an accumulation of hard concrete or mortar or worn blades shall not be used.

11. 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 45 minutes after the addition of the cement to the aggregates.

E. **Ready-Mixed Concrete.**

1. Ready-mixed concrete shall be central-mixed, shrink-mixed, or 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.

2. 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.

3. If the use of ready-mixed concrete is approved, the producers shall use only that cement approved by the Contracting Agency for use on the project. Contracting Agency approved cement shall be stored at the concrete plant in such a manner that it can be identified and kept separate from other cement.

4. Ready-mixed concrete for structures shall be transported in truck mixers or truck agitators.

5. 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.

6. 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.

   a. When any such change in condition is found, the concrete shall be subjected to the slump tests.

   b. If the tests indicate that the concrete is not being properly mixed, the faulty equipment shall be corrected before its further use is allowed.

7. 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, non-resettable 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.

8. When a truck mixer is used, each batch of concrete shall be mixed for not less than 70 and no more than 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.

9. 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.

10. 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 30 revolutions at mixing speed after the water is added and before discharge is commenced.

11. The rate of discharge of mixed concrete from truck mixer-agitators shall be controlled by the speed of revolution of the drum in the discharge direction with the discharge gate fully open.

12. 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. Do not exceed a total of 300 revolutions from the time of initial batching to complete discharge of delivered concrete.

13. 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 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 90 minutes may be required. When a truck mixer is used for the complete mixing of the concrete, the mixing operations shall begin within 30 minutes after the cement has been intermingled with the aggregate.

14. 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 as requirements can be complied with.

15. The organization supplying concrete shall have sufficient plant capacity and transporting apparatus to ensure continuous delivery at the rate required.

    a. The rate of delivery of concrete shall be used as to provide for the proper handling and placing of concrete.

    b. An interval of more than 45 minutes between any 2 consecutive batches or loads, or a delivery and placing rate of less than 8 cubic yards of concrete per hour shall constitute cause of shutting down work for the remainder of the day, and if so ordered by the Engineer, the Contractor shall make, at no additional cost to the Contracting Agency, a construction joint at the location and of the type directed by the Engineer in the concrete already mixed.

16. 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.

17. Wash water shall be completely discharged from the drum or mixing container before the succeeding batch is introduced. Cement balling (intermittent clumping) and mix foaming shall be prevented by controlling the batch sequence, mixing speed, and mixing time.

    a. When intermittent clumping exceeds 1-2 clumps per yard or 10 clumps per truck, the entire load will be rejected.

    b. The clumps shall not exceed 5 inches in diameter.

501.03.07 HAND MIXING

A. Hand mixing shall not be permitted, except in case of an emergency or under written permission of the Engineer.

B. When permitted, hand mixing shall be done only on watertight platforms.

1. The sand shall be spread evenly over the platform and the cement spread upon it.

2. 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.

3. 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.

4. The coarse aggregate shall then be thoroughly wetted and added to the mortar and the entire mass turned and returned at least 6 times and until all of the stone particles are thoroughly covered with mortar and the mixture is of a uniform color and appearance.

C. Hand mixing will not be permitted for concrete to be placed under water.

D. Preproportioned sack concrete may be used for grout caps or other nonstructural uses as approved by the Engineer.

501.03.08 RETEMPERING

A. 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.

B. No retempering of concrete shall be allowed.

501.03.09 CURING

A. Comply with ACI 308, Standard Specification for Curing Concrete, with the following exceptions or additions:

1. **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 procedures specified in Subsection 501.03.10.B, "Cold Weather – General."

   a. Cure all bridge decks and approach slabs according to Subsection 501.03.09.A.6, "Bridge Deck Curing."

   b. 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 2 below.

2. **Water Method.** The concrete shall be kept continuously wet by the application of water for a minimum period of 7 days after the concrete has been placed.

   a. Use fogging equipment capable of applying water through an atomizing nozzle in the form of a fine mist, not a spray. The equipment may use water pumped under adequate high pressure, or a combination of air and water pumped under high pressure. Use equipment sufficiently portable for use in the direction of any prevailing wind. Adapt equipment for intermittent use as directed to prevent excessive wetting of the concrete.

   b. 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.

3. **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 2 above before the curing compound is applied.

a. On decks or slabs cured by this method, foot traffic shall 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 7 days, the damaged portions shall be repaired immediately with additional compound.

b. Uniformly spray the entire surface of the concrete with a curing compound conforming to Subsection 702.03.01, "Curing Materials," except as hereinafter specified for concrete bridge decks that are to be the roadway surface. The curing compound shall be applied to the exposed surface at a uniform minimal rate of 1 gallon per 150 square feet of area.

c. Do not apply the curing compound until all patching and surface finishing, except grinding, have been completed. When ordered during periods of hot weather, continue fogging of the concrete with water after curing compound is applied until 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. 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.

e. Provide curing compounds which remain sprayable at temperatures above 40 degrees F and do not hard settle in storage.

f. 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 100 degrees F

g. Curing compound shall be packaged in clean 55-gallon steel barrels or round 5-gallon steel containers or supplied from a suitable storage tank located at the jobsite.

1) Each 55-gallon barrel shall be equipped with a built-in agitator having 2 sets of blades, one at the bottom and one midway between top and bottom, and with removable lids and airtight band fasteners.

2) On-site storage tanks shall be kept clean and free of all contaminants. Each tank shall be provided with a permanent system designed to completely redisperse any settled material without introducing air or any other foreign substance.

3) Barrels shall be filled in a manner that will prevent skinning.

4) Ring seals and lug type crimp lids shall be used to seal 5-gallon containers well.

5) Containers shall be provided with lining that will resist the solvent of the curing compound and will not permit skins to be loosened into the body of the curing compound.

6) Each container shall be labeled with the manufacturer’s name, batch number, type of compound, number of gallons, and date of manufacture. Each container shall also be labeled with an Interstate Commerce Commission Red Label warning concerning flammability.

The label shall also warn that the curing compound shall be well stirred before use.

7) When the curing compound is shipped in tanks or tank trucks, a shipping invoice shall be supplied with each load containing the same information as that required herein for container labels.

h. Curing compound may be sampled by the Engineer at the source of supply, at the job site, or at both locations.

i. Curing compound not used within 6 months of the date of manufacture will require certification from the manufacturer that the curing compound still conforms to ASTM C309. Curing compound more than 1 year old or without a manufacture date on the container will not be allowed for use.

4. Waterproof Membrane.

a. Keep the exposed finished surfaces of concrete damp with water using an atomizing nozzle, as specified in Subsection 501.03.09.A.2, until the concrete has set.

b. Place the curing membrane after the concrete has set.

1) The membrane shall be formed into sheets of such width as to provide a complete cover of the entire concrete surface.

2) All joints in the sheets shall be securely cemented together in such a manner as to provide a waterproof joint.

3) Overlap of sheets shall have a minimum lap of 18 inches.

4) The sheets shall be securely weighted down by placing a bank of earth on the edges of sheets or by other means satisfactory to the Engineer.

5) Sheeting material shall conform to Subsection 702.03.01, "Curing Materials."

c. The curing membrane shall remain in place for a period of not less than 7 days.

d. 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.

e. Sections of the membrane which have lost their waterproof qualities or have been damaged to such an extent as to render them unfit for curing shall not be used.

5. Form Method.

a. If forms are kept on the concrete surfaces, this will be considered adequate cure for these surfaces.

b. However, should the forms be removed within 7 days after the concrete has been placed, one of the above methods shall be used on the exposed surfaces.

c. Comply with Subsection 502.03.11, "Removal of Falsework and Forms."

6. Bridge Deck Curing.

a. Submit a quality control plan for concrete placement and curing, for review and approval, a minimum of 30 days prior to the pre-pour conference for bridge decks and approach slabs. The plan shall include, but not be limited to, information on the procedures for when and how the concrete and the curing system is to be placed, frequency for monitoring, maintaining, and re-wetting the curing system chosen, and a list of personnel responsible for performing such work. Include in the plan, equipment to be used for placement of concrete and the curing system, methods of protecting the covers from displacement from wind or weather, and methods of preventing loss of heat and moisture.

b. Describe procedures to be followed in the event of equipment breakdown or inclement weather during concrete placement. In addition, describe the method to be used to protect pedestrian and vehicular traffic under the structure.

c. Use Figure 2.1.5 from ACI 305R, Hot Weather Concreting, to determine the evaporation rate. Additional protection measures shall be provided if the rate of evaporation exceeds 0.1 pound per square foot per hour.

   1) Accurate record of placement location, air temperature, relative humidity, concrete temperature, and wind velocity shall be provided.

   2) Readings shall be taken an hour prior to the concrete placement and at 1-hour increments during concrete placement, until the final curing blanket is placed.

   3) Required data shall be submitted to the Engineer.

d. Concrete temperature shall be monitored during the entire curing period by utilizing recording thermocouples embedded at 1 inch below the concrete surface and 1 inch above the bottom concrete surface.

   1) A minimum of 2 sets of thermocouple installations will be required per each day's placement.

   2) The thermocouple shall be capable of recording the concrete temperature as a function of time.

   3) Acceptable devices include thermocouples connected to electronic data loggers.

   4) The recording time intervals shall be a maximum of 30 minutes.

   5) The recording devices shall be accurate to within ±1.8 degrees F. Concrete temperature between the top and bottom of the slabs and the supporting girders shall be maintained to a maximum differential temperature of 30 degrees F.

   6) If differential temperatures exceed the requirements, measures shall be taken to correct the curing process.

   7) Required data shall be submitted to the Engineer.

e. Immediately after the concrete is placed, the moisture content shall be maintained by humidifying the air directly above the concrete surface until the curing covers are placed. Fogging equipment described in

Subsection 501.03.09.A.2, "Water Method," shall be used, mounted on a finishing bridge that is separate from the concrete placing equipment.

f. Begin placing pre-soaked burlap within 30 minutes after finishing has started. Wet curing of the surface shall be performed for 10 days, unless otherwise directed, with the following covering:

1) Burlap and Polyethylene Covering. Burlap conforming to Subsection 702.03.01, "Curing Materials," and polyethylene (white or reflective) conforming to ASTM C171 shall be furnished. Soaker hose shall be placed or other approved method shall be used to provide continuous wetting of burlap between the burlap and polyethylene covering.

g. Pre-wetted curing coverings shall be placed with a finishing bridge. Covers shall be placed directly behind the concrete fogging operation.

h. The covering shall be maintained uniformly wet during the entire curing period. Provide 24-hour monitoring of the wet curing for the full length of the curing period. Water temperature shall not be more or less than 20 degrees F from the temperature of top of bridge deck.

i. Covers shall be lapped a minimum of 18 inches. All lapped edges shall be sealed to prevent loss of heat and moisture.

j. If the ambient temperature drops below 45 degrees F during the first 4 days of curing, additional protection shall be provided according to Subsection 501.03.10.C, "Low Temperature Protection."

k. After completion of wet curing and removal of curing covering, immediately remove excess water and apply an application of curing compound according to Subsection 501.03.09.A.3, "Curing Compound Method."

l. All cracks on new bridge decks and approach slabs shall be repaired. Requested method of repair shall be submitted for approval.

7. Maturity Meter Method:

a. This method may be used if referred to in the Contract Special Provisions.

b. The method specified in ASTM C1074 may be used in order to reduce the cure time. This method requires training and certification of the Quality Assurance and Control personnel.

c. This method shall not be used for acceptance but for reducing the time required for form removal. The Contractor shall have a plan of action approved by the Engineer and monitored by a third party engineer for meter placement and monitoring.

501.03.10 WEATHER LIMITATIONS

A. **General.** If impending inclement weather conditions exist, the Contractor shall decide whether or not to begin the placement and the Contractor shall have sole responsibility for Contractor's decision.

1. 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.

2. In case precipitation should occur after placing operations have started, the Contractor shall provide ample covering to protect the work.

3. 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.** Comply with ACI 306, Cold Weather Concreting, with the following exceptions or additions:

1. All concrete shall be maintained at a temperature of not less than 50 degrees F for 3 days or not less than 40 degrees F for 7 days. The count of time shall commence immediately upon completion of final placement and vibration. The three 50-degree F days need not be consecutive.

2. One 24-hour period shall constitute 1 day.

3. The temperature of the concrete shall be determined by placement of thermometers on the concrete surfaces and properly insulating these devices to record the surface temperature of the concrete.

   a. Temperature shall be monitored continuously throughout the total protection time required by this subsection.

   b. In case the surface temperature of the concrete falls below 40 degrees F for a duration of 3 hours or more in any 24-hour period during the time of temperature protection, the time shall be increased 1 day for each day this occurs.

   c. An absolute minimum temperature of 35 degrees F shall be maintained for the total time of protection specified in this subsection.

   d. Should the temperature of the concrete fall below 35 degrees F at any time, damage may occur.

   e. The assessment of damage will be determined by a professional engineer registered in Nevada and paid for by the Contractor and concrete so damaged may require repair or replacement at the option of the Engineer.

4. The concrete shall have a temperature of at least 50 degrees F and not more than 90 degrees F at the time of placing. (Also, comply with temperature constraints specified in Subsection 501.03.06, "Machine Mixing.")

   a. Heating equipment or methods which alter or prevent the entrainment of the required amount of air in the concrete shall not be used.

   b. The equipment shall be capable of heating the materials uniformly.

   c. Aggregates and water used for mixing shall not be heated to a temperature exceeding 150 degrees F.

   d. Concrete containing frost or lumps at the time of placing shall not be used.

5. 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.

6. Reinforcing steel shall be free of ice, snow, and frost during placement of concrete. Concrete shall not be placed on frozen ground.

C. **Low Temperature Protection.** Refer to guidelines in ACI 306, Cold Weather Concreting, with the following exceptions or additions:

1. **General.** After the concrete has been placed, means shall be taken to protect the concrete from any impending low temperatures.

   a. Methods and materials not hereinafter prescribed may be used if approved by the Engineer and the following requirements adhered to:

      1) Materials shall be fire resistant

      2) Materials shall be waterproof

      3) Materials shall not adhere, abrade or damage the surface of the concrete.

   b. Approval of the Engineer shall not relieve the Contractor from obtaining specification results.

2. **Insulating Blankets.**

   a. Insulating blankets used to protect concrete from low temperatures shall be fire resistant and waterproof.

   b. The blankets shall be secured and overlapped along the edges and joints to ensure that no opening will exist in the protection during high winds or other adverse conditions.

   c. Provisions shall be made to allow the reading of thermometers placed inside of the protection.

   d. When depositing concrete against previously cast concrete, the blanket insulation shall extend at least 14 inches onto the existing concrete and shall be securely held in place.

3. **Low Temperatures Protection – Heating and Housing.**

   a. In order to meet the provisions of Subsection 501.03.09, paragraphs A and B, the concrete may be protected by applying artificial heat within an enclosure.

   b. The enclosure shall be constructed with fire resistant material, unless otherwise directed by the Engineer, and shall be subject to Engineer's approval.

   c. The heating system shall be so arranged as to provide uniform heating, ensuring 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.

4. The temperature of the concrete will be determined by placement of thermometers on the concrete surfaces and properly insulating these devices to record the surface temperature of the concrete according to NV Test Method T440.

   a. Temperature will be monitored continuously throughout the total projection time required by this subsection.

   b. If the surface temperature of the concrete falls below 50 degrees F during the first 3 days and 40 degrees F during the next 4 days of the temperature protection for a duration of 3 hours, the curing time will be increased 1 day for each day this occurs.

   c. Should the temperature of the concrete fall below 35 degrees F at any time during the 7 days of temperature protection or if the surface temperature of the concrete falls below 40 degrees F during the first 24 hours of temperature

protection period, the assessment of damage will be determined by a Nevada registered professional engineer paid for by the Contractor and damaged concrete shall be repaired or replaced at the option of the Engineer.

d. Contractor shall be responsible for all costs associated with damage assessment and repair.

D. **Hot Weather.** Comply with guidelines in ACI 305, Hot Weather Concreting, with the following exceptions or additions:

1. The maximum temperature of cast-in-place concrete shall not exceed 90 degrees F immediately before placement.

2. For continuous placement of concrete on the deck with reinforcing steel units, retard the initial set of the concrete sufficiently to ensure that concrete remains plastic for subsequent placement.

3. For both simple and continuous spans, submit a retardation schedule for approval.

4. The consistency of the concrete as placed shall 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 fog spray only, and shall be held to a minimum amount. Apply fog spray for this purpose as specified in Subsection 501.03.09.A.2, "Water Method." Fog spray for this purpose may be applied with hand-operated fog equipment, as approved by the Engineer.

5. From the time of initial strike-off until final finish is complete, the unformed surfaces of slab concrete shall be protected from rapid evaporation of mixing water from the concrete due to wind, high temperature, low humidity, or combination thereof.

6. 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.

7. Use fogging equipment capable of providing a fog mist, as necessary, to the area between the finishing machine and the tining machine. The fogging equipment shall meet the requirements of Subsection 501.03.09.A.2, "Water Method." If at any time it becomes apparent that the combination of fogging and curing application are not, or will not be effective in preventing plastic shrinkage cracking, stop the concrete placement until environmental conditions improve substantially, or until other preventative measures are approved in writing by the Engineer.

8. After all finishing operations are complete a final curing membrane shall be applied.

501.03.11 TRIAL SLAB AND PROCESS CONTROL TESTING

A. If silica fume is used in bridge deck concrete, construct a trial slab at least 30 days prior to placement of concrete on a bridge deck. Submit a written plan for the casting of decks. Include in this plan, at a minimum, the location of slab, the equipment and personnel used for construction, and disposal of slab. Prior to placement of the trial slab, conduct a Pre-Activity Meeting.

B. Use approved mix designs. Place concrete at a location other than the bridge deck, but under similar conditions to those that exist during bridge deck concrete placement.

1. The trial slab shall have a minimum length and width of 50 feet and a depth of 8 inches.

2. Reinforce slab with a top and bottom mat of No. 5 bars spaced 6 inches longitudinally and transversely.

3. Place top mat at a depth of 2-1/2 inches from the top of the slab.

4. Place bottom mat at a depth 1-1/2 inches from the bottom of slab.

5. The trial slab shall be wet-cured in accordance with the specifications.

6. Use personnel such as superintendent, key operators, and finishers that are the same personnel who will be involved in the final construction of the bridge deck.

7. Demonstrate the use of equipment, proficiency of personnel, and techniques for mixing, transporting, placing, and curing of the concrete during the trial.

8. Fifteen days after the placement of the trial slabs, conduct a post construction critique of the trial slab placement in writing.

C. Do not commence placement of bridge deck concrete until after any issues from the post construction critique of trial slab construction have been resolved to satisfaction of the Engineer.

D. Upon notification, remove and dispose of trial slabs according to Subsection 107.14, "Disposal of Material Outside Project Right-of-Way."

501.03.12 MORTAR

A. Cement mortar shall consist of a mixture of Portland cement, sand, and water. Cement and sand shall first be combined in the proper proportions, and then thoroughly mixed with the required amount of water.

1. Cement mortar shall be designated by class and proportioned by loose volume as follows:

Table 3 - Mortar Proportioning

Designation	Proportions
Class "A" Mortar	1 Part Cement to 1 Part Sand
Class "B" Mortar	1 Part Cement to 1-1/2 Parts Sand
Class "C" Mortar	1 Part Cement to 2 Parts Sand
Class "D" Mortar	1 Part Cement to 2-1/2 Parts Sand
Class "E" Mortar	1 Part Cement to 3 Parts Sand
Class "F" Mortar	1 Part Cement to 3-1/2 Parts Sand

2. The quantity of water to be used in the preparation of mortar shall be only that required to produce a mixture sufficiently workable for the purpose intended.

3. Mortar shall be used as soon as possible after mixing and shall show no visible signs of setting prior to use. Re-tempering of mortar will not be permitted.

B. **Cement.** Cement shall conform to the requirements of Section 701, "Hydraulic Cement."

C. **Sand.** Sand shall conform to the requirements of Subsection 706.03.04, "Grout and Mortar Sand." In proportioning the sand it shall be measured loose (without shaking or compacting) in measuring boxes or other suitable containers of known capacity.

D. **Admixtures.** No admixture shall be used in mortar unless otherwise specified or approved by the Engineer.

METHOD OF MEASUREMENT

501.04.01 MEASUREMENT

A. Portland cement concrete will be measured for payment in accordance with the provisions specified in the various sections of these specifications covering construction requiring concrete.

BASIS OF PAYMENT

501.05.01 PAYMENT

A. Portland cement concrete shall be paid for in accordance with the provisions specified in the various sections of these specifications covering construction requiring concrete.

501.05.02 TRIAL SLAB PAYMENT

A. Full compensation for construction and removal of trial slabs and trial pours shall be considered as included in the contract unit price paid for other appropriate items and no separate payment will be made therefor.

SECTION 502

CONCRETE STRUCTURES

DESCRIPTION

502.01.01 GENERAL

A. 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.

B. 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.

C. The concrete shall be of the class or classes of concrete specified in the contract documents and shall conform to the requirements of Section 501, "Portland Cement Concrete," unless otherwise specified.

MATERIALS

502.02.01 GENERAL

A. 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:

Materials	Section
Portland Cement Concrete	501
Concrete Curing Materials and Admixtures	702
Joint Material	707
Reinforcement	713
Miscellaneous Metal	712
Elastomeric Bearing Pads	725

CONSTRUCTION

502.03.01 DEPTH OF FOOTINGS

A. 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

A. 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.

1. Forms previously used shall be thoroughly cleaned of all dirt, mortar, and foreign matter before being reused.

2. Before concrete is placed in forms, all inside surfaces of the forms shall be thoroughly coated with an approved coating or form oil.

3. Coating or form oil shall leave no film on the surface of the form that can be absorbed by the concrete.

4. When required by the Engineer and immediately before placing concrete, the forms shall be thoroughly wetted with water.

B. 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.

C. The forms shall be substantial and unyielding and shall be so designed that the finished concrete will conform to the proper dimensions and contours.

1. The design of the forms shall take into account the effect of vibration on the concrete as it is placed.

2. Forms shall be filleted at all exposed corners unless corners are rounded as hereinafter provided.

a. Triangular molding used for fillets shall have 2 equal sides.

b. In general, the width of the equal sides of moldings shall be 3/4 inch.

c. For massive work, such as heavy pier copings and columns, the width shall be 1-1/2 to 2 inches.

d. Top edges of walls may be filleted or rounded as hereinafter provided for curbs.

e. Top edges of curbs and slabs shall be rounded with an edging tool to a radius of 1/2 inch to 3/4 inch.

D. When concrete is placed in excavation, forms shall be provided for all vertical surfaces unless otherwise permitted by the Engineer.

1. On thin walls, such as abutments, wing walls, and retaining walls, the forms on 1 face may be built up as the concrete is poured, but only to such elevation as will permit proper placing and thorough spading, and in no case greater than the height which can be placed in 1 day's run.

2. Ports shall be provided in high, thin walls to permit thorough cleaning before placing concrete.

3. If the forms develop any defects, such as bulging or sagging, after the concrete has been placed, that portion of the work shall be corrected in a manner satisfactory to the Engineer, without additional compensation to the Contractor.

4. During the erection and after the completion of the forms, the forms shall be protected in such a manner as to preclude shrinkage, warping, curling, and distortion.

5. Form lumber used a second time shall be free from bulge or warp and shall be thoroughly cleaned.

E. 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.

F. 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.

1. Unless otherwise permitted by the Engineer, forms for the webs of box girders shall be removed before the deck slab is poured.

2. 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.

G. Side Forms:

1. 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 502.03.11, "Removal of Falsework Forms."

2. The side forms for arch rings, columns, and piers shall be removed before the members of the structure which the forms support are poured or placed, so that the quality of the concrete may be inspected.

3. All such side forms shall be so constructed that the forms may be removed without disturbing other forms which resist direct load or bending stresses.

H. The condition of the forms will have a direct bearing upon the amount of finishing required.

I. Form Requirements and Physical Design:

1. Full pieces of forms shall be used and shall extend from the bottom to the top of the wall or post.

2. Curved surfaces shall be formed to provide a smooth surface without visible breaks.

3. The forms shall be so constructed that portions, where finishing is required, may be removed without disturbing portions of forms to remain.

4. Forms shall be of sufficient strength to carry the dead weight of the concrete as a liquid without a deflection in excess of L/270, and if such deflection occurs, the deflection shall be sufficient cause for rejection of the work.

5. Forms for girders and slabs shall be cambered in such amounts as may be required by the Engineer.

6. 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.

7. Bolts or form clamps shall be positive in action and shall be of sufficient strength and number to prevent spreading of the forms.

   a. The clamps shall be of such type that the clamps can be entirely removed or cut back sufficiently to allow finishing of the concrete.

   b. All forms for the outside surfaces shall be constructed with stiff wales at right angles to the studs and all form clamps shall extend through and fasten such wales.

8. Plywood for forms shall be "exterior type" of the grade Concrete-Form Exterior.

   a. Plywood form panels shall be furnished and placed in 4-foot widths and in uniform lengths of not less than 8 feet, except where the dimensions of the member form are less than the specified panel dimensions.

   b. Where form panels are attached directly to the studding of joints, the panel shall not be less than 5/8 inch thick.

c. Form panels less than 5/8 inch thick, otherwise conforming to the requirement herein specified, may be used with continuous backing of 1 inch nominal thickness surfaced material.

d. All form panels shall be placed in a neat symmetrical pattern subject to the approval of the Engineer.

e. The panel shall be placed with the long dimensions perpendicular to the studs.

9. 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.

10. Fabricated stay-in-place metal forms may be used for concrete floor slabs at the Contractor's option when so noted on the plans.

11. Metal forms to remain in place for concrete floor slabs shall be fabricated from steel conforming to ASTM A466 (Grades A through E) having a coating class of G165.

12. The following criteria shall govern the design of permanent stay-in-place steel bridge deck forms:

a. The steel forms shall be designed on the basis of dead load of form, reinforcement, and plastic concrete plus 50 pounds per square foot for construction loads. The unit working stress in the steel sheet shall not be more than 0.725 of the specified minimum yield strength of the material furnished, but shall not exceed 36,000 pounds per square inch.

b. Deflection under the weight of the forms, the plastic concrete and reinforcement shall not exceed L/180 of the form span or 1/2 inch, whichever is less, but in no case shall this loading be less than 120 psf total.

c. 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 foregoing limits.

d. The design span of the form sheets shall be the clear span of the form plus 2 inches measured parallel to the form flutes.

e. 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.

f. All reinforcement shall have minimum concrete cover of 1 inch.

g. The plan dimensions of both layers of primary deck reinforcement from the top surface of the concrete deck shall be maintained.

h. Permanent steel bridge deck form shall not be considered as lateral bracing for compression flanges of supporting structural members.

i. Permanent steel bridge deck form shall not be used in panels where longitudinal deck construction joints are located between stringers.

j. Welding shall not be permitted to flanges in tension or to structural steel bridge elements fabricated from nonweldable grades of steel.

J. Fabricator's shop and erection drawings shall be submitted to the Engineer for approval. These drawings shall indicate the material properties and grade of steel, the properties of geometric sections for all permanent steel bridge deck form sheets, and all locations where the forms are in the vicinity of steel beam flanges subject to tensile stresses.

K. Form Supports:

1. Form sheets shall not be permitted to rest directly on the top of the stringer or floor beam flanges.

2. Sheets shall be securely fastened to form supports and shall have a minimum bearing length of 1 inch at each end.

3. Form supports shall be placed in direct contact with the flange of stringer or floor beam.

4. All attachments shall be made by permissible welds, bolts, clips, or other approved means.

5. Welding of form supports to flanges of steel not considered weldable and to portions of flange subject to tensile stresses shall not be permitted.

6. Welding and welds shall be in accordance with the provisions of AWS D2.0 pertaining to fillet welds except that 1/8-inch fillet welds will be permitted.

L. Any permanently exposed form metal where the galvanized coating has been damaged shall be thoroughly cleaned, wire brushed, and painted with 2 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.

M. Transverse construction joints shall be located at the bottom of the flute and 1/4-inch weep holes shall be field drilled at not more than 12 inches on center along the line of the joint.

N. Emphasis shall be placed on proper vibration of the concrete to avoid honeycomb and voids.

1. Pouring sequences, procedures, and mixes shall be approved by the Engineer.

2. Calcium chloride or any other admixture containing chloride salts shall not be used in the concrete placed on permanent steel bridge deck forms.

O. The Contractor's method of construction shall be carefully observed during all phases of the construction of the bridge deck slab.

1. 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.

2. 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 1 section of the forms at a location and time selected by the Engineer for each span in the contract.

3. 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.

4. An additional section shall be removed if the Engineer determines that there has been any change in the concrete mix or procedures warranting additional inspection.

P. After the deck concrete has been in place for a minimum period of 2 days, the concrete shall be tested for soundness and bonding of the forms by sounding with a hammer as directed by the Engineer.

1. 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.
2. This removal of the permanent steel bridge deck forms shall be at no additional cost to the Contracting Agency.
3. 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 ensure their satisfactory retention.
4. As soon as the form is removed, the concrete surfaces will be examined for cavities, honeycombing and other defects.
5. 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.
6. 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.
7. All unsatisfactory concrete shall be removed or repaired as directed by the Engineer.

Q. 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

A. 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 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 the plans as may be required.

B. In addition to the detailed drawings of the falsework or centering which are to be furnished to the Engineer as specified herein, the Contractor shall also furnish the Engineer with a copy of falsework or centering design calculations.

C. All falsework or centering shall be designed and constructed to provide the necessary rigidity and to support the loads.

1. 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 1 time.
2. For designing falsework and centering, a weight of 150 pounds per cubic foot shall be assumed for green concrete (120 pounds for lightweight concrete) and an allowance of not less than 25 pounds per cubic foot for forms, live load, and impact.
3. Falsework or forms shall be constructed to produce in the finished structure the lines and grades indicated on the plans.

4. 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.

5. Excessive use of blocking and shims shall be cause for rejection of the falsework.

6. Falsework failures shall become the sole responsibility of the Contractor.

D. Immediately prior to placing bridge or slab concrete, the Contractor shall check all falsework and wedges or jacks and shall make all necessary adjustments.

1. Care shall be exercised to ensure that settlement and deflection due to the added weight of the deck or slab concrete will be minimal.

2. Suitable means such as telltales shall be provided by the Contractor to permit ready measurement of settlement and deflection as it occurs.

E. 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.

F. 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 2 or more adjacent arch spans will be struck simultaneously.

G. 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.

H. Falsework and forms left in place in the cells of box girders shall not exceed 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 48 hours.

502.03.04 REINFORCEMENT

A. 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

A. 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.

B. 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."

1. Approval of such drawings shall in no way relieve the Contractor of Contractor's responsibility under the contract for the successful completion of the improvement.

2. Cofferdam construction shall not start before the submitted drawings are approved and returned.

C. After the completion of the substructure, the cofferdams with all sheeting and bracing shall be removed to 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

A. 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.

B. No pumping will be permitted during the placing of concrete or for a period of at least 24 hours thereafter, unless it be done from a suitable pump separated from the concrete work by a watertight wall or other effective means.

C. Pumping to dewater a sealed cofferdam shall not commence until the seal has set sufficiently to withstand the hydrostatic pressure.

502.03.07 MIXING CONCRETE

A. 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.

1. 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.

2. These temporary members shall be entirely removed from the forms and not buried in the concrete.

B. No concrete shall be used which does not reach its final position in the forms within the time and temperature stipulated under Section 501, "Portland Cement Concrete."

C. Surfaces on which concrete is to be placed shall be thoroughly moistened with water immediately before placing concrete.

D. Concrete shall be placed so as to avoid segregation of the material and the displacement of the reinforcement.

1. 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.

2. 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.

3. 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.

4. 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.

E. When placing operations would involve dropping the concrete more than 5 feet, concrete shall be deposited through sheet metal or other approved pipes, except when placing

concrete for thin vertical walls less than 15 inches thick, double belting may be used in lieu of adjustable pipes or elephant trunks.

1. As far as practicable, the pipes shall be kept full of concrete during placing and the lower ends of pipe shall be kept buried in the newly placed concrete.

2. After initial set of the concrete, the forms shall not be jarred and no strain shall be placed on the projecting ends of reinforcement bars.

F. All concrete placed in concrete structures, except tremie seal 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 15 minutes after concrete is deposited in the forms. In all cases, at least 2 vibrators shall be available at the site of the structures in which more than 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 4,500 impulses per minute.

4. The intensity of vibration shall be such as to visibly affect a mass of concrete of 1-inch slump over a radius of at least 18 inches.

5. Vibrators shall be manipulated to thoroughly work the concrete around the reinforcement and imbedded fixtures and into the corners and angles of the forms.

6. 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.

7. The vibration shall be of sufficient duration and intensity to thoroughly compact the concrete, but shall not be continued at any 1 point to the extent that localized areas of grout are formed.

8. Application of vibrators shall be at points uniformly spaced and not farther apart than twice the radius over which the vibration is visibly effective.

9. 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.

10. Vibration 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.

11. Vibration shall be supplemented by such spading as is necessary to ensure smooth surfaces and dense concrete, along form surfaces and in corners and locations impossible to reach with the vibrators.

12. 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.

G. Immediately following the discontinuance of placing concrete, all accumulations of mortar splashed upon the reinforcement steel and the surface of forms shall be removed.

1. Dried mortar chips and dust shall not be puddled into the unset concrete.

2. 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.

H. **Culverts.**

1. The base slab or footings of box culverts shall be placed and allowed to set before the remainder of the culvert is constructed. Suitable provisions shall be made for bonding the sidewalls to the culvert base.

2. 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 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.

3. 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 2 hours before the top slab is placed.

4. 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 12 hours before the top slab is placed.

5. 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.

I. **Girders, Slabs, and Columns.**

1. When the height of a web in a "T" beam is more than 3 feet, the top slab shall be poured independently.

2. When the distance from a construction joint to the top of the web in a box girder exceeds 3 feet, the top slab shall be poured independently.

3. Concrete in slab spans shall be placed in 1 continuous operation for each span unless otherwise specified.

4. Concrete in columns shall be placed in 1 continuous operation, unless otherwise specified. The concrete shall be allowed to set at least 12 hours before the succeeding pour is started.

5. 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 CONCRETE DEPOSITED UNDER WATER

A. If conditions render it impossible or inadvisable, in the opinion of the Engineer, to dewater excavation 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.

1. The concrete shall be carefully placed in a compact mass and shall not be disturbed after being deposited.

2. Still water shall be maintained at the point of deposit.

B. The use of an aluminum tremie for placing concrete is prohibited.

C. A tremie shall consist of a watertight tube having a diameter of not less than 10 inches with a hopper at the top.

1. The tube shall be equipped with a device that will prevent water from entering the tube while charging the tube with concrete.

2. 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.

3. The tremie shall be filled by a method that will prevent washing of the concrete.

4. 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.

5. 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.

6. The flow shall be continuous until the work is completed and the resulting concrete seal shall be monolithic and homogeneous.

D. The underwater bucket shall have an open top and the bottom doors shall open freely and outward when tripped.

1. 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.

2. After discharge, the bucket shall be raised slowly until well above the concrete.

E. Concrete deposited in water shall be in accordance with Section 501, "Portland Cement Concrete," with 10 percent extra cement added.

1. 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 2 feet in thickness, unless otherwise shown on the plans.

2. Before dewatering, the concrete in the seal shall be allowed to cure for not less than 5 days after placing.

F. If a seal which is to withstand hydrostatic pressure is placed in water having a temperature below 45 degrees F, the curing time before dewatering shall be increased.

1. Periods of time during which the temperature of the water has been continuously below 38 degrees F shall not be considered as curing time.

2. After sufficient time has elapsed to ensure adequate strength in the concrete seal, the cofferdam shall be dewatered and the top of the concrete cleaned of all scum, laitance, and sediment.

3. Before fresh concrete is deposited, local high spots shall be removed as necessary to provide proper clearance for reinforcing steel.

502.03.10 CONSTRUCTION JOINTS

A. Construction joints shall be made only where located on the plans or shown in the pouring schedule, unless otherwise approved by the Engineer.

B. 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.

1. The placing of concrete shall be continuous from joint to joint.
2. These joints shall be perpendicular to the principal lines of stress and, in general, located at points of minimum shear.
3. Only joints shown on the plans will be permitted in a cantilevered member.
4. Horizontal joints at piers and abutments, except where specified, shall be avoided, and when used shall not be located within 2 feet of the normal water level.

C. Unless otherwise specified, construction joints shall be struck off but not troweled.

D. 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 straight by placing a temporary straightedge on the inside of the form and pouring the concrete so that it will set flush with the edge as provided.

E. 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 slope top surface of a wing wall, an insert form block shall be used to produce a blocked out portion in the proceeding layer which shall produce an edge thickness of not less than 6 inches in the succeeding layer.

F. 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, the Contractor 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.

G. 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 1 of the following methods:

1. Concrete surface of fresh concrete (not more than 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.
2. Hardened concrete surface (more than 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.

H. 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.

502.03.11 REMOVAL OF FALSEWORK AND FORMS

A. **General.**

1. Methods of form removal likely to cause overstressing of the concrete shall not be used.
   a. Forms and their supports shall not be removed without the approval of the Engineer.

b. 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 ASTM C39 and ASTM C31 and will be considered information tests only and not acceptance tests as described in Subsection 501.02.04, "Concrete Making Properties."

3. Comply with Subsection 501.03.09, "Curing."

B. **Falsework.**

1. 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 10 days and it has reached 75 percent of the required 28-day compressive strength.

2. In the event of cold weather, the 10-day time requirements shall be increased 1 day for every day the curing time is increased as prescribed in Subsection 501.03.10.B, "Cold Weather — General."

3. 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.

4. Form removal and replacement with shoring will not be permitted.

C. **Forms.**

1. Forms on parapets and curbs shall not be removed until concrete has set sufficiently to prevent distorting or cracking.

2. Forms for columns, walls, side of beams, girders and all other parts that are not subjected to stress shall not be removed until the concrete has reached a minimum age of 40 hours unless authorized by the Engineer.

3. Forms that are subjected to stresses shall not be removed until the requirements of Subsection 502.03.11.B have been satisfied, unless otherwise approved by the Engineer.

502.03.12 EXPANSION AND FIXED JOINTS AND BEARINGS

A. All joints shall be constructed according to details shown on the plans and as specified in this subsection.

B. **Open Joints.**

1. 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.

2. The insertion and removal of the template shall be accomplished without chipping or breaking the corners of the concrete.

3. Reinforcement shall not extend across an open joint unless so specified on the plans.

C. **Filled Joints.**

1. Poured expansion joints shall be constructed similar to open joints.

2. When premolded types are specified, the filler shall be placed in correct position before concrete is placed against the filler.

3. Holes and joints in the filler shall be filled with mastic to prevent the passage of mortar or concrete from 1 side of the joint to the other.

4. The edges of the concrete at the joint shall be edger finished.

D. **Steel Joints.**

1. The plates, angles, or other structural shapes shall be accurately shaped, at the shop, to conform to the section of the concrete floor.

2. The fabrication and painting shall conform to the requirements of these specifications covering those items.

3. When called for on the plans or in the Special Provisions, the materials shall be galvanized in lieu of painting.

4. Care shall be taken to ensure that the surface in the finished plane is true and free of warping.

5. Positive methods shall be employed in placing the joints to keep the joints in correct position during the placing of the concrete.

6. 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.

E. **Waterstops.**

1. Waterstops shall be furnished and installed in accordance with the details shown on the plans.

2. The edge of the waterstop shall be supported in a manner satisfactory to the Engineer.

3. Waterstops shall be manufactured from either natural rubber, synthetic rubber, or polyvinyl chloride (PVC) at the option of the Contractor.

4. Waterstops shall be manufactured with an integral cross section which shall be uniform within ±1/8 inch in width, and the web thickness or bulb diameter, within +1/16 inch and -1/32 inch .

   a. No splices will be permitted in straight strips.

   b. Strips and special connection pieces shall be well cured in a manner such that any cross section shall be dense, homogeneous, and free from porosity.

   c. Junctions in the special connection pieces shall be fully molded.

   d. During the vulcanizing period, the joint shall be securely held by suitable clamps.

   e. The material at the splices shall be dense and homogeneous throughout the cross section.

5. 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 600x (width in inches) pounds.

6. Field splices for polyvinyl chloride waterstops shall be formed by heat sealing the adjacent surfaces in accordance with the manufacturer's recommendations.

   a. A thermostatically controlled electric source of heat shall be used to make all splices.

   b. The heat shall be sufficient to melt but not char the plastic.

7. 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.

F. **Bearing Devices.**

1. 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."

2. Structural steel and cast steel shall conform to the provisions in Section 506, "Steel Structures," for those items.

3. 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.

4. When bearing assemblies or masonry plates are shown on the plans to be placed (not embedded) directly on concrete, the concreted 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 1/8 inch from the elevation shown on the plans.

5. 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 1/16 inch from a straightedge placed in any direction across the area. The finished plane shall not vary more than 1/8 inch from the elevation shown on the plans.

6. 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 506.03.25, "Bearing and Anchorage."

G. **Elastomeric Bearing Pads.**

1. Pads over 1 inch in thickness shall be laminated.

2. Laminated pads shall consist of alternate laminations of elastomer and metal or elastomer and fabric bonded together.

3. All elastomeric bearing pads shall be 50 durometer.

4. Pads shall be installed where designated on the plans.

502.03.13 CURING

A. Curing of formed concrete shall conform to the requirements of Subsection 501.03.09, "Curing."

502.03.14 PATCHING

A. After removal of forms, all metal ties except those to be used to aid future forming shall be cut back and patched.

1. Honeycomb shall be removed and patched.
2. When honeycomb is determined by the Engineer to be excessive, the excessive honeycombing shall be sufficient cause for rejection of all or a part of the structure.

B. Loose or broken material shall be chipped away until a dense, uniform surface exposing solid coarse aggregate is obtained.

1. Feather edges shall be cut away to form a face perpendicular to the surface being patched.
2. All surfaces of the cavity shall be thoroughly saturated with water.
3. Contact surfaces shall be coated with an approved bonding agent.
4. Bonding agent may be mixed with mortar in lieu of coating the contact surfaces.

C. Patching mortar shall consist of 1 part cement and 3 parts sand.

1. White cement or other approved tinting materials shall be used on all surfaces where an "ordinary finish" is final.
2. For patching large or deep areas, coarse aggregate shall be added to the patching mortar.

D. The patching mortar shall be thoroughly tamped into place.

1. Mortar may be placed pneumatically when approved by the Engineer.
2. The surface of the mortar shall be floated with a wooden float before initial set takes place.
3. The patch shall present a neat and workmanlike appearance.

E. The patched surface shall be cured by 1 of the methods described in Subsection 501.03.09, "Curing."

F. Patching is the only treatment required for those portions of the structure below ground.

502.03.15 FINISH OF HORIZONTAL SURFACES

A. 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.

1. When a transversely broomed finish is used, the allowable variations noted herein shall be independent of the depth of the broom marks.
2. No variations will be permitted that will tend to prevent complete drainage on all parts of the deck.
3. The surface shall be corrected by grinding off the high spots, or other approved method, as may be required to conform to these limits.
4. An edging tool shall be used at expansion joints and deck edges not armored.

B. Approach slabs to concrete bridges shall be finished to the tolerances specified for bridge decks.

C. Finishing Bridge Decks.

1. A smooth riding surface of uniform texture, true to the required grade and cross section, shall be obtained on all bridge roadway decks.

2. 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.

3. Finishing of concrete placed in bridge decks shall consist of striking off the surface of the concrete as placed and floating with longitudinal floats the surface so struck off.

4. The placing of concrete in bridge roadway decks will not be permitted until the Engineer is satisfied that:

   a. The rate of producing and placing concrete will be sufficient to complete the proposed placing and finishing operations within the scheduled time.

   b. Experienced finishing machine operators and concrete finishers are employed to finish the deck.

   c. Fogging equipment and all necessary finishing tools and equipment are on hand at the site of the work and in satisfactory condition for use.

5. Finishing machines shall be set up sufficiently in advance of use to permit inspection by the Engineer during the daylight hours before each pour.

6. 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.

7. 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.

8. Rails for the support and operation of finishing machines and headers for hand-operated strike off devices shall be completely in place and firmly secured for the scheduled length for concrete placement before placing of concrete will be permitted.

   a. Rails for finishing machines shall extend beyond both ends of the scheduled length for concrete placement a sufficient distance that will permit the float of the finishing machine to fully clear the concrete to be placed.

   b. Rails or headers 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.

   c. Rails or headers 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.

   d. Rails or headers shall be adjusted as necessary to correct for unanticipated settlement or deflection which may occur during finishing operations.

9. 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.

    a. 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 the location determined by the Engineer.

    b. All concrete in place ahead of the bulkhead shall be removed.

10. Unless otherwise permitted by the Engineer, bridge deck concrete shall be placed 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 10 feet ahead of strike-off.

11. After the concrete has been placed and consolidated, the surface of the concrete shall be carefully struck off by means of a hand-operated strike board operating on headers, or by a finishing machine operating on rails. A uniform deck surface true to the required grade and cross section shall be obtained.

12. Following strike off, the surface of the concrete shall be floated longitudinally.

    a. In the event strike off is performed by means of a hand-operated strike board, 2 separate hand-operated float boards for longitudinal floating shall be provided.

    b. The first float shall be placed in operation as soon as the condition of the concrete will permit and the second float shall be operated as far back of the first float as the workability of the concrete will permit.

13. In the event the strike off is performed with a finishing machine, longitudinal floating of the concrete shall be performed by means of a hand-operated float board or a finishing machine equipped with a longitudinal wooden float.

    a. The longitudinal wooden float on the finishing machine shall have a length of not less than 8 feet nor more than 12 feet.

    b. When both strike off and longitudinal floating are to be performed by finishing machines, 1 machine, with operator, shall be used for strike off and a second machine, with second operator, shall be used for longitudinal floating.

    c. Longitudinal floating may be performed with the same finishing machine that is used for strike off provided that the length of deck unit being placed is not more than 30 feet and the strike off operation is completed for the deck unit before the condition of the concrete requires that longitudinal floating be started.

14. Finishing machines used for strike off having a wheel base 6 feet or less shall be followed by 2 separate hand-operated float boards for longitudinal floating. All the provisions in this section pertaining to hand-operated float boards shall apply to the 2 separate float boards for longitudinal floating.

15. 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.

a. 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.

b. Each pass of the float shall lap the previous pass by 1/2 the length of the float.

c. Floating shall be continued until a smooth riding surface is obtained.

D. 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.

E. Hand-operated float boards shall be from 12 feet to 16 feet long, ribbed and trussed as necessary to provide a rigid float and shall be equipped with adjustable handles at each end.

1. The float shall be wood, not less than 1 inch thick and from 4 inches to 8 inches wide.

2. Adjusting screws spaced at not to exceed 24 inches on centers shall be provided between the float and the rib.

3. The float board shall be maintained true and free of twist.

F. Hand-operated float boards shall be operated from transverse finishing bridges.

1. 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.

2. Not less than 2 transverse finishing bridges shall be provided when hand-operated float boards are used.

3. When a finishing machine is used for longitudinal floating, 1 finishing bridge equivalent to the transverse finishing bridge specified herein shall be furnished for use by the Engineer.

G. 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.

H. Fogging equipment 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. The fog mist shall be applied at the time and in the manner approved by the Engineer.

I. Immediately following completion of the deck finishing operations, the concrete in the deck shall be cured as specified in Subsection 501.03.09, "Curing."

J. The finished surface of the concrete shall be tested by means of a straightedge 12 feet long.

1. The surface shall not vary more than 0.01 foot from the lower edge of the straightedge.

2. All high areas in the hardened surface in excess of 0.01 foot as indicated by testing shall be removed by abrasive means.

3. 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.

4. Ground areas shall be of uniform texture and shall present neat and approximately rectangular patterns.

K. Where the concrete of the bridge deck is to be covered by bituminous surfacing, earth, or other cover, 1 inch or more in thickness, the surface of the concrete shall not vary more than 0.03 feet from the lower edge of the 12-foot straightedge.

L. 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.

M. 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 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 1/8 inch from the theoretical grade or alignment in 12 feet, except that proper allowance shall be made for curves and camber.

N. Manual methods, other than specified in this subsection, or other machine methods for finishing bridge deck concrete may be permitted in accordance with the provisions in Subsection 108.05, "Character of Workmen; Methods and Equipment."

502.03.16 FORMED SURFACES REQUIRING FINISHING

A. Structures requiring a "fine surface finish (F.S.F.)" will be noted on the plans.

B. All structures not requiring a fine surface finish shall be given an ordinary surface finish.

C. Only exposed surfaces of structures will require finishing (ordinary or fine).

D. Exposed surfaces are defined as follows:

1. Exterior vertical faces of slab spans, rigid frames, arches, and box girders.

2. The underside of overhanging slabs to point of junction of the supporting beams.

3. Vertical surfaces of piers, columns, bent caps, abutments, wing walls, and retaining walls which are exposed to view after all backfill and embankment is placed. Exposed surfaces in this case are considered to extend to 1 foot below finished grade.

4. The inside of culvert barrels over 4 feet in height for the same distance as the height of the opening when seen from a traveled way.

5. The underside of superstructures in urban areas.

502.03.17 ORDINARY SURFACE FINISH

A. The surface shall have all holes left by form ties and all other holes 1/4 inch or more in largest diameter repaired in accordance with Subsection 502.03.14, "Patching." The surface shall be true and even, free from stone pockets, depressions, or projections beyond the surface.

B. All fins and projections shall be knocked off or ground flush. Offsets greater than 1/8 inch shall be filled or tapered back to present a smooth appearance. A uniform color and appearance shall be obtained on all patched surfaces.

502.03.18 FINE SURFACE FINISH

A. 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 specified below.

1. Before the finish is applied, the surface shall be true and even and free from stone pockets, depressions, or projections beyond the surface.
2. All fins and projections shall be knocked off or ground flush.
3. Offsets greater than 1/8 inch shall be filled or tapered back to present a smooth appearance.
4. All holes 1/4 inch or more in largest diameter shall be patched in accordance with Subsection 502.03.14, "Patching."

B. **Bonded Grout Finish.**

1. This finish shall be an application of grout consisting of sand and other pigments and mineral fillers combined with a suitable binder.
   a. The sand shall pass a No. 30 sieve.
   b. The binder shall be either an epoxy, acrylic, vinyl, or phenolic resin.
   c. This mixture may be thinned by not more than 25 percent water by volume.
2. 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, "Concrete Surface Finishing Material."
3. At least 30 days in advance of placing bonded grout finish, the Contractor shall furnish the Engineer a quart sample or larger, of the complete mixture for testing.
   a. The Contractor shall also furnish 2 certificates, issued by the manufacturer, certifying that the product complies with the specifications.
   b. The certificates shall be delivered to the Engineer at least 30 days in advance of placing the material.
4. The grout shall be applied by spray, using conventional spray equipment with a 1/4-inch round spray head.
   a. Material shall be supplied by either a surge pump with a 12-to-1 ratio or an auger type pump, with air pressure sufficient to achieve uniform texture.
   b. Worn spray heads shall be replaced as required to achieve a uniform finish.
5. Application shall be at the rate of 25-40 square feet per gallon.
6. The finish surface shall present a uniform appearance.
7. Color of fine surface finish to be applied will be 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.
8. Surfaces of concrete shall be thoroughly cleaned just before applying fine surface finish. This may be accomplished by:
   a. Application of a 10 percent solution of muriatic acid or a 25 percent zinc sulfate solution, which shall be applied to completely remove oily film and to lightly etch the surface, or
   b. Thorough cleaning by an approved abrasive as required to remove all oily film.

9. 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.

10. **CAUTION:** Do not apply finish unless temperature is at least 40 degrees F and is rising. Application shall be stopped if temperature is 40 degrees F and is dropping.

502.03.19 LIVE LOADS

A. Live loads such as traffic or superimposed earth loads shall not be allowed on the structure until concrete has reached an age of 14 days and has reached the 28-day compressive strength required.

B. Live loads may be allowed on the structure, with the approval of the Engineer, when the concrete has reached an age of 8 days and/or the 28-day compressive strength required in cases where Type III (high-early strength) cement is used.

C. Approach slabs shall be treated as concrete paving under Section 409, "Portland Cement Concrete Pavement."

D. In the event of cold weather, the above specified time requirement shall be increased 1 day for every day the curing time is increased as prescribed in the Subsection 501.03.10.B, "Cold Weather — General."

E. 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

A. The estimated quantity shown on the plans, plus or minus quantities covered by approved changes will be the quantity used for payment.

1. The Contractor may, however, request a final measurement and calculation.

2. The Contractor's request for final measurement and calculation shall be in writing.

3. 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.

4. Each class of concrete will be considered separately.

5. Furthermore, when the Contractor requests final measurement and calculations and the quantities thus determined are the same or less than the planned quantities plus authorized changes, the Contractor shall reimburse the Contracting Agency for the Agency's expenses incurred by such final measurements and calculations.

B. Box culverts, bridges, and 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.

C. Pipe headwalls, endwalls, drop inlets, and 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)."

D. In the event any class of Portland cement concrete is placed and is shown by test to be below any specified 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.

E. This determination shall be based on an evaluation of the durability and other qualities of the concrete necessary to the integrity of the structure.

1. If the concrete is allowed to remain in place, it is agreed by the parties to the contract that the Contracting Agency will deduct from money due, or to become due the Contractor from the Contracting Agency, a percentage of the contract unit bid price.

2. This deduction shall be considered to be liquidated damages and shall be at a rate of 5 percent of the contract unit bid price for each 50 psi or portion thereof below the specified minimum compressive strength, to a maximum of 50 percent, as set forth in the following example for the class of concrete shown:

Specified 28-Day Compressive Strength	**Liquidated Damages (Per Unit Bid Price)**
psi	**Percent**
3000	0
2999-2950	5
2949-2900	10
2899-2850	15
2849-2800	20
2799-2750	25
2749-2700	30
2699-2650	35
2649-2600	40
2599-2550	45
2549-2500	50
Below 2500	Remove

F. The reduced price shall apply to all concrete represented by the strength tests below the specified minimum compressive strength.

G. When a compressive strength test falls below the specified 28-day compressive strength, the Contracting Agency may determine that an alternate strength test is required or the Contractor may request such a test.

1. When the Contracting Agency determines an alternate strength test is required, the Contractor will not be liable for the cost of such test.

2. In case the Contracting Agency has not determined that an alternate strength test is necessary and the Contractor elects to have an alternate strength test made, the Contracting Agency will then make such a test; however, should this test indicate that the 28-day compressive strength requirement has not been met, the cost thereof shall be deducted from any money due or to become due the Contractor from the Contracting Agency.

3. The cost of all other alternate strength tests made at the Contractor's request shall be borne by the Contractor.

4. The alternate strength test shall consist of obtaining and testing 3 drilled core samples in accordance with ASTM C42.

5. 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.

6. The cores shall be obtained and the test performed by the Contracting Agency.

7. The test shall be accomplished as soon as possible after the 28-day compressive strength test.

H. The average compressive strength of the 3 drilled core samples at the age tested shall be converted to a 28-day compressive strength by subtracting 8 psi from the average for each day beyond 28 days, with a maximum conversion adjustment of 200 psi.

1. This calculation value shall be termed the "result of the core test." When the result of the core test validates the original 28-day strength test, the quality of the concrete shall be assessed on the basis of the original test.

2. When the core test does not validate the 28-day strength, then the result of the core test shall be used to assess the quality of the concrete.

I. Concrete removed will not be paid for and the removal thereof will be at no additional cost to the Contracting Agency.

J. No measurement or other allowances will be made for work, materials for forms, falsework, cofferdam, pumping, bracing, and so forth.

K. The quantity of concrete involved in fillets, scorings, and chamfers 2 square inches or less in cross-sectional area shall be neglected.

1. No deduction shall be made for the volume of concrete displaced by reinforcing steel, expansion joint material, drainage, and weep holes.

2. The volume of concrete displaced by pipes, conduits, ducts, and forms for voids embedded in concrete that are in excess of 2 square inches in cross-sectional area shall be deducted.

3. Deductions shall also be made for the volume of timber piles, concrete piles, and cast-in-place piles embedded in the concrete.

L. Each class of concrete will be considered separately.

M. Tremie seal concrete will be measured on the basis of batched volume placed.

N. The quantity of concrete rail to be measured for payment will be the number of linear feet complete and in place.

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

BASIS OF PAYMENT

502.05.01 PAYMENT

A. 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.

1. Reinforcing steel will be paid for as provided in Section 505, "Reinforcing Steel."

2. All metal parts, fabrics, pads, joint fillers, drains, and 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.

B. The accepted quantity of concrete rail measured as provided in Subsection 502.04.01, "Measurement," will be paid for at the contract unit price bid per linear foot.

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

D. Payment will be made under:

PAY ITEM	PAY UNIT
Class _____ Concrete (Major)	Cubic Yard
Class _____ Concrete (Minor)	Cubic Yard
Concrete Rail	Linear Foot
Tremie Seal Concrete	Cubic Yard
Class _____ Concrete, Modified (Major)	Cubic Yard

SECTION 503

PRECAST PRESTRESSED CONCRETE MEMBERS

DESCRIPTION

503.01.01 GENERAL

A. This work shall consist of furnishing and placing precast prestressed concrete members as specified in these specifications and the contract documents.

B. 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."

C. 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

A. Concrete shall conform to the applicable requirements of Section 501, "Portland Cement Concrete" and Section 502, "Concrete Structures."

B. Prestressing steel shall conform to the applicable requirements of Section 713, "Reinforcing."

C. If lightweight concrete is used, this concrete shall conform to the applicable requirements of Section 504, "Lightweight Concrete for Structures."

CONSTRUCTION

503.03.01 PRESTRESSING METHODS

A. Prestressing shall be performed by either pretensioning or post-tensioning methods. The method of prestressing to be used shall be optional with the Contractor, subject to the requirements specified in these specifications.

B. 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 the Contractor proposes to use in the prestressing and construction and erection operations.

1. Details shall outline the method of prestressing, and shall include:

   a. The arrangement of the prestressing steel and mild steel reinforcement in the members.

   b. Anchoring stresses.

   c. Sequence of stressing post-tensioned prestressing steel.

   d. Sequence of cutting or releasing pretensioned prestressing steel.

   e. Type of post-tensioning enclosures.

   f. Specifications and details of anchoring devices and distribution plates or assemblies, if required, for post-tensioning and pressure grouting materials and equipment.

g. Complete drawings of the forms proposed for casting the precast members. These drawings shall show complete details of the type of forms proposed for providing the ducts and proposed method of supporting and anchoring the forms.

2. Working drawings shall be in accordance with Subsection 105.02, "Plans and Working Drawings."

503.03.02 FORMS

A. Concrete shall not be deposited in the forms until the Engineer has inspected the placing of the reinforcement, enclosure, anchorages, and prestressing steel.

B. 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.

C. 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.

D. 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.

E. 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.

F. 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

A. Anchorages and distribution shall be constructed as specified in Subsection 495.03.02, "Anchorages and Distribution."

503.03.04 ENCLOSURES

A. 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.

B. 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.

C. 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

A. All prestressing steel shall be tensioned by means of hydraulic jacks.

1. Each jack shall be equipped with either a pressure gauge or a load cell for determining the jacking stress, at the option of the Contractor.

2. The pressure gauge, if used, shall have an accurate reading dial at least 6 inches in diameter.

3. Each jack and its gauge 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.

4. 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.

5. The range of the load cell shall be such that the lower 10 percent of the manufacturer's rated capacity will not be used in determining the jacking stress.

B. The tensioning of prestressing steel in any post-tensioned member and the cutting or releasing of prestressing steel in any pretensioned member shall not be performed until tests on concrete cylinders made of the same concrete and cured under conditions identical to the member have attained the minimum compressive strength value specified for detensioning or stressing of the steel.

C. 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 3 hours prior to placing concrete for the members.

1. The method and equipment for checking the loss of prestress shall be subject to approval by the Engineer.

2. All tendons which show a loss of prestress in excess of 3 percent shall be retensioned to the original computed jacking stress.

D. 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 75 percent of the specified minimum ultimate tensile strength of the prestressing steel.

E. 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.

F. 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.

G. Post-tensioning 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.

H. The tensioned 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 gauge pressures and elongations at all times and shall be submitted to the Engineer for approval.

I. Prestressing steel in post-tensioned members shall be tensioned by simultaneously jacking at each end of the assembly, except as provided in the following:

1. Jacking from 1 end of the assembly will be permitted on simple span members under 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 70 percent of the specified minimum ultimate tensile strength of the prestressing steel.

2. For simple span members 65 feet and over in length, jacking from 1 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 70 percent of the specified minimum ultimate tensile strength of the prestressing steel.

J. Unless otherwise permitted by the Engineer, half of the prestressing steel in each member shall be stressed from 1 end of the span and the other half from the opposite end.

K. Determination of the jacking stresses shall be supported by calculations, or by calculations and field tests when so specified, prepared by the Contractor.

1. The Contractor shall submit Contractor's calculations to the Engineer for approval.

2. Prior to making field tests, the Contractor shall submit to the Engineer for approval details of Contractor's proposed gauges and load devices for determining the jacking load at each end of the test prestressing unit.

3. Unless otherwise permitted by the Engineer, a load cell shall be used at the end opposite the jacking end.

4. Measurement of elongation and stress shall agree within 3 percent.

5. The stress at the center will be calculated from the average of the end test loads.

6. Jacking stresses within 2 percent of the calculated required jacking stresses will be considered satisfactory.

L. 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	0.0020	0.30
	Galvanized	0.0015	0.25
Bright metal bars	Bright Metal	0.0003	0.20
	Galvanized	0.0002	0.15

M. The maximum temporary tensile stress (jacking stress) in prestressing steel shall not exceed 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 70 percent of the specified minimum ultimate tensile of strength of the prestressing steel.

N. The loss of stress in post-tensioned 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.

O. 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
Inches	psi
3/8	3,500
7/16	4,000
1/2	4,000

P. 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 60 percent of the specified minimum ultimate tensile strength of the prestressing steel.

Q. 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 of 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.

503.03.06 CURING

A. Curing shall conform to the applicable provisions of Subsection 501.03.09, "Curing," and, in addition, the following steam curing requirements shall apply.

B. Any steam curing operation which deviates from the procedure listed below shall be subject to the approval of the Engineer.

C. Steam curing shall be done under a suitable enclosure to contain the live steam in order to minimize moisture and heat losses.

1. The initial application of the steam shall be from 2 to 4 hours after the final placement of concrete to allow the initial set of the concrete to take place.
2. If retarders are used, the waiting period before application of the steam shall be from 4 to 6 hours.
3. The steam shall be at 100 percent relative humidity to prevent loss of moisture and to provide excess moisture for proper hydration of the cement.
4. Application of the steam shall not be directly on the concrete.
5. During application of the steam, the ambient air temperatures shall increase at a rate not to exceed 40 degrees F per hour until a maximum temperature of from 140 degrees F to 160 degrees F is reached.
6. The maximum temperature shall be held until the concrete has reached the desired strength.
7. In discontinuing the steam, the ambient air temperature shall decrease at a rate not to exceed 40 degrees F per hour until a temperature has been reached about 20 degrees F above the temperature of the air to which the concrete will be exposed.
8. The concrete shall not be exposed to temperatures below freezing for 6 days after casting.

503.03.07 SHIPPING

A. For prefabricated tendons, the Contractor shall give the Engineer at least 10 days' notice before commencing the installation of end fittings or the heading of wires. The Engineer will inspect end fitting installation 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.

B. No prefabricated tendon shall be shipped to the site without first having been released by the Engineer.

1. Each tendon shall be tagged before shipment for identification purposes at the site.

2. All unidentified tendons received at the site will be rejected.

C. 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

A. 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.

B. Precast prestressed members shall be handled, transported, and erected in an upright position, and the points of support and direction 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

A. 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.

1. **Precast Prestressed Concrete I-Beams.**

Dimension	Tolerance
Depth (flanges, web, and fillets)	±1/4 inch
Depth (overall)	+1/2 inch to -1/4 inch
Width (flanges and fillets)	+3/8 inch to -1/4 inch
Width (web)	+3/8 inch to -1/4 inch
Length of Beam	±1/8 inch per 10 feet or 1/2 inch whichever is greater
Exposed Beam Ends Deviation from square or designated skew	Horizontal ±1/4 inch Vertical ±1/8 inch per 10 feet of beam height
Side inserts (spacing between centers of inserts and from the centers of inserts to the ends of the beams)	±1/2 inch
Bearing Plates (spacing between the centers of bearing plates)	±1/8 inch per 10 feet or 1/2 inch whichever is greater
Bearing Plates (spacing from the centers of bearing plates to the ends of the beams)	±1/2 inch
Bearing Plate or Bearing Area deviation from plane	±1/16 inch
Stirrup Bars – Projection above top of beam	±3/4 inch
Stirrup Bars – Longitudinal Spacing	±1 inch
End Stirrup Bars	not more than 2 inches from the end of the beam
Horizontal Alignment (deviation from a straight line	1/8 inch per 10 feet

Dimension	Tolerance
parallel to the centerline of beam)	
Camber differential between to adjacent beams	1/8 inch per 10 feet of span to maximum of 1 inch
Center of gravity of strand group	±1/4 inch
Center of gravity of depressed strand group at end of beam	±1/2 inch
Position of post-tensioning duct	±1/4 inch
Position of hold-down points for depressed strands	±6 inches
Position of handling devices	±6 inches

2. **Precast Prestressed Concrete Box Beams and Flat Slabs.**

Dimension	Tolerance
Depth (top slab)	±1/2 inch
Depth (bottom slab)	+2 inches
Depth (overall)	±1/4 inch
Width (web)	±3/8 inch
Width (overall)	±1/4 inch
Length	±1/8 inch per 10 feet or 1/2 inch whichever is greater ±1/2 inch from end of void to center tie hole
Void Position	±1 inch adjacent to end block
Square Ends (deviation from square)	±1/4 inch
Skew Ends (deviation from designated skew)	
Skew angle equal to or less than 30 degrees	±1/4 inch
Skew angle greater than 30 degrees	±1/2 inch
Beam Seat Bearing Area (variation from plane surface when tested with a straight edge) through middle half of member	±1/16 inch
Horizontal Alignment (deviation from a straight line parallel to the centerline of member	1/4 inch under 40-foot lengths; 3/8 inch from 40- to 60-foot lengths; 1/2 inch over 60-foot lengths
Dowel Tubes (spacing between the centers of tubes and from the centers of tubes to the ends and sides of member)	±1/2 inch
Tie Rod Tubes (spacing between the centers of tubes and from the centers of tubes to the ends of member)	+1/4 inch
Total Width of Deck	Theoretical width +1/2 inch per joint
Camber differential between adjacent units	1/2 inch maximum
Camber differential between high and low members in same span	1 inch maximum
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

3. **Precast Prestressed Concrete Piling.**

Dimension	Tolerance
Width or Diameter	-1/4 inch to +3/8 inch
Head out of square	1/16 inch per 12 inches of width
Length of Pile	±1-1/2 inch
Horizontal Alignment (deviation from a straight line parallel to the centerline of the pile)	1/8 inch per 10 feet
Void location	±1/2 inch
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

A. The quantity of the various sizes and types for furnishing and erecting precast prestressed concrete members to be measured for payment will be the number of each complete and in place.

B. 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.

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

BASIS OF PAYMENT

503.05.01 PAYMENT

A. 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 price 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.

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

C. 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

A. This work shall consist of furnishing and placing lightweight Portland cement concrete in bridges, culverts, and other types of concrete structures.

B. The construction of conventionally reinforced lightweight concrete structures shall conform to the requirements of Section 501, "Portland Cement Concrete, and Section 502, "Concrete Structures."

MATERIALS

504.02.01 GENERAL

A. 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:

Materials	Section
Portland Cement Concrete	501
Concrete Structures	502
Aggregate for Portland Cement Products	706

B. 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

A. Admixtures shall conform to the applicable requirements of Subsection 501.02.03, "Admixtures."

504.02.03 CONCRETE MAKING PROPERTIES

A. Lightweight concrete shall be subject to the following requirements and test methods:

Test	Test Designation	Requirements
Making Test Specimens (laboratory)	ASTM C192	-----
Making Test Specimens (field)	ASTM C31	-----
Compressive Strength	ASTM C39	Table 1
Unit Weight & Cement Factor (wet)	ASTM C138	Table 1
Tests for Popouts	ASTM C330	No surface popouts
Freezing & Thawing	ASTM C666	-----
Air Content	ASTM C173	Table 1
Slump	ASTM C143	Table 1
Air Dried Weight	ASTM C567	Table 1
Coring Concrete	ASTM C42	Subsection 504.04.01

B. 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 3 standard cylinders at 28 days. The cylinder strengths shall be determined in accordance with ASTM C39.

C. A test, as defined above, will be required for each 50 cubic yards, or portion thereof, placed each day.

1. For large, continuous pours, 1 test near the beginning of the pour and 1 test near the end of the pour may be substituted for the 50-cubic-yard requirement.

2. In any case, there shall be at least 1 strength test made each day that concrete is placed, regardless of the volume placed.

3. Other cylinders may be made and broken for information purposes.

CONSTRUCTION

504.03.01 GENERAL

A. 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 Section 501, "Portland Cement Concrete," and Section 502, "Concrete Structures."

B. The Contractor shall notify the Engineer not less than 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.

1. Samples will not exceed 500 pounds for each separate grading.

2. The Contractor shall furnish a written statement (job mix) giving the cement factor in sacks per cubic yard, the proportions of cement and each 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.

3. If the Contractor proposes to use an admixture other than air-entraining agent, the Contractor shall state its complete brand name and the quantity proposed to be used per sack of cement.

4. The Engineer, after making such tests as the Engineer deems advisable, will either accept the proposed materials and proportions or suggest modifications needed for acceptance.

C. After acceptance by the Engineer of batch proportions and materials, the proportions and materials 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.

D. In no case shall revised batch proportions result in concrete that contains an amount of total water per cubic yard greater than 105 percent of that contained in concrete of the accepted proportions.

504.03.02 STORAGE OF AGGREGATES

A. Storage of aggregates shall conform to the pertinent requirements of Subsection 501.03.03, "Storage of Aggregates," except as noted below.

B. Lightweight aggregate shall be stockpiled on the job or at a central batching plant for a minimum time of 24 hours prior to its use in the project.

C. Fine and coarse aggregates shall be stockpiled separately.

504.03.03 CLASSIFICATION AND PROPORTIONS

A. Lightweight concrete shall be proportioned by weight, using the lightweight aggregates, such that the requirements in Table 1 will be satisfied.

B. The Contractor shall give the Engineer advance notice in writing when any changes are to be made in the batch proportions.

C. Batches of lightweight concrete placed on the work shall not vary more than 3 pounds per cubic foot in unit weight from the design mix.

D. The cement factor of any individual batch placed in the work shall not be more than 0.15 sacks per cubic yard less nor more than 0.25 sacks per cubic yard greater than the designated factor (sacks of cement per cubic yard).

E. 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 weight specified for lightweight concrete.

504.03.04 MIXING

A. 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 24 hours in advance of batching.

B. Mixing methods shall be as specified in Subsection 501.03.06, "Machine Mixing," except that the batch shall be so charged that 3/4 of the total mixing water and admixtures be introduced in the mixer in advance of the aggregates.

1. The aggregates shall then be introduced and mixed for a minimum of 45 seconds.
2. The amount of absorption by the aggregate will be the determining factor in mixing time.
3. The cement and final water shall be added and mixing completed.
4. The total mixing time for stationary mixers shall not be less than 3 minutes.
5. Minimum mixing for concrete mixed in trucks shall be 100 revolutions of the drum.

C. The drum on truck mixers shall be operated at high speed while charging it with aggregate.

1. Cement shall be introduced into the mixing drum while it is rotating at slow speed.
2. Immediately prior to discharge of the concrete, the drum shall be rotated at high speed for at least 60 seconds.

TABLE 1 - LIGHTWEIGHT CONCRETE MIX REQUIREMENTS

Class	Sacks Cement Per Cubic Yard		Maximum Water Gallons Per Sack of Cement*	Minimum Compressive Strength 28-Day	Slump Range	Entrained Air Range	Unit Weight Variation	Air Dried Weight, Maximum
	Min.	Max.		psi	Inches	Percent	Pounds	Pounds per Cubic Foot
LA	6.0	7.0	6.0	3,000	1 – 4	0	±3	115
LAA	6.0	7.0	5.5	3,000	1 – 4	4-7	±3	115

TABLE 1 - LIGHTWEIGHT CONCRETE MIX REQUIREMENTS								
Class	**Sacks Cement Per Cubic Yard**		**Maximum Water Gallons Per Sack of Cement***	**Minimum Compressive Strength 28-Day**	**Slump Range**	**Entrained Air Range**	**Unit Weight Variation**	**Air Dried Weight, Maximum**
	Min.	**Max.**		**psi**	**Inches**	**Percent**	**Pounds**	**Pounds per Cubic Foot**
Modified LA or LAA	6.0	8.0	6.0	Specified on plans	1 – 4	4-7	±3	115

* Based on aggregate in a saturated surface - dry condition

METHOD OF MEASUREMENT

504.04.01 MEASUREMENT

A. 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 orders, will be the quantity used for payment.

1. The Contractor may, however, request a final measurement.
2. The Contractor's request for final measurement shall be in writing.
3. 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.
4. Each class of lightweight concrete will be considered separately.
5. Furthermore, when the Contractor requests final measurement and calculations and the quantities thus determined are the same or less than the planned quantities plus authorized changes, the Contractor shall reimburse the Contracting Agency for the Agency's expenses incurred by such final measurements and calculations.
6. Only those quantities complete and in place will be measured for payment.

B. In the event any class of Portland cement concrete is placed and is shown by test to be below the specified 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.

1. This determination shall be based on an evaluation of the durability and other qualities of the concrete necessary to the integrity of the structure.
2. If the concrete is allowed to remain in place, it is agreed by the parties to the contract that the Contracting Agency will deduct from money due, or to become due, the Contractor from the Contracting Agency, a percentage of the contract unit bid price.
3. This deduction shall be considered to be liquidated damages and shall be at a rate of 5 percent of the contract unit price bid for each 50 psi or portion thereof below the specified minimum compressive strength, to a maximum of 50 percent, as set forth in the example for the class of concrete shown in the table in Subsection 502.04.01, "Measurement."
4. The reduced price shall apply to all concrete represented by the strength tests below the specified minimum compressive strength.

5. Concrete removed will not be paid for, and the removal thereof will be at no additional cost to the Contracting Agency.

C. When a compressive strength test falls below the specified 28-day compressive strength, the Contracting Agency may determine that an alternate strength test is required or the Contractor may request such a test.

1. When the Contracting Agency determines that an alternate strength test is required, the Contractor will be liable for the cost of such test.

2. In case the Contracting Agency has not determined that an alternate strength test is necessary and the Contractor elects to have an alternate strength test made, the Contracting Agency will then make a test; however, should this test fail to indicate that the 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 Contracting Agency.

3. The cost of all other alternate strength tests made at the Contractor's request shall be borne by the Contractor.

4. The alternate strength test shall consist of obtaining and testing 3 drilled core samples in accordance with ASTM C42.

5. 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.

6. The cores shall be obtained and the test performed by the Contracting Agency.

7. The test shall be accomplished as soon as possible after the 28-day curing period.

D. The average compressive strength of the 3 drilled core samples at the age tested shall be converted to a 28-day compressive strength by subtracting 8 psi from the average for each day beyond 28 days, with a maximum conversion adjustment of 200 psi. This calculated value shall be termed the "Result of the Core Test."

1. When the results of the core test validates the original 28-day strength test, the quality of the concrete shall be assessed on the basis of the original test.

2. When the core test does not validate the 28-day strength test, then the result of the core test shall be used to assess the quality of the concrete.

E. No measurement or other allowance will be made for work, material for forms, falsework, cofferdams, pumping, bracing, and so forth.

F. The quality of concrete involved in fillets, scorings, and chamfers 2 square inches or less in cross-sectional area shall be neglected.

G. 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.

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

BASIS OF PAYMENT

504.05.01 PAYMENT

A. 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.

B. Reinforcing steel will be paid for as provided in Section 505, "Reinforcing Steel."

C. All metal parts, fabrics, pads, joint fillers, 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.

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

E. Payment will be made under:

PAY ITEM	PAY UNIT
Class _____ Lightweight Concrete	Cubic Yard

SECTION 505

REINFORCING STEEL

DESCRIPTION

505.01.01 GENERAL

A. This work shall consist of furnishing and placing reinforcing steel and mesh reinforcing in accordance with ACI 318 Chapter 7 and ACI 315 with the additions or exceptions listed below.

MATERIALS

505.02.01 GENERAL

A. Materials shall conform to the requirements specified in the following subsections:

Materials	Subsection
Fabricated Steel Bar or Rod Mats Reinforcement	713.03.02
Bar Steel Reinforcement	713.03.01
Welded Steel Wire Fabric Reinforcement	713.03.03

B. Bar steel reinforcement shall be Grade 60 bar steel reinforcement unless otherwise specified on the plans.

C. Spiral Reinforcement may be either Bar Steel Reinforcement or Steel Wire, of the equivalent size of the bar steel.

D. Epoxy coatings for steel reinforcing bars shall conform to ASTM D3963. Epoxy coatings listed in the NDOT QPL, found on the web at http://www.nevadadot.com/reports_pubs/qpl/pdfs/QPL.pdf, shall be used.

E. Tie wire shall be commercial quality 16 gage minimum, black annealed soft iron wire, unless otherwise approved. Tie wires used on epoxy coated reinforcing steel shall be coated with plastic or an equal type coating as approved.

505.02.02 SAMPLES

A. One extra bar of each diameter shall be furnished for each 100 tons or fraction thereof.

1. This bar shall be selected from the longest bar of each size so that the bar, or a portion of it, can be used to replace any bar of that diameter that is selected to be used as a field sample.
2. Supplied field sample shall be of sufficient length to provide two 30-inch samples of each diameter.
3. The extra bars shall be indicated on the fabricator's details.

505.02.03 SPECIFICATIONS FOR COATING REINFORCING STEEL

A. Coating of reinforcing steel shall conform to AASHTO M284.

1. The coating fabricator for epoxy coated reinforcing steel shall be certified by the Concrete Reinforcing Steel Institute's Certification Program for Fusion Bonded Epoxy Coating Applicator Plants.

2. A copy of the Epoxy Coating Certification along with notification starting date of coating application shall be submitted.

B. Notification shall be given of the date and location of the coating operation, in writing, at least 10 days before the planned date for beginning the coating operation.

1. The Engineer shall be allowed free access to plant of the coating applicator for inspection.

2. If the representative so elects, preparation, coating, and curing of the bars shall be performed in the representative's presence.

C. Patching or repair material that is in compliance with AASHTO M284 shall be made available from the coating manufacturer.

CONSTRUCTION

505.03.01 REINFORCING STEEL LIST

A. In accordance with ACI 315, before placing reinforcing steel, the Contractor shall submit shop drawing details and furnish 2 copies of a list of all reinforcing steel showing sizes, lengths, and numbers of pieces and bends required to the Engineer at the site for Engineer's use in administering the contract.

1. Furnishing such lists to the Engineer shall not be construed to mean that the lists will be reviewed for accuracy.

2. 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

A. Reinforcing steel shall be protected at all times from damage.

B. When placed in the work, the reinforcing steel shall be free from dirt, detrimental scale, paint, oil, or other foreign substance.

C. However, when steel has on its surface loose mill scale or dust that is easily removable, it may be cleaned by a satisfactory method, if approved by the Engineer.

505.03.03 BENDING

A. Bent bar reinforcement shall be cold bent to the shape shown on the plans.

B. 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

A. In accordance with ACI 315, all bar reinforcement shall be accurately placed in the positions shown on the plans and firmly held during the placing and setting of concrete.

B. When the spacing of bars exceeds 1 foot in either direction, all intersections shall be tied.

C. Distances from the vertical and horizontal forms shall be maintained by means of stays, blocks, ties, hangers, or other approved supports.

1. 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 psi.
2. Metal chairs that are in contact with the exterior surface of the concrete shall be fabricated of galvanized steel, or have the steel tips plastic coated to at least 3/4 inch into the concrete, or be of stainless steel conforming to the requirements of ASTM A493, Type 430.
3. The use of pebbles, pieces of broken stone or brick, metal pipe, and wooden blocks will not be permitted.

D. 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.

E. If mesh reinforcement is shipped in rolls, it shall be straightened into flat sheets before being placed.

505.03.05 SPLICING

A. In accordance with ACI 315, all reinforcement bars shall be furnished in the full lengths indicated on the plans.

B. Splicing of bars, except where shown on the plans, will not be permitted without the written approval of the Engineer.

1. Splices shall be staggered as far as possible.
2. Unless otherwise shown on the plans, bars near the top of beams and girders having more than 12 inches of concrete under the bar shall be lapped 35 diameters and all other bars shall be lapped 20 diameters to make the splice.
3. In lapped splices, the bars shall be placed in contact and wired together.

C. 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.

D. Lapped splices in reinforcement shall not be used for sizes larger than No. 11.

E. Tensile reinforcement shall preferably not be spliced at points of maximum stress. The length of lap for deformed bars shall not be less than 24 and 36 bar diameters for Grade 40 and Grade 60, respectively, nor less than 12 inches.

F. Where lapped splices are used in reinforcement in which the critical design stress is compressive and with concrete having a strength of 3,000 psi or more, the length of lap for deformed bars shall be 20 bar and 24 bar diameters for Grade 40 and Grade 60, respectively, but not less than 12 inches. When the specified concrete strengths are less than 3,000 psi, the amount of lap shall be 1/3 greater than the values given above.

G. Splices in spiral steel shall be made by welding or a lap of 1-1/2 turns.

H. 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 1 mesh in width.

505.03.06 SUBSTITUTIONS

A. Substitution of different size bars will be permitted only with specific authorization by the Engineer.

B. The bars substituted shall have an area equivalent to the design area or larger.

METHOD OF MEASUREMENT

505.04.01 MEASUREMENT

A. The calculated quantity of reinforcing steel shown on the plans, plus or minus quantities covered by approved changes, will be the quantity used for payment.

1. The Contractor may request final measurement if a possible error is suspected in the quantities shown on the plans.

2. The Contractor's request for final measurement shall be in writing.

3. 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.

4. Furthermore, when the Contractor requests final measurement and calculations and the quantities thus determined are the same or less than the planned quantities plus authorized changes, the Contractor shall reimburse the Contracting Agency for the agency's expenses incurred by such final measurements and calculations.

B. The calculated weights of the plain and deformed bars shall be based on the following table:

Size Number	Nominal Diameter Inches	Weight Per Foot 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

C. 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.

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

BASIS OF PAYMENT

505.05.01 PAYMENT

A. 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.

B. 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.

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

D. 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

A. This work shall consist of furnishing, fabricating, casting, machining, or otherwise preparing, transporting, erecting, and painting structural steel, rivet and eye bar steel, steel forgings, casting, 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

A. Materials shall meet the pertinent requirements of the following sections:

Materials	Section
Structural and Eyebar Steel	710
Aluminum for Bridge Rail	711
Miscellaneous Metal	712
Paint and Pavement Markings	714
Galvanizing	715
Elastomeric Bearing Pads	725

B. 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 A153. Bolts for fastening tubes to the rail posts sockets shall be stainless steel.

C. Steel bridge and pedestrian railing shall be primed and painted in accordance with Subsection 714.03.01, "Iron and Steel Use Items Classifications."

D. Bridge or pedestrian rail and posts made of aluminum shall not be painted.

E. Shims shall be either aluminum alloy or asbestos sheet packing, at the Contractor's option.

1. Aluminum Alloy Shims shall conform to ASTM B209, Alloy 1100-0.
2. Asbestos sheet packing shall be composed essentially of asbestos fibers bonded together with a cementing medium rendering it tough and pliable.
3. The deformation of the packing under a load of 10,000 pounds per square inch shall be less than 16 percent of the thickness and the loss on ignition shall not be more than 25 percent.

F. Insulating material for insulating the base 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.

G. Shims for steel railing shall be galvanized steel plates.

H. All bolts, nuts, and washers shall be either steel galvanized in accordance with ASTM A153; stainless steel conforming to ASTM A276; or steel cadmium plated in accordance with ASTM B766, Type TS.

CONSTRUCTION

506.03.01 SHOP DRAWINGS

A. Shop drawings shall consist of shop detail, erection, and other working drawings showing dimensions, size of material, details, and other information necessary for the complete fabrication and erection of the metal work.

1. The drawings shall be prepared on sheets 24 inches by 36 inches.
2. Eetails shall be drawn so that the prints will be clear and legible.

B. Unless otherwise requested, the Contractor shall submit to the Engineer, for approval, 3 sets of drawings.

1. The Engineer reserves the right to refuse prints of shop drawings which are not clear and legible.
2. Upon approval, the Contractor shall furnish the Engineer with the number of sets of shop drawings requested.
3. All shop plans shall be submitted for approval at least 15 days before fabrication is started and no material shall be fabricated until the plans have been finally approved by the Engineer.

C. After approval, there shall be no deviation from the shop drawings or changes made thereon without the prior approval of the Engineer.

D. 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, but it is expressly understood that it will not relieve the Contractor from the responsibility for errors or omissions on the shop drawings.

E. The contract price shall include the cost of furnishing all shop drawings and the Contractor will be allowed no extra compensation for shop drawings.

506.03.02 NOTICE OF BEGINNING WORK

A. The Contractor shall give the Engineer ample notice of manufacturing of material at the mill so that inspection may be provided. "Mill" means any rolling mill or foundry where material for the work is to be manufactured.

B. No material shall be manufactured or fabrication begun without authorization by the Engineer.

C. The Engineer may inspect the material, as provided for in ASTM A6, at Engineer's option.

D. Material not inspected at the place of manufacture shall be subject to inspection as provided for in Subsection 506.03.03, "Inspection and Testing."

E. Prior to the beginning of fabrication, a 15-day written notice shall be provided by the Contractor to the Engineer.

F. 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

A. The Engineer will examine and test as necessary all material before fabrication.

1. Adequate facilities and free access to the necessary work areas will be provided to the Engineer by the manufacturer and fabricator.
2. Required test samples will be furnished free of charge.
3. Material not inspected at the place of manufacture shall be subject to all chemical, physical, and workmanship requirements established for the material supplied.
4. Materials or workmanship not in conformity with the specified product may be rejected.

B. The Engineer may inspect and test all material by any visual, destructive, or non-destructive method to evaluate the material for its specified properties.

1. Mill orders and certificates, showing test values obtained, shall be furnished in triplicate to the Engineer.
2. All certified test values shall include physical and chemical results and steel making process used.
3. Test samples will be obtained from all steel not identified by mill heat numbers.
4. Acceptance of any material at the mill or fabrication shop prior to incorporation shall not prevent the rejection of the material or finished member if defects are discovered during the fabrication process.

C. Inspection in the fabrication shop is intended as a means of facilitating the work and avoiding errors as far as possible.

1. 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.

D. 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.

1. The field inspection will cover the general appearance, size, thickness, etc., of the pipe and tubing.
2. Conformance of chemical and mechanical properties to requirements of the specifications will also be considered before the material is approved.
3. Shop inspection of rail posts will be made on the first few rail post castings furnished for each project in order to establish a satisfactory class of finish and workmanship.
4. 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.

E. Fabrication of aluminum alloy material shall, in general, conform to or be equivalent to fabrication methods and practices recommended in the handbook of the major producers of aluminum materials and specifically the following requirements:

1. Material shall be sawed, routed, or milled.
2. Flame cutting is not permissible.
3. Tubing may be heated to a temperature not exceeding 400 degrees F for a period not exceeding 15 minutes to facilitate bending.

4. Holes in pipe tubing shall be drilled. Holes in castings shall be cored and reamed, or drilled from the solid. Seats for pipe shall be finished smooth.

F. 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.

1. An objectionable appearance resulting from such scoring or marring shall be cause for rejection of the material.

2. Sleeves and rails shall be fabricated in lengths indicated on the plans.

G. 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

A. 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.

1. When unloaded, the material shall be placed on skids above the ground.

2. All material for the project shall be stored separate from "in stock" materials.

3. Girders and beams shall be placed upright and shored.

4. Long members, such as columns and chords, shall be supported on skids placed near enough together to prevent injury from deflections.

B. Different grades and classifications of material shall be color coded, as provided for in ASTM A6. This color code shall be transferred throughout fabrication.

C. If the contract covering the erection of the steel does not include the fabrication, the Contractor shall check the material received by Contractor and report promptly, in writing to the Engineer, any shortage or injury discovered.

506.03.05 STRAIGHTENING

A. Rolled material before being laid out or worked shall be straight. Subassemblies and completed members shall be straight before being incorporated into the work.

B. 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.

C. After straightening, evidence of fracture or other damage will be cause for rejection of the material.

D. Dimensional tolerances and repairs of surface irregularities described in ASTM A6 shall govern for the acceptance of repaired material.

506.03.06 SUBPUNCHING, DRILLING, AND REAMING

A. 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.

B. The assembly, including camber, alignment, accuracy of holes and mill joints, shall be approved by the Engineer before reaming is commenced.

C. 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.

D. All holes for floor beams and stringer field end connections shall be subpunched and reamed to a steel template.

506.03.07 BOLTS AND BOLTED CONNECTIONS

A. **Bolted Connections:**

1. Bolted connections shall not be used unless called for in the contract documents.
2. Where bolted connections are permitted, the bolts furnished shall be as hereinafter specified.
   a. Ribbed high-tensile strength 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.
   b. Bolts shall be of such length that they will extend entirely through the nut, but not more than 3/8 inch beyond.
   c. 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 bolts lost or rejected.
3. The holes, except holes in end diaphragms, shall be truly cylindrical.
   a. Holes shall be at right angles to the surface of the metal so that both head and nut will bear squarely against the metal.
   b. Bolts shall be driven accurately into the holes without damaging the thread.
   c. A snap shall be used to prevent damaging the heads.
4. Bolt holes in end diaphragms shall be slotted 1/2 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.
5. Bolts in end diaphragms to girder connections shall not be tightened until the deck pour has been completed.
6. 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.

506.03.08 SHOP ASSEMBLY

A. Shop assembly of trusses, arches, continuous beams, continuous plate girders, plate girders, and rigid frames shall be according to Subsection 506.03.06, "Subpunching, Drilling, and Reaming." All members shall be match marked before being disassembled.

B. 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.

1. The several component parts of a built-up member shall be straight and close fitting.
2. Surfaces of metal in contact shall be cleaned before assembling.
3. The parts of a member shall be assembled, well pinned, and firmly drawn together with bolts before drilling, reaming, or riveting is commenced.
4. Assembled pieces shall be taken apart, if necessary, for the removal of burrs and shavings produced by the operations.
5. The member shall be free from twists, bends, and other deformations.
6. 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.

C. The drifting done during assembling shall be 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.

D. Parts not completely riveted in the shop shall be secured by bolts insofar as practicable to prevent damage in shipment and handling.

E. 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.

506.03.09 EDGE PLANING

A. Sheared edges of plates more than 5/8 inch in thickness and carrying calculated stress shall be planed to a depth of 1/4 inch.

B. Re-entrant cuts shall be filleted to a radius of 3/4 inch.

506.03.10 FACING OF BEARING SURFACES

A. 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

B. Surfaces of bronze bearing plates intended for sliding contact shall be planed parallel to the movement of the spans and polished.

506.03.11 ABUTTING JOINTS

A. Abutting joints in compression members of trusses and in columns shall be milled.

B. Opening and abutting joints in tension members shall not exceed 1/4 inch.

C. Abutting joints of continuous I-beam spans shall be square and tight-fitting.

D. Abutting joints in top and bottom flanges of plate girders shall be square and tight-fitting.

506.03.12 FLAME CUTTING

A. Preparation of material for flame cutting shall be in accordance with the provisions of AWS D2.0, Paragraph 302.

506.03.13 END CONNECTION ANGLES

A. Floor beams, 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 minus 1/16 inch.

B. Where continuity is required, end connections shall be faced.

C. The thickness of the connection angles shall not be less than 3/8 inch, nor less than that shown on the detail drawings.

506.03.14 LACING BARS

A. The ends of lacing bars shall be neatly rounded unless another form is required.

506.03.15 WEB PLATES

A. In girders having no cover plates and not to be encased in concrete, the top edge of the web plate shall not extend above the backs of the flange angles and shall not be more than 1/8 inch below at any point.

   1. Any portion of the plate projecting beyond the angles shall be chipped flush with the backs of the angles.

   2. Web plates or girders having cover plates may be 1/2 inch less in width than the distance back to back of flange angles.

B. Splices in webs of girders without cover plates shall be sealed on top by welding.

C. At web splices, the clearance between the ends of the web plates shall not exceed 3/8 inch. The clearance at the top and bottom ends of web splice plates shall not exceed 1/4 inch.

506.03.16 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.

   1. The type, size or diameter, placement pattern, and length of stud shall be as specified in the contract documents. (See Figure No. 1, below, for allowable tolerances or dimensions).

2. A maximum variation of 1 inch from the location shown will be accepted provided the adjacent studs are not closer than 2-1/2 inches center to center.

3. The clear distance between the edge of a girder flange and the edge of the shear connectors shall be not less than 1 inch.

4. Fillet welds varying in size from 3/16 inch to 5/16 inch are satisfactory provided the studs pass all other tests required.

5. Adequate provision shall be made in 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.

1. The studs shall be free from rust, scale, rust pits, and oil at the time of welding and immediately before the concrete is placed.

2. 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.

3. 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:

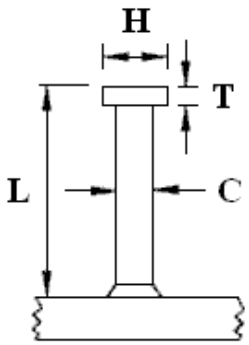
1. The name of the manufacturer.

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 D2.0. The certification must also indicate the heat from which the studs were manufactured.

D. Welding specifications and procedure requirements shall conform to AWS D2.0.

STEEL STRUCTURES — **STANDARD DIMENSIONS**



C	L*	H	T
3/4" +0.000" –0.010"	4" +0.062" –0.125"	1-1/4" ±1/64"	3/8" minimum
7/8" +0.000" –0.010"	4" +0.062" –0.125"	1-3/8" ±1/64"	3/8" minimum

*NOTE: 4" length is standard. Other lengths may be obtained by special order.

Figure 1. DIMENSIONS AND TOLERANCES

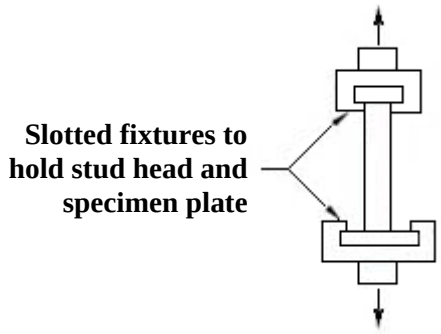


Figure 2. TYPICAL TENSILE TEST FIXTURE

506.03.17 WELDING

A. 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 most recent edition of the American Welding Society's *Bridge Welding Code*, except as modified in this subsection.

B. All welding shall be performed in the fabrication shop, except as otherwise noted on the plans or permitted by the Engineer.

C. **Inspection and Testing of Shop Welds:**

1. **Radiographic Inspection:**

a. The procedure, techniques, and standards of acceptance shall be in conformance with the current AWS D2.0 Specifications.

b. The Engineer will make all final interpretations of weld defects and film quality.

c. All radiographs will be the property of the Contracting Agency during and after completion of the project.

2. **Ultrasonic Inspection.** The procedure, techniques, and standards of acceptance shall be in conformance with the current AWS D2.0 Specifications except as modified in this subsection.

3. **Magnetic Particle Inspection.** This procedure and technique shall be in conformance with ASTM E709, "Standard Guide for Magnetic Particle Testing."

D. **Inspection and Testing of Field Welds:**

1. The Contracting Agency will make magnetic particle inspections, ultrasonic inspections, or radiographic inspections of field welds when so required by the plans or the Special Provisions.

2. The acceptability of welds will be judged in accordance with the Inspection and Testing of Shop Welds for the type of inspection employed.

E. Welds shall be painted according to the applicable provisions of Section 614, "Painting."

F. 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.

506.03.18 FIT OF STIFFENERS

A. 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.

1. Intermediate stiffeners shall fit sufficiently tight to exclude water after being painted.

2. Fillers under stiffeners shall fit within 1/4 inch at each end.

B. Welding will be permitted in lieu of milling or grinding if noted in the contract documents. Where stiffeners are required on 1 side of the web only, they shall be welded to the compression flange.

506.03.19 ANNEALING AND STRESS RELIEVING

A. Members such as bridges 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.

506.03.20 PINS AND PIN HOLES

A. Rollers shall be of structural carbon steel, and pins shall be carbon steel forgings meeting the requirements of Subsection 710.03.08, "Pins and Rollers."

1. Pins and rollers shall be accurately turned to the dimensions shown on the drawings and shall be straight, smooth, and free from flaws.

2. Final surface shall be produced by a finishing cut.

B. In pins larger than 9 inches in diameter, a hole not less than 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.

C. 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.

D. 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 1/32 inch. Boring of holes in built-up members shall be done after the assembly is completed.

E. The diameter of the pin hole shall not exceed that of the pin by more than 1/50 inch for pins 5 inches or less in diameter, or more than 1/32 inch for larger pins.

F. 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 1-3/8 inches or more shall be threaded 6 threads to the inch.

G. Pilot and driving nuts shall be used in driving pins.

1. They shall be furnished by the Contractor without charge.

2. Two pilot nuts and 2 driving nuts for each size of pin shall be furnished, unless otherwise specified.

3. Pins shall be so driven that the members will take full bearing.

4. Pin nuts shall be screwed up tight and the threads burred at the face of the nut with a pointed tool.

506.03.21 SHOP PAINTING

A. Unless otherwise provided, the application of shop paints shall conform to the requirements of Section 614, "Painting."

B. Surfaces to be in contact after shop riveting is completed shall be cleaned but shall not be painted.

506.03.22 MARKING AND SHIPPING

A. 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.

B. Members weighing more than 3 tons shall have the weight marked thereon.

C. 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.

D. All girders shall be shipped with the web vertical, which position shall be maintained in subsequent operations.

506.03.23 ERECTION METHODS AND EQUIPMENT

A. Before starting work, the Contractor shall inform the Engineer fully as to the method of erection the Contractor proposes to follow and as to the amount and character of the equipment the Contractor proposes to use, the adequacy of which shall be subject to the approval of the Engineer.

   1. The approval of the Engineer shall not be considered as relieving the Contractor of the responsibility for the safety and adequacy of Contractor's methods or equipment or from carrying out the work in full accordance with the plans and specifications.

   2. No work shall be done without the sanction of the Engineer.

B. Spot welding for the purpose of eliminating field erection bolts or for holding steel parts together while fastening will not be permitted.

C. All work of erection shall be subject to inspection.

   1. The Contractor shall furnish facilities for inspection of material and workmanship.

   2. Material and workmanship not previously inspected shall be inspected after delivery to the site of the work.

D. 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.

E. 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.

   1. 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.

   2. 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.

F. Rail posts shall be erected in sections.

1. Erection of sections of rails and posts shall continue successively until all or an approved portion of the required rail is erected.
2. The rail shall then be aligned and the nuts on the anchor bolts tightened.
3. In final adjustment, no posts shall deviate more than 1/8 inch from true alignment and there shall be no abrupt break in alignment of any location.
4. Aluminum shims may be slotted for ease in placing if approved by the Engineer.

506.03.24 FALSEWORK

A. The falsework shall be designed and substantially constructed and maintained for the vertical and lateral loads that will be applied to the structure.

1. 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.
2. Approval of the Contractor's plans shall not be considered as relieving the Contractor of any responsibility.

B. 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.

C. All excavated material or falsework placed in the stream channel before construction shall be removed by the Contractor before final acceptance.

506.03.25 BEARING AND ANCHORAGE

A. Masonry bearing plates shall not be placed upon bridge seat bearing areas which are improperly finished, deformed, or irregular.

1. Bearing plates shall be set level in exact position and shall have a full and even bearing upon the masonry.
2. Unless otherwise directed by the Engineer, the bearing plates shall be placed on a layer of canvas and red lead applied as follows:
   a. Thoroughly swab the bridge seat bearing area with red lead paint and place upon it 3 layers of 12-ounce to 14-ounce duck, each layer being thoroughly swabbed on its top surface with red lead paint.
   b. Place the superstructure shoes or pedestals in position while the paint is plastic.
   c. As an alternate to canvas and red lead, sheet lead may be used if called for on the plans.

B. 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.

C. 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.

1. The bolts shall be set accurately and fixed with Portland cement grout, completely filling the holes.
2. 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.
3. The nuts on anchor bolts at the expansion ends of spans shall be adjusted to permit free movement of the span.

D. Elastomeric bearing pads shall conform to Subsection 502.03.12, "Expansion and Fixed Joints and Bearings."

506.03.26 FIELD ASSEMBLING

A. The parts shall be accurately assembled as shown on the plans and match-marks shall be followed.

1. The material shall be carefully handled so that no part will be bent, broken, or otherwise damaged.
2. Hammering which will injure or distort the members shall not be done.
3. Bearing surfaces and surfaces to be in permanent contact shall be cleaned before the members are assembled.
4. Unless erected by the cantilever method, truss spans shall be erected on blocking so placed as to give the trusses proper camber.
5. The blocking shall be left in place until the tension chord splices are fully fastened and all other truss connections pinned and bolted.
6. Splices of butt joints of compression members, in railings, and in other field splice connections shall have 1/2 of the connection holes filled with bolts and cylindrical erection pins (half bolts and half pins) before fastening.
7. Splices and connections carrying traffic during erection shall have 3/4 of the holes so filled.

B. Cylindrical erection pins shall be 1/32 inch larger than the fitting up bolts.

506.03.27 MISFITS

A. The correction of minor misfits involving nonharmful amounts of reaming, cutting, and chipping shall be considered a legitimate part of the erection.

B. 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 Engineer's approval of the method of correction obtained.

C. The correction shall be made in the Engineer's presence.

D. The Contractor shall be responsible for all misfits, errors, and injuries and shall make the necessary corrections and replacements.

506.03.28 FIELD PAINTING

A. Structural steel, unless otherwise specified, shall be painted as specified in Section 614, "Painting."

METHOD OF MEASUREMENT

506.04.01 MEASUREMENT

A. Measurement of structural steel will be either by the pound or lump sum.

1. The calculated poundage shown on the plans, plus or minus quantities covered by approved changes, will be the poundage 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.

2. Furthermore, when the Contractor requests a final measurement and calculation and the quantities thus determined are the same or less than the planned quantities adjusted for authorized changes, the Contractor shall reimburse the Contracting Agency for the Agency's expenses incurred by the final measurements and calculations.

3. The Contractor's request for final measurement shall be in writing.

4. 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.

B. The calculated weights shall be based on the following assumptions:

Unit Weight	Pounds per Cubic Foot
Iron, malleable	470
Iron, wrought	487
Steel, rolled, cast, copper bearing, silicon, nickel, and stainless	490

1. 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	Per 100 Rivets
Inches	**Pounds**
1/2	20
5/8	30
3/4	50
7/8	100
1	150
1-1/8	250
1-1/4	325

3. 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.

4. The weight of paint will not be included in the computed weight of metals.

5. 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.

C. Lump Sum Basis:

1. When specified, structural steel acceptably completed in the structure as shown on the plans will be measured for payment by the lump sum plus or minus approved changes. There will be no change in measurement due to substitutions made at the Contractor's request.
2. If the proposal contains such an item, bridge rail shall be measured in linear feet between concrete posts in the completed work.
3. Measurement will be made to the nearest foot of rail for each structure measured along the top of the parapet from concrete ends posts to concrete end posts.
4. Pedestrian rail shall be measured by the linear foot of rail installed, complete and in place.

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

BASIS OF PAYMENT

506.05.01 PAYMENT

A. 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 price for structural steel as set forth for the bid item in the proposal.

B. The additional steel in substitutions made at the Contractor's request will not be paid for.

C. 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 tests and test specimens, except the specimens for full size tests.

1. 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.
2. Unless otherwise specified and provided for in the proposal, the lump sum price shall include all specified and approved metal in the finished structure.

D. Bridge rail or pedestrian rail shall be paid for at the contract unit price bid per linear foot for the type specified, whether constructed of steel or aluminum, which shall be full compensation for furnishing, fabricating, delivering, erecting, and painting; for all labor, material, tools, supplies, equipment and incidentals necessary to complete the item; and for furnishing mill test reports and test specimens.

E. 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 price for structural steel and no separate payment will be made therefor.

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

G. Payment will be made under:

PAY ITEM	PAY UNIT
Structural Steel	Pound, Lump Sum
Bridge Rail (type)	Linear Foot
Pedestrian Rail (type)	Linear Foot

SECTION 507

TIMBER STRUCTURES

DESCRIPTION

507.01.01 GENERAL

A. This work 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

A. Materials shall meet the requirements of the following sections:

Materials	Section
Structural and Eyebar Steel	710
Paint and Pavement Markings	714
Miscellaneous Metal	712
Hardware	723
Timber	718
Timber Preservatives	719

B. 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 the lists. The revision of materials furnished in accordance with revised lists to make the materials comply with the design drawings shall be at no additional cost to the Contracting Agency.

C. 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

A. Lumber and timber on the site of the work shall be stored in piles.

B. Untreated material shall be open-stacked at least 12 inches above the ground surface and piled to shed water and prevent warping. When required by the Engineer, the material shall be protected from the weather by suitable covering.

C. Treated timber and piling shall be close-stacked and piled to prevent warping.

D. The ground underneath and in the vicinity of all material piles shall be cleared of all weeds and rubbish.

507.03.02 WORKMANSHIP

A. None but competent bridge carpenters shall be employed, and all framing shall be true and exact.

1. Unless otherwise specified, nails and spikes shall be driven with just sufficient force to set the heads flush with the surface of the wood.

2. Deep hammer marks in wood surfaces shall be considered evidence of poor workmanship and sufficient cause for removal of the workman causing them.

B. The workmanship on all metal parts shall conform to Section 506, "Steel Structures."

507.03.03 TREATED TIMBER

A. Treated timber and piling shall be carefully handled without sudden dropping, breaking of the outer fibers, bruising, or penetrating the surface with tools.

1. Timber and piling shall be handled with rope sling.

2. Cant hooks, peaveys, pikes, or hooks shall not be used.

B. All cutting, framing, and boring of treated timbers shall be done before treatment insofar as is practicable.

C. All cuts in treated piles or timbers, and all abrasions, after being carefully trimmed, shall be covered with 2 applications of a mixture of 60 percent creosote oil and 40 percent roofing pitch, or brush coated with at least 2 applications of hot creosote oil and covered with hot roofing pitch.

D. 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 creosote plugs.

E. 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

A. In structures of untreated timber the following surfaces shall be thoroughly coated with 2 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.

B. 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.

C. Unless untreated timber is to be used in the construction within 3 days after date of delivery, the timber 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

A. Holes for round driftholes and dowels shall be bored with a bit 1/16 inch less in diameter than the bolt or dowel to be used.

B. The diameter of holes for square drift-bolts or dowels shall be equal to the least dimension of the bolt or dowel.

C. Holes for machine bolts shall be bored with a bit of the same diameter as the bolt.

D. Holes for roads shall be bored with a bit 1/16 inch greater in diameter than the rod.

E. 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. A washer of the size and type specified shall be used under all bolts and nuts which would otherwise come in contact with wood.

B. The nuts of all bolts shall be effectively locked after they have been finally tightened.

C. Countersinking shall be done whenever smooth faces are required. 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

A. 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 surface.

1. Mortises shall be true to size for their full depth and tenons shall fit snugly.

2. No shimming will be permitted in making joints nor will open joints be accepted.

B. Mud sills shall be firmly and evenly bedded to solid bearing and tamped in place.

C. Concrete pedestals for the support of framed bents shall be carefully finished so the sills or posts will take even bearing on them. Dowels of not less than 3/4-inch diameter, used for anchoring the sills or posts and projecting at least 6 inches above the tops of the pedestals, shall be set in the pedestals when the pedestals are cast.

D. Sills shall have true and even bearing on mud sills, piles, or pedestals.

1. Sills shall be drift-bolted to mud sills or piles with bolts of not less than 3/4-inch diameter and extending into the mud sills or piles at least 6 inches.

2. When possible, all earth shall be removed from contact with sills so that there will be free air circulation around them.

E. Posts shall be fastened to pedestals with dowels of not less than 3/4 inch diameter, extending at least 6 inches into the posts.

F. Posts shall be fastened to sills by one of the following methods, as indicated on the plans:

1. By dowels of not less than 3/4-inch diameter, extending at least 6 inches into posts and sills.

2. By drift-bolts of not less than 3/4-inch diameter driven diagonally through the base of the post and extending at least 9 inches into the sill.

507.03.08 CAPS

A. 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.

B. All caps shall be secured by drift-bolts, as indicated on the plans, extending at least 9 inches into the posts or piles.

C. Drift-bolts shall be approximately in the center of the post or pile.

507.03.09 BRACING

A. The ends of bracing shall be bolted through the pile, post, or cap with a bolt of not less than 5/8-inch diameter.

B. 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

A. 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.

B. 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.

1. The lapped ends of untreated stringers shall be separated at least 1/2 inch for the circulation of air and shall be securely fastened by drift-bolts where specified.

2. When stringers are 2 panels in length, the joints shall be staggered.

C. Cross-bridging between stringers shall be neatly and accurately framed and securely toenailed with at least 2 nails at each end.

1. All cross-bridging members shall have full bearing at each end against the sides of stringers.

2. Unless otherwise specified in the contract, cross-bridging shall be placed at the center of each span.

507.03.11 PLANK FLOORS

A. Unless otherwise specified, flooring plank shall be surfaced 1 side and 1 edge.

1. Single plank floors shall consist of a single thickness of plank supported by stringers or joists.

2. The plank shall be laid heart side down with 1/4-inch openings between them for locally seasoned material and with tight joints for unseasoned material.

3. Each plank shall be securely spiked to each joist.

4. The plank shall be carefully graded as to thickness and so laid that not 2 adjacent planks will vary in thickness more than 1/16 inch.

B. Two-ply timber plank floors shall consist of 2 layers of flooring supported on stringers or joist.

1. The lower course shall be pressure-treated with a creosote oil.

2. The top course may be laid either diagonally or parallel to the centerline of the roadways, as specified, and each floor piece shall be securely fastened to the lower course.

3. Joints shall be staggered at least 3 feet.

4. 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.

5. At each end of the bridge, these members shall be beveled.

507.03.12 LAMINATED FLOORS

A. Laminated floors shall be composed of 3-inch by 6-inch or 2-inch by 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.

B. The flooring may be of random length and multiples of the stringer spacing with no single piece less than 6 feet long. All splices shall be made on the centerline of a stringer and shall not occur more often than once in 6 inches on any 1 stringer.

C. Laminations shall be laid with a finished edge down.

1. Before laying, the tops of stringers shall be checked with a straightedge and adjacent stringers which vary more than 1/8 inch from a true plane, except treated stringers, shall be surfaced to meet this requirement.

2. Treated stringers which do not meet the requirements may be rejected but shall not be framed or adzed after treatment.

3. Each piece of flooring shall be fastened to the preceding strip at each end and at approximately 18-inch intervals with spikes or nails driven alternately near the top and bottom edges.

4. Spikes or nails shall be of sufficient length to pass through 2 strips and at least halfway through the third strip.

5. If timber supports are used, each piece shall be toenailed to every other support with 20d or 30d nails.

6. Care shall be taken to have each strip vertical and tight against the preceding strip, and bearing evenly on all supports.

507.03.13 TRUSSES

A. Trusses, when completed, shall show no irregularities of line.

1. 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.

2. All bearing surfaces shall fit accurately.

3. Uneven or rough cuts at the points of bearing shall be cause for rejection of the piece containing the defect.

B. 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

A. Outside stringers, wheel guards, rails, rail posts; exposed surfaces of scupper blocks, filler blocks, and flooring of untreated timber; and timber treated with preservative salts shall be painted as specified in Section 614, "Painting."

B. Ends of all pieces of untreated timber not otherwise painted shall be painted with 1 prime coat.

C. 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, "Iron and Steel Use Items Classifications."

METHOD OF MEASUREMENT

507.04.01 MEASUREMENT

A. 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.

B. All measurements will be in accordance with Subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

507.05.01 PAYMENT

A. 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).

B. The above price 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."

C. Payment will be made under:

PAY ITEM	PAY UNIT
Type Lumber	Thousand Feet Board Measure

SECTION 508

PILING

DESCRIPTION

508.01.01 GENERAL

A. This work shall consist of furnishing and driving bearing piles of the kind, shape, and size called for in the contract documents.

B. Work 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

A. Materials shall conform to the requirements of the following sections and subsections:

Materials	Section/Subsection
Steel Shell for Piles	712.03.08
Steel Piles ("H" piles, sheet piling)	712.03.07
Reinforcement	713
Timber Piles	717
Concrete	501

B. 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

A. Bearing piles of any material shall be of the length 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 cutting off any damaged portion.

B. 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 no additional cost to the Contracting Agency, may drive test piles, make borings, or make other investigations as necessary.

508.03.02 TEST PILES

A. Test piles furnished and driven by the Contractor for Contractor's use in determining the lengths of piles to be furnished may be so located that the test piles may be cut off and become a part of the completed structure, provided that the test piles conform to the requirements for piling as specified.

B. Test piles designated in the contract documents shall conform to the requirements for piling as specified and shall be so located that the test piles may be cut off and become a part of the completed structure.

C. Test piles that are to become a part of the completed structure shall be driven with the same type of equipment to be used for driving foundation piles.

D. Test piles that are not to be incorporated in the completed structure shall be removed to at least 2 feet below the surface of the ground and the remaining hole shall be backfilled with earth or other suitable material.

E. 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

A. The driving equipment shall be in good operating condition.

B. The size of hammer shall be selected to suit the conditions that will be encountered.

1. The hammer 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.

2. If the size of the hammer used is found to be unsatisfactory, the hammer shall be replaced with a larger or smaller hammer or other corrective measures shall be used as required to produce satisfactory results.

C. All piles shall be driven with either single- or double-acting steam, air, or diesel hammers.

D. 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 1 foot-pound for each pound of weight driven.

E. 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.

F. 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.

G. Steam or air hammers shall be furnished with broiler or air capacity at least equal to that specified by the manufacturers of the hammers to be used.

1. The boiler or compressor shall be equipped with an accurate pressure gauge at all times.

2. 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.

3. Inefficient steam or air hammers shall be removed from the work.

4. When necessary to obtain the required penetration, the Contractor shall supply and operate, at no additional cost to the Contracting Agency, 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.

5. If a pile is set in a drilled hole, it shall be driven sufficiently to fix the point firmly and secure full bearing.

6. 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.

H. 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.

I. Driving leads shall be used, constructed to afford freedom of movement of the hammer, and held in position by guys or stiff braces to ensure 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

A. 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.

B. Care shall be exercised to prevent damage to the piles due to overdriving.

C. Piles shall be driven battered (sloped) if called for on the plans.

D. Piles, other than sheet piles, shall not be driven until the approach fills are compacted and in place to an elevation of 1-1/2 feet above the bottom of the concrete abutment, as indicated on the plans.

1. When piles are to be driven through embankment and the depth of the embankment at the pile location is in excess of 5 feet, the pile (other than sheet pile) shall be driven in a hole drilled through the embankment.

2. The hole shall have a diameter large enough to allow a minimum of 2 inches of clearance around the pile.

3. After driving the pile, the space around the pile shall be filled to ground surface with dry sand or crushed rock.

E. 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.

F. All piles raised during the process of driving adjacent piles shall be driven down again.

G. Unless otherwise ordered, inclined leads shall be used in driving battered piles.

H. 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 2 separate steel straps shall be placed within 2 feet of the butt of each pile.

1. Steel strapping shall conform to A.W.P.A. specifications, except that the straps shall encircle the pile only once per strap.

2. 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.

I. When load tests are required, no other piling shall be driven until test loading has been completed, except in case of service piles driven to serve as anchor piles for the test loading.

J. 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.

K. The driving heads shall closely fit the top of the steel pile or shell and shall extend down over the sides of the pile at least 4 inches.

L. Piles shall be driven to the position and line indicated on the plans.

1. Piles out of position and line more than the diameter of the pile shall be pulled and replaced unless otherwise approved by the Engineer.

2. 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 9 inches.

3. Any additional materials required because of out-of-line piles that are allowed to remain in place will be at no additional cost to the Contracting Agency.

508.03.05 BEARING VALUE AND PENETRATION

A. Piles shall be driven to a bearing value of not less than the design loading shown on the plans.

B. Unless a lesser penetration is permitted in writing by the Engineer, piles shall penetrate to:

1. The specified tip elevation shown on the plans.

2. At least 10 feet into the natural ground when a tip elevation is not specified or shown on the plans.

3. Natural ground shall be defined as the bottom of the highway embankment.

C. 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 AASHTO Standard Specifications for Highway Bridges.

1. 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 5 to 10 blows

2. 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.

D. Twice the height of bounce shall be deducted from H to determine its value in the formula.

E. 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 following factor, where P is the weight of the pile and cap:

$$\frac{2W}{W + P}$$

F. In case jets are permitted in connection with the driving, the bearing value shall be determined by the above formula from results after the jets have been withdrawn.

508.03.06 CUT OFF AND EXTENSIONS

A. Timber piles that are to be capped shall be accurately cut off so that true bearing is obtained on every pile without use of shims.

1. Other timber piles shall be cut off on the square at the elevation designated.
2. Piles inaccurately cut off shall be replaced.
3. Splicing of timber piles will not be permitted except upon the written permission of the Engineer.

B. Concrete piles shall be cut off at such elevation that the piles will extend into the cap or footing as indicated on the plans.

1. 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.
2. 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.
3. 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.

C. 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.

D. The work of cutting off precast concrete piles shall be performed so as to avoid spalling or damaging the pile below the cut off. Such damage to the pile shall be replaced or repaired as required by the Engineer.

E. All cut-off lengths of piling shall remain the property of the Contractor and shall be disposed of outside the right-of-way in accordance with the provisions of Subsection 107.14, "Disposal of Material Outside Project Right-of-Way."

508.03.07 LOAD TESTING

A. If load tests are required, the tests shall be performed on the test piles as specified in Subsection 508.03.02, "Test Piles." The loading shall not be applied until 48 hours after the pile is driven or, in the case of cast-in-place piles, the concrete has attained a minimum compressive strength of 2,000 psi.

B. A loading test shall consist of the continuous application of a load of twice the design load to the pile being tested.

1. The pile shall be considered to have a bearing value equal to the design load if the permanent settlement produced by such test loading is not greater than 1/4 inch.

2. Unless otherwise permitted by the Engineer, the loading tests shall be completed before the remaining piles are cast or driven.

C. When a loading test is required, the Contractor shall provide suitable facilities and equipment to transmit the prescribed test load vertically to each pile to be tested.

1. Provisions for varying the applied load shall be made, and the loads must be in known and measurable increments, applied axially to the pile.

2. The marks, gauges, dials, or other instruments of loading equipment required to determine settlement of the pile shall be arranged for convenient observation without danger to the observer or the equipment.

3. All test equipment shall be accurately calibrated and shall be approved by the Engineer.

D. The test loads shall be applied under the direction of the Engineer, and at such rate or in such increments as the Engineer may specify.

1. When a load test of a pile is commenced, the test shall be continuous, and the Contractor shall furnish all facilities on a 24-hour, 7-day week basis until the test is completed.

2. Forty-eight hours after all deflection and settlement has ceased, or sooner if directed by the Engineer, the test load shall be removed at the rate or in increments as the Engineer may direct.

3. If the results of the above prescribed operations indicate that excessive permanent settlement of the test pile has occurred, the pile shall be driven to such additional depths as the Engineer may specify, and the above described test loading operations repeated.

4. Each complete operation, which shall include loading and unloading as above prescribed, shall be considered as an individual test.

508.03.08 TIMBER PILES

A. The species of timber used for timber piles shall be either Douglas Fir, Southern Yellow Pine, Larch, or Cedar as shown in the contract documents.

B. When treated piles are required, the piles shall be given a preservative treatment of creosote by pressure processes to retain at least 10 pounds of creosote per cubic foot.

C. Timber piles shall conform to the requirements of Section 717, "Timber Piles," and shall be inspected as therein provided.

D. 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.

E. Treated timber piles shall be carefully handled during and after loading from cars.

1. The piles shall not be dragged across the ground at any time and shall be handled only with rope slings or with wooden equipment.

2. Sharp tools shall be permitted only when used for necessary field cutting and trimming.

3. All places where the surface of creosoted piling is broken by cutting, boring, or otherwise, shall be thoroughly coated with at least 3 applications of hot creosote oil.

4. Each application shall be allowed to become reasonably dry before the succeeding one is applied.

F. 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.

G. Heads of piles, when the nature of the driving is such as to unduly injure them, shall be protected by caps of approved design.

1. 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 3 layers of asphalt or tar and 2 layers of fabric.

2. The fabric shall measure at least 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 2 turns of No. 10 galvanized wire.

3. 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.

H. In lieu of the above method of treatment, the sawed surface may be covered with 3 applications of a hot mixture of 60 percent creosote oil and 40 percent roofing pitch, or thoroughly brush coated with 3 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.

I. 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

A. Precast concrete piles shall be constructed of Portland cement concrete proportioned and mixed in accordance with Section 501, "Portland Cement Concrete," and placed in accordance with Section 502, "Concrete Structures." Reinforcing steel shall conform to Section 505, "Reinforcing Steel."

B. Concrete for precast concrete piles shall be poured in smooth, watertight forms supported 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 1 inch from the face of the pile at any point.

C. Concrete piles shall be kept continuously wet for at least 10 days after pouring and shall be allowed to harden for at least 30 days before being lifted or driven, except that this 30-day requirement may be decreased if the specimen of concrete from which the piles were poured develops a strength of 3,000 psi or more of compression.

D. 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.

1. Piles materially damaged in handling or driving shall be replaced.

2. 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

A. Concrete filling for cast-in-place concrete piles shall be Portland cement concrete conforming to Section 501, "Portland Cement Concrete."

1. Reinforcement shall conform with the details shown on the plans and with Section 505, "Reinforcing Steel."

2. Cast-in-place concrete piles shall consist of one of the following:

a. Steel shells driven permanently to the required bearing value and filled with concrete.

b. Drilled holes filled with concrete.

B. **Steel Shells.**

1. 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.

2. The shells shall also be sufficiently watertight to exclude water during the placing of concrete.

3. The shells may be cylindrical or tapered, step tapered, or a combination of either with cylindrical sections.

4. The tip diameter shall not be less than 8 inches and the butt diameter shall not be less than shown on the plans.

5. 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.

6. 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.

a. 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 no additional cost to the Contracting Agency.

b. Driven shells or casings shall be clean and free from water before concrete and reinforcing steel are placed.

c. The Contractor shall have available at all times a suitable light for the inspection of the shells, throughout the entire length, before the shells are filled with concrete and reinforcing steel.

7. Concrete shall be placed in steel shells so that it is dense and homogeneous. Concrete placed in the upper portion of the shell shall be vibrated to a depth of not less than 1/3 the length of the pile or 10 feet, whichever is greater.

8. 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 for payment in Subsection 508.04.01, "Measurement," shall be at no additional cost to the Contracting Agency.

C. **Drilled Holes.**

1. Each pile excavation shall be drilled to the minimum specified diameter and depth as shown on the plans.

   a. The bottom of each drilled excavation shall be reasonably free of loose soil and mud at the completion of drilling and prior to the placement of concrete.

   b. Existing groundwater may remain in the excavation and need not be pumped out.

   c. Holes shall be examined for straightness and any hole which on visual inspection from the top shows less than 1/2 the diameter of the hole at the bottom of the holes shall be rejected.

   d. Suitable casing shall be furnished and placed when required to prevent caving of the hole before concrete is placed therein.

2. All loose material existing at the bottom of the hole after drilling operations have been completed shall be removed or recompacted to the satisfaction of the Engineer before placing concrete in the hole.

3. Materials resulting from drilling holes shall be disposed of as provided in the last paragraph of Subsection 206.03.01, "General."

4. Casing, if used in drilling operations, shall be removed from the hole as concrete is placed therein.

   a. The bottom of the casing shall be maintained not more than 5 feet nor less than 1 foot below the top of the concrete during withdrawal and placing operations unless otherwise permitted by the Engineer.

   b. The casing shall be hammered or the concrete vibrated during withdrawal of the casing.

5. Care shall be exercised to ensure that the concrete in the hole is dense and homogeneous. Vibration of the concrete during placing will be required. The concrete in the hole for the length of the reinforcing cage (bottom of spiral wire) shall be vibrated.

6. 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.

D. For either steel shells or drilled holes, the bottom of each shell casing or hole shall be filled with mortar to a depth of not less than 2 feet immediately before placing the concrete filling materials. The mortar shall be as specified in Subsection 501.03.12, "Mortar," Class C.

E. Drilled pile excavations which encounter caving or sloughing conditions shall be deepened at the direction of the Engineer. The additional depth to be drilled shall equal the height of caving or sloughing encountered in the pile excavation.

F. Concrete placement in the pile excavation shall be accomplished with a concrete pump and steel pipe tremie.

1. The concrete pump shall have sufficient capacity to fill the pile excavation by displacing the water and mud out of the top of the drilled hole.

2. A minimum 10-foot head of concrete shall be maintained above the bottom of the steel tremie pipe at all times.

G. The Contractor shall drill the pile excavations and pour the concrete in such a manner as to ensure the structural integrity of the concrete pile.

1. All phases of pile drilling, steel reinforcement installation, and concrete placement shall be inspected by the Engineer.

2. Inspection by the Engineer does not, however, relieve the Contractor in any way of the responsibility for constructing piles that meet the requirements of the plans and specifications.

H. The Contractor shall test all completed drilled shaft foundations with the nondestructive testing (NDT) method called Crosshole Sonic Logging (CSL) after at least 1 day of curing time.

1. Final approval for the first drilled shaft constructed will be given after the CSL tests have been performed on the shaft and the results have been analyzed.

2. Concrete placement in subsequent shaft excavations will not be allowed until the first shaft has been approved.

I. The consultant who will conduct the Crosshole Sonic Logging (CSL) tests shall submit evidence of qualification to the Engineer for approval. Such evidence of qualification shall include the following:

1. Written evidence of successful completion of CSL tests, brief descriptions and references for 4 recent CSL projects, and a list of tested shafts with a minimum of 75 shafts tested in the past 5 years.

2. Personnel qualifications.

3. Equipment description and test procedure.

4. Example reports.

J. For the purposes of CSL tests, tubes shall be installed in each pile to permit access for the CSL test probes.

1. The tubes shall be ASTM A53, Grade B Schedule 40 steel pipe or Schedule 40 PVC.

2. The maximum number of days from placing concrete to completing CSL testing is 45 calendar days for Schedule 40 steel access tubes and 10 calendar days for Schedule 40 PVC access tubes.

3. The tubes shall be 1.5 inches to 2 inches in inside diameter and shall have a round, regular inside diameter free of defects or obstructions, including obstructions at any pipe joints, to permit the free, unobstructed passage of 1.35-inch diameter source and receiver probes used for the CSL tests.

4. The tubes shall be watertight and free from corrosion with clean internal and external faces to ensure good bond between the concrete and the tubes.

5. The tubes shall be fitted with a watertight cap on the bottom and the top.

K. The design drawings for each foundation may specify the number of tubes and the tube spacing angles. Otherwise, the CSL testing firm shall be consulted for the proper number of tubes, which shall be spaced evenly around the perimeter of the reinforcing cage.

L. Prior to placing the pile reinforcement cage into the shaft, the tubes shall be securely attached to the interior of the reinforcement cage.

1. Use a regular, fairly symmetrical pattern in which each tube is spaced the maximum distance possible from adjacent tubes.
2. The number and spacing of tubes around the perimeter of the cage shall correspond to the design drawings.
3. Position tubes so that, after reinforcement operations, the tubes will be as near to vertical and as parallel as possible.
4. Fit access tubes with a watertight shoe on the bottom and a removable cap on the top.
5. Any joints added to make full-length tubes must be watertight.
6. Wire-tie tubes to the interior of the cage every 3 feet, or otherwise secure so tubes remain in place for remaining operations.

M. The tubes shall extend from the bottom of the reinforcement cage to at least 3 feet above the top of the shaft.

1. If the shaft top is below ground elevation, extend tubes at least 2 feet above the ground surface.
2. Under no circumstance shall the tubes be allowed to rest on the bottom of the drilled excavation.
3. Care shall be taken to prevent damaging the tubes during reinforcement cage installation operations in the drilled shaft excavation.
4. The tubes shall be filled with potable water prior to or as soon as possible after concrete placement (but no later than 4 hours) and the tube tops shall be capped.

N. The Contractor is responsible for good care and workmanship in installing testing tubes so that the testing equipment will pass through the entire length of the tube.

1. If the inspection equipment cannot pass through the full length of the inspection tube, a 2-inch diameter hole shall be cored through the concrete the full length of the pole, at no additional cost to the Contracting Agency, to replace the defective tube.
2. Core holes shall be located as determined by the Engineer and approximately 9 inches inside the drilled shaft reinforcement.

O. The final acceptance of each drilled shaft shall be determined by the Engineer and will be based on the CSL test results.

1. If any shaft is determined to be unacceptable, the Contractor shall submit a plan for remedial action to the Engineer for approval.
2. Any modifications to the dimensions of the drilled shafts shown on the contract plans caused by remedial action will require calculations and working drawings stamped by a Nevada licensed professional engineer.
3. The Engineer, prior to repair operations, shall approve any remedial correction procedures or designs.

P. At the Engineer’s direction, a core hole shall be drilled in any questionable quality shaft (as determined from the CSL test results or by observation of the Engineer) to explore the shaft condition.

1. A coring method that provides complete core recovery and minimizes abrasion and erosion of the core (i.e., double or triple core barrels) shall be used.
2. If a defect is confirmed, the Contractor shall pay for all coring costs.
3. If no defect is encountered, the Contracting Agency will pay for all coring costs, and compensation for the delay will be granted by an appropriate time extension and payment.
4. Materials and work necessary, including engineering analysis and redesign, to effect corrections for the shaft defects shall be furnished to the Engineer's satisfaction with no additional compensation.

Q. After completion of the CSL testing and acceptance of the pile, testing tubes shall be cut off flush with the top of the drilled shaft, and all core holes and testing tubes shall be filled with grout from the bottom up.

508.03.11 COVERING HOLES

A. To eliminate hazard to life and to preclude dirt or debris from falling or being thrown into them, the tops of driven pile shells or drilled holes shall be securely covered immediately upon withdrawal of the material or drilling equipment.

508.03.12 STEEL PILES

A. Steel piles shall be H-bearing of the section shown on the plans.

B. The length of steel pile may be built up in sections either before or during the driving operations.

1. The sections, unless otherwise shown on the plans, shall be identical in cross section.
2. The connections shall be made by welding the entire cross section in conformance with Subsection 506.03.20, "Welding."
3. Care shall be taken to properly align the sections connected so that axis of the pile will be straight.
4. The number of welded connections in the length of a pile shall be as few as practicable.
5. If a welded splice is made during the driving operation, it shall be done when the top of the lower portion is at least 3 feet above the ground to permit observation of the welded connection during several feet of driving.

C. 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, "Steel Structures."

METHOD OF MEASUREMENT

508.04.01 MEASUREMENT

A. The quantity of Furnish and Drive (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.

B. 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.

C. Load tests will be measured per each and the number used in the work will be the number paid for.

D. 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.

1. Length of extensions will be determined by the Engineer.

2. 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 no additional cost to the Contracting Agency.

E. 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.

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

BASIS OF PAYMENT

508.05.01 PAYMENT

A. The accepted quantity of Finish and Drive (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 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; 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 crushed rock; all to the required bearing and penetration as shown on the plans or ordered by the Engineer.

B. Test piles that become a part of the completed structure will be paid for at the contract prices for the type of piling used.

C. 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.

D. 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."

E. 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 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.

F. 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 shall be full compensation for all material, equipment, tools, and labor incidental to make the splice.

G. 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.

H. The accepted quantity of Cast-in-Place 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 shall be full compensation for drilling holes for piling and disposing of material resulting therefrom; 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.

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

J. Payment will be made under:

PAY ITEM	PAY UNIT
Furnish and Drive (Type) Piles	Linear Foot (Meter)
Load Test	Each
Splices	Each
Cast-in-Place Drilled Hole Concrete Piles	Linear Foot

SECTION 601

PIPE CULVERTS – GENERAL

DESCRIPTION

601.01.01 GENERAL

A. This section includes general requirements that are applicable to all types of culvert pipes regardless of the material or culvert use with the following exceptions:

1. Structural plate pipe,
2. Water distribution systems and sanitary sewer system specifications will specify the pipe to be used in their respective installations.

B. This work shall consist of furnishing and installing pipe culverts, siphons, end sections, end walls, and so forth, as may be required to complete the work shown on the plans or established by the Engineer.

C. The pipe shall comply with AASHTO Design and Construction LRFD Specifications most current edition and these specifications. The more stringent requirements shall apply.

MATERIALS

601.02.01 GENERAL

A. The materials used shall conform to the requirements in the following subsections:

Materials	Section/Subsection
Bituminous Coated Corrugated Metal Pipe and Pipe Arches	709.03.02
Clay Pipe	708.03.04
Corrugated Aluminum Pipe	709.03.04
Corrugated Metal Pipe and Pipe Arches	709.03.01
Grout and Mortar Sand	706.03.04
Nonreinforced Concrete Pipe	708.03.02
Portland Cement	701
Reinforced Concrete Pipe	708.03.01
Rubber Gaskets	707.03.06
Thermoplastic Pipe	709.03.10

B. When the location of manufacturing plants allows, the plants will be inspected periodically for compliance with specified manufacturing methods.

1. Material samples will be obtained for laboratory testing for compliance with materials quality requirements as specified in the referenced specifications.
2. This can be the basis for acceptance of manufacturing lots.

C. 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.

D. The lengths shown on the plans are approximate.

E. For structural plate pipe and arches, comply with Section 606, "Structural Plate Pipe and Pipe Arch Culverts."

CONSTRUCTION

601.03.01 EARTHWORK

A. Excavation and backfill shall conform to the requirements of Section 206, "Structure Excavation," and Section 207, "Structure Backfill," or Section 208, "Trench Excavation and Backfill," when the culvert is placed in a trench.

1. The pipe shall be bedded as shown in the plans and/or drawings appended to the plans or as specified in the Special Provisions.
2. When no bedding class is specified, the requirements for normal bedding as shown in the Uniform Standard Drawings shall apply.
3. The lines and grades will be established by the Engineer or as designated in the contract documents.

B. 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.

C. 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 using Class II CLSM or concrete.

601.03.02 HEADWALLS

A. Where shown on the plans, inlet and outlet headwalls shall be constructed or installed in connection with culvert pipes.

B. Where 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.

C. Headwalls shall be constructed to conform to Section 501, "Portland Cement Concrete" and Section 502, "Concrete Structures."

601.03.03 END SECTIONS

A. The bed for the end section shall be excavated to the required width and grade.

B. For metal end sections with toe plates, a trench shall be excavated for the toe plate in a manner to permit the toe plate from 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.

C. Precast concrete end section shall be placed with its tongue (or groove) fully entered in the groove (or tongue) of the pipe.

D. Thermoplastic pipe greater than 30 inches shall not be used at the open-end sections.

601.03.04 JACKED PIPES

A. 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.

B. The strength of pipe or gauge of pipe will be determined for vertical load only in embankment conditions. Any additional reinforcement or strength required to withstand jacking pressure shall be determined and furnished by the Contractor at no additional cost to the Contracting Agency.

C. Variation from theoretical alignment and grade at the time of completion of placing shall not exceed 0.2 foot for each 20 feet of pipe placed.

D. The diameter of the excavated hole shall not be more than 0.1 foot greater than the outside diameter of the pipe.

1. Sluicing and jetting with water will not be permitted.

2. 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 1-1/2 feet unless permitted by the Engineer.

E. Areas resulting from caving or excavating outside the above limits shall be backfilled with sand or grout by a method that will fill the voids.

601.03.05 LAYING CULVERT PIPE

A. Laying of culvert pipe shall conform to the requirements of the respective sections of culvert pipe.

601.03.06 EXTENDING EXISTING CULVERTS

A. 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.

B. 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. Comply with Section 202, "Removal of Structures and Obstructions."

C. 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.

601.03.07 VIDEO INSPECTION

A. Unless otherwise approved by the Contracting Agency, all video inspection shall be completed by a National Association of Sewer Service Companies (NASSCO) certified operator, certified at the user level minimum.

1. The user shall have completed the Pipeline Assessment and Certificate Program (PACP).

2. Video inspection reports must follow the NASSCO format and use standard sewer defect codes.

METHOD OF MEASUREMENT

601.04.01 MEASUREMENT

A. The materials to be paid for under these specifications will be listed in the contract items by size, class, type, gauge, or whatever information is necessary for identification.

B. 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 2-foot increments.

C. 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.

D. Structure excavation and structure backfill, Portland cement concrete, and reinforcement required for headwalls, end walls, 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.

E. No separate measurement or payment will be made for constructing jacking pits and backfilling all pits after the pipe is jacked, or 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.

F. 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.

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

BASIS OF PAYMENT

601.05.01 PAYMENT

A. 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.

B. When any of the various sizes, types, and gauges of pipe is 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.

C. 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 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.

D. 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.

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

SECTION 602

NON-REINFORCED CONCRETE AND CLAY PIPE

DESCRIPTION

602.01.01 GENERAL

A. This work shall consist of furnishing and installing non-reinforced 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 these specifications.

MATERIALS

602.02.01 GENERAL

A. Materials and their use shall conform to the applicable requirements of Subsection 603.02.01, "General," and Subsection 601.02.01, "General."

CONSTRUCTION

602.03.01 GENERAL

A. The construction requirements shall be as prescribed in Subsection 603.03.01, "General," through Subsection 603.03.06, "Junctions," with the modifications specified below:

B. External bands of Class "C" mortar as designated in Subsection 501.03.12, "Mortar," may be placed around the pipe joints as herein specified.

1. Several sections of pipe shall be joined before commencing banding operations, but the placing of external bands shall never be more than 5 lengths of pipe behind joining operations.
2. Immediately in advance of placing external band mortar, the external surface of the pipe sections at the joints shall be thoroughly cleaned and wetted to ensure proper bonding of the band mortar with the pipe.
3. Care shall be exercised to make a union between the band and the mortar that was placed under the joint before the pipe sections were abutted.
4. The band shall not be less than 3/8 inch thick at the pipe joint and shall be approximately 4 inches wide, overlapping the abutting ends of the pipe sections approximately 2 inches.
5. The edges of the band shall adhere to the pipe surface to prevent peeling and shall be finished in a workmanlike manner.
6. Rubber gaskets may be used to join the pipe.
7. Rubber gaskets shall conform to the requirements of Subsection 707.03.06, "Rubber Gaskets."

C. 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 90 percent will not be required.

D. Openings shall be cut into irrigation or sewer pipe and connections made thereto as shown on the plans or directed by the Engineer.

1. Openings shall be cut to proper sizes.
2. Connections shall be cut to fit closely and shall be strongly cemented to the pipe with banding mortar.
3. 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

A. 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

A. Payment shall conform to the requirements of Subsection 601.05.01, "Payment," and this subsection.

B. The accepted quantities of non-reinforced concrete or clay pipe will be paid for at the contract bid price per linear foot for the types and sizes specified.

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

D. Payment will be made under:

PAY ITEM	PAY UNIT
(Size) Non-reinforced Concrete Pipe (type)	Linear Foot
(Size) Clay Pipe (type)	Linear Foot

SECTION 603

REINFORCED CONCRETE PIPE

DESCRIPTION

603.01.01 GENERAL

A. This work shall consist of furnishing circular or elliptical, reinforced concrete pipe, siphons, and conduits of the size, classes, and dimensions and at locations shown on the plans or established by the Engineer and in accordance with ASTM C76, ASTM C655, or ASTM C507, with design basis in accordance with Section 708, “Concrete and Clay Pipe and Drains,” and where indicated in these specifications.

B. The installation shall conform to the AASHTO LRFD Bridge Construction Specifications and these specifications.

MATERIAL

603.02.01 GENERAL

A. Materials and their use shall conform to Subsection 601.02.01, "General," and the requirements below.

B. Prior to the use of these materials, the Contractor shall submit to the Engineer for approval a document certifying that the material meets these specifications and Section 708, “Concrete and Clay Pipe and Drains,” from an authorized source approved by the Interagency Quality Assurance Committee (IQAC).

C. Flared end sections (precast) shall conform to the details and dimensions shown on the plans and, except for shape, shall conform to the material requirements of this section for reinforced concrete pipe.

D. Rubber gaskets are required for all circular pipes and mastic for elliptical. Rubber gaskets shall conform to Subsection 707.03.06, "Rubber Gaskets."

E. If joint mortar is required, it shall be as specified in Subsection 501.03.12, "Mortar," Class "C."

1. Sand shall conform to Subsection 706.03.04, "Grout and Mortar Sand."
2. The materials shall be mixed to a consistency suitable for the purpose intended.
3. All mortar shall be used within 30 minutes after the mixing water has been added.
4. 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.
5. The amount of admixture to be added shall be the quantity determined by the Engineer.

CONSTRUCTION

603.03.01 GENERAL

A. Construction methods shall conform to Subsection 601.03.01, "Earthwork," through Subsection 601.03.06, "Extending Existing Culverts," and shall meet the requirements below. All pipe installations shall conform to the workmanship and inspection

requirements of the AASHTO LRFD Bridge Construction Specifications and this specification as applicable.

B. No pipe shall be laid that is excessively cracked (in accordance with Subsection 603.03.07, "Inspection"), checked, spalled, or damaged, and all such sections of pipe shall be permanently removed from the work. Pipes that show defects due to handling shall be rejected at the site of the installation regardless of prior acceptance.

603.03.02 EARTHWORK

A. Where pipes are to be installed in new embankment (projection), the embankment shall first be constructed to the required elevation as set forth below. The height of embankment to be constructed in advance of installing the pipe may be varied when permitted by the Engineer.

B. In the case of pipes 24 inches or less in diameter, the roadway embankment shall be constructed to an elevation of 6 inches above the grade proposed for the top of the pipe, after which the trench shall be excavated and the pipe installed.

C. In the case of pipes more than 24 inches in diameter, the roadway embankment shall be constructed to an elevation of 30 inches above the grade proposed for the bottom of the pipe, after which the trench shall be excavated and the pipe installed.

D. When pipe having bells or hubs is used, cross trenches shall be excavated for them to prevent non-uniform loading of the joints.

603.03.03 LAYING CULVERT PIPE

A. Construction installation shall comply with the AASHTO LRFD Bridge Construction Specifications; Section 208, “Trench Excavation and Backfill”; and this subsection.

1. The installation shall be conducted by a certified supervisor/foreman at the crew level who is responsible for the work.
2. The certified person is the designated installation inspector for the Contractor and shall generate a daily report attesting to the workmanship for each of the installation components described below.
3. This does not relieve the Contractor of responsibility for other Quality Control aspects of this and other specifications.

B. Installation Components:

1. Bedding.
2. Pipe Condition.
3. Pipe Installation.
4. Haunch Compaction.
5. Complete Pipe Zone Compaction.

C. The bottom of the trench shall be graded and prepared to provide a firm and uniform bearing throughout the entire length of the pipe. Blocking shall not be used to bring the pipe to grade.

D. Pipe sections shall be checked for alignment and grade at the time of joining the sections.

1. Pipe laying shall begin at the downstream end of the pipeline except for extensions of existing pipes.

2. Place the bottom of the pipe in contact with the shaped bedding throughout its full length.
3. 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.
4. Maintain the manufacturer's recommended minimum and maximum cover at all times unless otherwise shown in the contract.
5. Pipe will be inspected before any backfill is placed.
6. Ensure that no rocks greater than 3 inches or other rigid or jagged material is present in the bedding material where pipe may be laid directly on the material.
7. Take up and relay or replace pipe that is out of alignment, unduly settled, or damaged.

E. The interior of the pipe shall be kept free of dirt, 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 re-laid at the Contractor's expenses.

F. **Backfill:** Prior to placing backfill material, all lifting holes in concrete culverts shall be completely filled with grout.

603.03.04 RUBBER GASKETED JOINTS

A. Circular reinforced concrete culvert pipe shall use rubber or neoprene gasketed joints.

B. Rubber gaskets shall not be exposed to the direct rays of the sun for more than 72 hours.

C. The Contractor shall make every effort to provide a concrete-to-concrete connection and pull the pipe completely home.

1. Should gapping occur due to changes or corrections in horizontal or vertical alignment or radius turns, the gaps shall not exceed the gap tolerance indicated in Table 1.
2. If pipes are laid that exceed these tolerances, the inner annular space between the pipe sections shall be completely filled with cement mortar (where pipe diameters allow for entry).
3. If pipes are laid that exceed the tolerances in Column 2, the pipe will need to be removed and re-laid or an acceptable concrete collar will need to be installed.

Table 1 - Maximum Joint Gap Tolerances[1]

	Column 1	Column 2
Inner Diameter of Pipe	**Maximum Joint Gap Tolerance**	**Maximum Joint Gap Tolerance (with Grouting)**
12-inch to 36-inch	5/8 inch	3/4 inch
42-inch to 48-inch	7/8 inch	1-1/8 inch
54-inch to 90-inch	1 inch	1-1/4 inch
96-inch	1- 5/8 inch	1-3/4 inch
Above 96-inch up to 144-inch	As recommended by Manufacturer	As recommended by Manufacturer

[1] In no case shall maximum joint gap tolerance exceed ½ of the length where the gasket seats within the pipe

D. 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.

E. 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 24 inches in diameter may be pointed inside by brushing smooth and removing all surplus mortar.

F. 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

A. Reinforced concrete pipe used for siphons or pressure pipe shall be laid in accordance with the above provisions, be connected by flexible, watertight rubber gasket joint and, prior to backfilling, be subject to the following hydrostatic test:

1. The pipeline shall be filled with water at a hydrostatic head of that required to maintain the design pressure.
2. The pressure head shall be maintained for a period of not less than 24 hours and any visible leak or other defects that develop under test shall be corrected by the Contractor at no additional cost to the Contracting Agency.
3. Sweating that does not develop into a flow or drip will not be considered as leakage.
4. The test shall be repeated until all leaks or other defects are eliminated

603.03.06 JUNCTIONS

A. All junctions of laterals with a main line or junctions of 2 or more main lines, which are not made in a manhole or concrete junction structure, shall be in a manufactured wye or tee.

B. The wye or tee shall be of the same material as the conduits to which they are joined, and shall have the same or greater stiffness as the pipe.

603.03.07 INSPECTION

A. All pipe joints and lengths shall be 100 percent inspected.

1. Inspection and testing shall be performed by the Contractor during and after installation to ensure proper performance.
2. Installation, placement, and compaction of bedding and backfill materials shall comply with this section.
3. During the initial phases of the installation process, inspection shall concentrate on detecting improper practice and poor workmanship.
4. Errors in line and grade, improper assembly, and improper backfill techniques shall be corrected prior to placing significant backfill or trench fill.
5. Bell/spigot joints shall be properly assembled to prevent the infiltration of soil fines.
6. Gaskets shall be properly seated to prevent groundwater infiltration and shall appear uniformly oriented around the pipe.
7. Shallow cover installations shall be checked to ensure the minimum cover level is provided.

B. After the pipe has been bedded and backfilled to subgrade level, internal quality inspection shall be paid for and performed by the Contractor a minimum of 30 days after final backfill has been placed and prior to final acceptance by the Contracting Agency.

1. The line shall be cleaned and inspected for cracks and joint gaps using visual physical measurement or other devices, including but not limited to calibrated television or video cameras, subject to approval by the Engineer.

2. Cracks in pipes (both longitudinal and circumferential) that are less than 0.10 inch in width are generally considered non-structural flaws and need not be repaired.

3. Cracks that are equal to or exceed 0.10 inch in width shall require an evaluation by a Nevada licensed professional engineer.

4. The Contractor's engineer shall provide a recommendation regarding removal or repair subject to approval by the Contracting Agency.

5. Pipe joints and lengths that do not meet the specification shall be repaired or pipe replaced at no additional cost to the Contracting Agency.

C. All inspection results shall be submitted and approved by the Engineer before final payment.

1. Any replacement pipe shall also be subject to the same testing.

2. All inspection and testing results shall be submitted to the Engineer for approval.

D. The Engineer shall be allowed access to randomly inspect at least 10 percent of the total number of pipe runs.

METHOD OF MEASUREMENT

603.04.01 MEASUREMENT

A. Method of measurement shall conform to Subsection 601.04.01, "Measurement" and the requirements below.

B. 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. Precast pipe and cast-in-place sections that are an integral part of the manhole will not be included in the linear foot measurement for reinforced concrete pipe.

C. The measurement for the quantity of radius RCP will be measured as standard RCP of the equivalent size.

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

BASIS OF PAYMENT

603.05.01 PAYMENT

A. Payment shall conform to Subsection 601.05.01, "Payment," and the requirements below.

B. 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 shall be full compensation for removal of existing pavement (only if pavement removal is not included with roadway excavation) trench excavation, furnishing and placing bedding and backfill material, Type II aggregate base, compaction, furnishing and placing pipe and jointing

mortar, covering open ends of laterals with plywood, cut and join connections, dewatering of trench, shoring, disposal of excess excavated material, protection and restoration, potholing to determine location of existing utilities, temporary pavement, video inspection cost, related items of work not otherwise provided for, and for all labor, tools, and equipment necessary to complete the work as shown on the plans, as specified herein, and as directed by the Engineer.

C. 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.

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

E. Payment will be made under:

PAY ITEM	PAY UNIT
(Size) Reinforced Concrete Pipe (class)	Linear Foot
(Size) Oval Reinforced Concrete Pipe (class)	Linear Foot
(Size) Reinforced Concrete Siphon Pipe (class)	Linear Foot
(Size) Reinforced Concrete 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

A. This work shall consist of furnishing and installing corrugated metal pipe, corrugated metal arch pipes and corrugated metal slotted pipe and the relaying of salvaged corrugated metal pipe and pipe arches at locations shown on the plans, or established by the Engineer, and in accordance with the design requirements of Section 709, “Metal and Thermoplastic Pipe,” and where indicated in these specifications.

B. The installation shall conform to the AASHTO LRFD Bridge Construction Specifications and these specifications.

MATERIALS

604.02.01 GENERAL

A. Materials and their use shall conform to Subsection 601.02.01, "General," Section 709, “Metal and Thermoplastic Pipe,” and the requirements below

B. Prior to the use of these materials, the Contractor shall submit to the Engineer for approval a document certifying that the material meets these specifications and Section 709, “Metal and Thermoplastic Pipe,” from an authorized source approved by the Interagency Quality Assurance Committee (IQAC).

C. Corrugated metal pipe shall be furnished in the sizes, gauges, and corrugation patterns as shown on the project plans.

D. 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.

CONSTRUCTION

604.03.01 GENERAL

A. Construction methods shall conform to Subsection 601.03.01, "Earthwork," through Subsection 601.03.06, "Extending Existing Culverts," and the requirements below.

1. All pipe installation shall conform to the workmanship and inspection requirements of AASHTO LRFD Bridge Construction Specifications AASHTO M36, AASHTO M196, and this specification as applicable.

2. The more stringent requirements shall apply.

B. Prior to the use of these materials, the Contractor shall submit to the Engineer for approval a document certifying that the material meets these specifications and Section 709, “Metal and Thermoplastic Pipe,” from an authorized source approved by the Interagency Quality Assurance Committee (IQAC).

1. If the manufacturer is not authorized, the Contractor shall provide a Quality Control Program with test and inspection data to the Engineer for approval.

2. Subsequent submittals and reports shall be reviewed by the Contractor for compliance, then transmitted to the Engineer for approval.

3. It is then the responsibility of the Contractor to visit the manufacturer to ensure that the non-authorized source is conforming to the QC program requirement.

C. Culverts shall be handled so as to prevent bruising, scaling, and breaking of the spelter coating. Pipes that show defects due to handling shall be rejected at the site of the installation regardless of prior acceptance.

604.03.02 EARTHWORK

A. Where pipes are to be installed in new embankment (projection), the embankment shall first be constructed to the required elevation as set forth below. The height of embankment to be constructed in advance of installing the pipe may be varied when permitted by the Engineer.

B. In the case of pipes 24 inches or less in diameter, the roadway embankment shall be constructed to an elevation of 6 inches above the grade proposed for the top of the pipe, after which the trench shall be excavated and the pipe installed.

C. In the case of pipes more than 24 inches in diameter, the roadway embankment shall be constructed to an elevation of 30 inches above the grade proposed for the bottom of the pipe, after which the trench shall be excavated and the pipe installed.

D. When pipe having bells or hubs is used, cross trenches shall be excavated for the pipe to prevent non-uniform loading of the joints.

604.03.03 LAYING CULVERT PIPE

A. Installation shall comply with the AASHTO LFRD Bridge Construction Specifications; Section 208, “Trench Excavation and Backfill”; and this subsection.

1. The installation shall be conducted by a certified supervisor/foreman at the crew level who is responsible for the work.
2. The certified person is the designated installation inspector for the Contractor and shall generate a daily report attesting to the workmanship for each of the installation components described below.
3. This does not relieve the Contractor of responsibility for other Quality Control aspects of this and other specifications.

B. Installation Components:

1. Bedding
2. Pipe Condition
3. Pipe Installation
4. Haunch Compaction
5. Complete pipe zone compaction

C. The bottom of the trench shall be graded and prepared to provide a firm and uniform bearing throughout the entire length of the pipe. Blocking shall not be used to bring the pipe to grade.

D. Pipe sections shall be checked for alignment and grade at the time of joining the sections.

1. Pipe sections shall be fitted and matched so that when laid in the work, the sections form a smooth and uniform invert.
2. Pipe laying shall begin at the downstream end of the pipeline except for extensions of existing pipes.

3. Place the bottom of the pipe in contact with the shaped bedding throughout its full length.
4. The first section of pipe to be laid shall be firmly placed to the designated line and grade at the outlet end.
5. Corrugated metal pipe with riveted seams shall be laid so that flow is over the lap of the sheets.
6. Field joints shall be made by butting the ends of pipe together and the sections joined with a band bolted firmly in place.
7. Coupling band details for corrugated metal pipe arches shall be as shown on the project drawings or approved working drawings.
8. Maintain the manufacturer's recommended minimum and maximum cover at all times unless otherwise shown in the contract.

E. The interior of the pipe shall be kept free of dirt, and other foreign material as the pipe laying progresses, and left clean at the completion of the work. Any pipe that is not in true alignment, or that shows any undue settlement after laying, or that is damaged shall be taken up and relaid at no additional cost to the Contracting Agency.

F. Pipe shall be inspected before any backfill is placed.

1. Ensure that no rocks greater than 3 inches in diameter or other rigid or jagged material is present in the bedding material where pipe may be laid directly upon the material.
2. Ensure that no "floating" occurs during installation of plastic pipe culverts.
3. Take up and relay or replace pipe that is out of alignment, unduly settled, or damaged.

604.03.04 SLOTTED PIPE

A. This subsection covers slotted drain pipe used for the removal of surface water as shown on the plans.

1. The corrugated steel pipe (CSP) used to manufacture the slotted drain shall comply with Section 709, "Metal and Thermoplastic Pipe."
2. The diameter, gauge, and metallic coating shall be as shown on the plans.

B. The corrugated steel pipe shall have a minimum of 2 rerolled annular ends.

1. The connecting bands shall be modified Hugger-type bands to secure the pipe and prevent infiltration of the backfill.
2. When the slotted drain is banded together, the adjacent grates shall have a maximum 3-inch gap.

C. The grates shall be manufactured from ASTM A1011, Grade 26 steel and fabricated in accordance with Caltrans Standard Plan D98B[1].

1. The spacers and bearing bars (sides) shall be 3/16-inch material plus or minus 0.008 inches.

[1] Standard plans are on the Caltrans website, www.dot.ca.gov

2. The spacers shall be on 6-inch centers and welded on both sides to each bearing bar (sides) with four 1-1/4-inch long 3/16-inch fillet welds on each side of the bearing bar.

3. The minimum results for an in-place spacer pulled perpendicular to the bearing bar shall be:

   a. T = 12,000 pounds for 2-1/2-inch grate.

   b. T = 15,000 pounds for 6-inch grate.

D. The grates shall be vertical (straight sides) or trapezoidal with a 1-3/4-inch opening in the top and 30-degree slanted spacers as shown on the plans. The grate shall be 2-1/2 inches or 6 inches high as shown on the plans.

E. If variable height grate is shown on the plans, the grate shall be vertical (straight sides) with a 1-3/4-inch opening in the top and spacers shall be placed on 6-inch centers.

1. The top and bottom grates shall be 2-1/2 inches or 6 inches high, as needed.

2. Plate extenders shall be attached to achieve the slope shown on the plans.

F. The grate (and plate extenders for variable height grate) shall be galvanized in accordance with ASTM A123, except with a 2-ounce galvanized coating. The grate shall be fillet welded with a minimum weld 1 inch long to the CSP on each side of the grate at every other corrugation.

G. Finished slotted drain, in 20-foot nominal lengths, shall satisfy the following tolerances:

1. Vertical bow: ±3/8 inch.

2. Horizontal bow: ±5/8 inch.

3. Twist: ±1/2 inch.

604.03.05 RUBBER GASKETED JOINTS

A. Rubber gaskets of the type requiring lubrication shall use the lubricant supplied by the manufacturer of the pipe.

1. Manufactured self-lubricating gaskets are also acceptable.

2. Rubber gaskets shall not be exposed to the direct rays of the sun for more than 72 hours.

B. The Contractor shall make every effort to provide a tight connection and pull the pipe completely home.

1. Should gapping occur due to changes or corrections in horizontal or vertical alignment or radius turns, the gaps shall not exceed the gap tolerance indicated in Table 1.

2. If pipes are laid that exceed the maximum gap tolerance, the pipe shall be removed and relaid.

Table 1 - Maximum Joint Gap

Inner Diameter of Pipe	Maximum Joint Gap Tolerance
10 inches to 12 inches	3/4 inch
15 inches to 30 inches	1-1/4 inch
36 inches to 54 inches	1-1/2 inch
60 inches	1-3/4 inch

604.03.06 SIPHONS AND PRESSURE PIPE

A. 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:

1. The pipeline shall be filled with water at the hydrostatic head required to maintain the designed pressure.
2. The pressure head shall be maintained for a period of not less than 24 hours and any visible leak or other defects that develop under test shall be corrected by the Contractor at no additional cost to the Contracting Agency.
3. Sweating that does not develop into a flow or drip will not be considered as leakage.
4. The test shall be repeated until all leaks or other defects are eliminated.

604.03.07 JUNCTIONS

A. All junctions of laterals with a main line or junctions of 2 or more main lines, that are not made in a manhole or concrete junction structure, shall be in a manufactured wye or tee.

B. The wye or tee shall be of the same material as the conduits to which they are joined, and shall have the same or greater stiffness as the pipe.

604.03.08 INSPECTION AND DEFLECTION TESTING

A. All pipe joints and lengths shall be 100 percent inspected.

1. Inspection and testing shall be performed by the Contractor during and after installation to ensure proper performance.
2. Installation, placement, and compaction of bedding and backfill materials shall comply with this specification.
3. During the initial phases of the installation process, inspection shall concentrate on detecting improper practice and poor workmanship such as sags in grade, deflection, joint gap, gaskets, dents, coating integrity, and condition of the lockseam.
4. Errors in line and grade, as well as any improper assembly or backfill techniques, shall be corrected prior to placing significant backfill or trench fill.
5. Coupling bands shall be properly indexed with the corrugation and tightened to prevent the infiltration of soil fines.
6. Gaskets shall be properly seated to prevent groundwater infiltration and shall appear uniformly oriented around the pipe.
7. Shallow cover installations shall be checked to ensure the minimum cover level is provided.

B. After the pipe has been bedded and backfilled to subgrade level, internal quality inspection shall be paid for and performed by the Contractor a minimum of 30 days after final backfill has been placed.

1. The line shall be cleaned and inspected for damage, joint gaps, and deflection using visual physical measurement or other devices, including but not limited to calibrated television or video cameras, subject to approval by the Engineer.
2. Damaged pipe shall be repaired or replaced.

3. The replacement pipe shall also be subject to the same testing.

4. Joints that do not meet the specification shall be repaired or pipe replaced at no additional cost to the Contracting Agency.

5. All inspection results shall be submitted and approved by the Engineer before final payment.

C. The video camera shall physically verify quality of the pipe installation and shall not be limited by poor lighting, water flow, pipe length, or other limiting conditions of the installed environment.

D. For pipe greater than 36-inch inside diameter, deflection determination by physical measurement may be performed using 4 cross section measurements taken beginning at the vertical and for each 90-degree interval with a longitudinal frequency of once every 10 feet of the pipe.

E. The minimum diameter at any point shall be 5 percent less than the nominal diameter (minus fabrication tolerance in accordance with AASHTO M36, Section 8.0) for the type of pipe installed.

F. For locations where pipe deflection exceeds 5 percent of the inside diameter and/or failure of other quality pipe criteria, an evaluation shall be conducted by the Contractor and a recommendation by the Contractor's Nevada registered professional engineer submitted to the Engineer for review and approval, addressing the severity of the deflection, structural integrity, environmental conditions, and the design service life of the pipe. For locations where pipe deflection exceeds 7.5 percent of the inside diameter, remediation or replacement of the pipe is required.

G. Unless otherwise permitted, pipe that does not meet the specified pipe tolerance shall be uncovered and, if not damaged, corrected in accordance with the Engineer approved recommendation from the Contractor at no additional cost to the Contracting Agency.

1. Do not reinstall damaged pipe, but remove and replace with new pipe.

2. The replacement pipe shall also be subject to the same testing.

H. All inspection and testing results shall be submitted to the Engineer for approval. The Engineer shall be allowed access to randomly inspect at least 10 percent of the total number of pipe runs.

METHOD OF MEASUREMENT

604.04.01 MEASUREMENT

A. Method of measurement shall conform to Subsection 601.04.01, "Measurement," and the requirements below.

B. The quantity of corrugated metal pipe measured for payment will by the number of linear feet of each size and class complete and in place.

C. 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.

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

BASIS OF PAYMENT

604.05.01 PAYMENT

A. Payment shall conform to Subsection 601.05.01, "Payment," and the requirements below.

B. 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. The contract unit price paid for metal pipe shall be full compensation for excavating trench, disposal of excess material, hauling, placing and compacting backfill, dewatering, compaction, shoring, furnishing and placing pipe, pipe fittings, protection and restoration, if damaged, of all existing facilities and improvements required to remain in place, related items of work not otherwise provided for, and for all labor, tools, and equipment necessary to complete the work as shown on the drawings, as specified herein, and as directed by the Engineer..

C. 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.

D. 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.

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

F. 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) Corrugated Metal Arch Pipe (type)	Linear Foot
(Size) Corrugated Metal Siphon Pipe (type)	Linear Foot
(Size) Corrugated Metal Slotted Pipe (type)	Linear Foot
(Size) Corrugated Metal End Section (type)	Each
(Size) Corrugated Metal Arch End Section (type)	Each

SECTION 605

THERMOPLASTIC PIPE CULVERTS

DESCRIPTION

605.01.01 GENERAL

A. This work shall consist of furnishing and installing thermoplastic pipe culverts, storm drains, and conduits of the size and dimensions and at locations shown on the plans or established by the Engineer.

B. Installation shall conform to Section 709, “Metal and Thermoplastic Pipe,” and these specifications including exceptions/additions below. The more stringent requirements shall apply.

MATERIALS

605.02.02 GENERAL

A. Materials and their use shall conform to Subsection 601.02.01, "General," and the requirements below.

B. Prior to the use of these materials, the Contractor shall submit to the Engineer for approval a document certifying that the material meets these specifications and Section 709, “Metal and Thermoplastic Pipe,” from an authorized source approved by the Interagency Quality Assurance Committee (IQAC).

605.02.03 MARKINGS

A. Markings on pipe shall be in accordance with Section 709, “Metal and Thermoplastic Pipe.”

CONSTRUCTION

605.03.01 GENERAL

A. Construction methods shall conform to Subsection 601.03.01, "Earthwork," through Subsection 601.03.06, "Extending Existing Culverts," and shall conform to the workmanship and inspection requirements of AASHTO LRFD Bridge Construction Specifications, AASHTO M278, AASHTO M294, AASHTO M304, and this section. The more stringent requirements shall apply.

B. The pipe shall be excavated and backfilled in accordance with Section 208, “Trench Excavation and Backfill.”

C. Non-UV protected pipe shall be protected from direct sunlight until the day of installation.

605.03.02 EARTHWORK

A. Where pipes are to be installed in new embankment (projection), the embankment shall first be constructed to the required elevation as set forth below. The height of embankment to be constructed before installing the pipe may be varied when permitted by the Engineer.

B. In the case of pipes 24 inches or less in diameter, the roadway embankment shall be constructed to an elevation of 6 inches above the grade proposed for the top of the pipe, after which the trench shall be excavated and the pipe installed.

C. In the case of pipes more than 24 inches in diameter, the roadway embankment shall be constructed to an elevation of 30 inches above the grade proposed for the bottom of the pipe, after which the trench shall be excavated and the pipe installed.

D. When pipe having bells or hubs is used, cross trenches shall be excavated for the pipe to prevent non-uniform loading of the joints.

605.03.03 LAYING CULVERT PIPE

A. Installation shall comply with the AASHTO LRFD Bridge Construction Specifications, Section 30; Section 208, "Trench Excavation and Backfill"; and this subsection.

1. The installation shall be conducted by a certified supervisor/foreman at the crew level who is responsible for the work.
2. The certified person is the designated installation inspector for the Contractor and shall generate a daily report attesting to the workmanship for each of the installation components described below.
3. This does not relieve the Contractor of responsibility for other Quality Control aspects of this and other specifications.

B. Installation Components:

1. Bedding
2. Pipe Condition
3. Pipe Installation
4. Haunch Compaction
5. Complete pipe zone compaction

C. Pipe section shall be checked for alignment and grade at the time of joining the sections. All pipes shall be laid true to the designated line and grade, unless otherwise permitted by the Engineer.

D. The bottom of the trench shall be graded and prepared to provide a firm and uniform bearing throughout the entire length of the pipe. Blocking shall not be used to bring the pipe to grade.

E. Pipe laying shall begin at the downstream end of the pipeline except for extensions of existing pipes.

1. Place the bottom of the pipe in contact with the bedding throughout its full length.
2. Place the spigot or outside circumferential laps of pipes facing upstream such that a shingling effect is obtained.
3. Place pipe with longitudinal laps or seams with the laps or seams at the sides.
4. Maintain the manufacturer's recommended minimum and maximum cover at all times unless otherwise shown in the contract.

F. Pipe shall be inspected before placing backfill.

1. Ensure that no rocks or other rigid or jagged material is present in the bedding material where pipe may be laid directly on the material.
2. Ensure that no “floating” occurs during installation of plastic pipe culverts.
3. Remove and relay or replace pipe that is out of alignment, unduly settled, or damaged.

605.03.04 RUBBER GASKETED JOINTS

A. Rubber gaskets shall not be exposed to the direct rays of the sun for more than 72 hours.

B. Rubber gaskets of the type requiring lubrication shall be lubricated with the lubricant supplied by the manufacturer of the pipe. Manufactured self-lubricating gaskets are also acceptable.

C. The Contractor shall make every effort to provide a tight connection and pull the pipe completely home.

1. Should gapping occur due to changes or corrections in horizontal or vertical alignment or radius turns, the gaps shall not exceed the gap tolerance indicated in Table 1.
2. If pipes are laid that exceed the maximum, the pipe will need to be removed and relaid.

Table 1 - Maximum Joint Gap[1]

Inner Diameter of Pipe	Maximum Joint Gap Tolerance
10-inch to 12-inch	3/4 inch
15-inch to 30-inch-inch	1-1/4 inch
36-inch to 54-inch	1-1/2 inch
60-inch	1-3/4 inch

605.03.05 SIPHONS AND PRESSURE PIPE

A. 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:

1. The pipeline shall be filled with water at the hydrostatic head required to maintain the designed pressure.
2. The pressure head shall be maintained for a period of not less than 24 hours and any visible leaks or other defects that develop under test shall be corrected by the Contractor at no additional cost to the Contracting Agency.
3. Sweating that does not develop into a flow or drip will not be considered as leakage.
4. The test shall be repeated until all leaks or other defects are eliminated.

605.03.06 JUNCTIONS

A. All junctions of laterals with a main line or junctions of 2 or more main lines, that are not made in a manhole or concrete junction structure, shall be in a manufactured wye or tee.

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[1] In no case shall maximum joint gap tolerance exceed 1/2 the length where the gasket seats within the pipe

B. The wye or tee shall be of the same material as the conduits to which they are joined, and shall have the same or greater stiffness as the pipe.

605.03.07 INSPECTION AND DEFLECTION TESTING

A. All pipe joints and lengths shall be 100 percent inspected.

1. Installation, placement, and compaction of bedding and backfill materials shall conform to this specification.
2. During the initial phases of the installation process, inspection shall concentrate on detecting improper practice and poor workmanship.
3. Errors in line and grade, improper assembly, and improper backfill techniques shall be corrected prior to placing significant backfill or trench fill.
4. Joints shall be properly assembled to prevent the infiltration of soil fines.
5. Gaskets shall be properly seated to prevent groundwater infiltration and shall appear uniformly oriented around the pipe.
6. Shallow cover installations shall be checked to ensure the minimum cover level is provided.

B. After the pipe has been bedded and backfilled to subgrade level, internal quality inspection shall be paid for and performed by the Contractor a minimum of 30 days after final backfill has been placed.

1. The line shall be cleaned and inspected for damage, joint gaps, and deflection using visual physical measurement or other devices, including but not limited to calibrated television or video cameras, subject to approval by the Engineer.
2. Damaged pipe shall be repaired or replaced.
3. The replacement pipe shall also be subject to the same testing.
4. Joints that do not meet the specification shall be repaired or pipe replaced at no additional cost to the Contracting Agency.
5. All inspection results shall be submitted and approved by the Engineer before final payment.

C. The video camera shall physically verify quality of the pipe installation and shall not be limited by poor lighting, water flow, pipe length, or other limiting conditions of the installed environment.

D. For pipe greater than 36-inch inside diameter, deflection determination by physical measurement may be performed using 4 cross section measurements taken beginning at the vertical and for each 90-degree interval with a longitudinal frequency of once every 10 feet of the pipe.

E. The minimum diameter at any point shall be 5 percent less than the nominal diameter (minus fabrication tolerance in accordance with AASHTO M294, Section 7.2.3) of the pipe being tested.

F. If a mandrel is used, it must be approved before use.

1. Mandrel shall be rigid, nonadjustable, odd-numbered legged (minimum 9 legs) having a length not less than its nominal diameter.

2. Mandrel shall be fitted with pulling rings at each end, stamped or engraved on some segment other than a runner with the nominal pipe size and mandrel outside diameter, and furnished in a suitable carrying case.

3. Use of an unapproved mandrel or a mandrel altered or modified after approval will invalidate the test.

4. If the mandrel fails to pass, the pipe is overdeflected.

5. A properly sized proving ring shall be used to check or test the mandrel for accuracy.

6. The mandrel shall be pulled through the pipe with a force not greater than 1,000 pounds.

G. For locations where pipe deflection exceeds 5 percent of the inside diameter and/or fails other quality pipe criteria, an evaluation shall be conducted by the Contractor and a recommendation by the Contractor's Nevada registered professional engineer submitted to the Engineer for review and approval addressing the severity of the deflection, structural integrity, environmental conditions, and the design service life of the pipe. For locations where pipe deflection exceeds 7.5 percent of the inside diameter, remediation or replacement of the pipe is required.

H. Unless otherwise permitted, pipe that does not meet the specification shall be uncovered and, if not damaged, corrected in accordance with the Engineer approved recommendation from the Contractor at no additional cost to the Contracting Agency.

1. Do not reinstall damaged pipe, but remove and replace with new pipe.

2. The replacement pipe shall also be subject to the same testing.

I. The Engineer shall be allowed access to randomly inspect at least 10 percent of the total number of pipe runs.

METHOD OF MEASUREMENT

605.04.01 MEASUREMENT

A. Method of measurement shall conform to Subsection 601.04.01, "Measurement," and the requirements below.

B. The quantity of thermoplastic pipe measured for payment will be the number of linear feet complete and in place.

C. The quantity of thermoplastic pipe end sections measured for payment will be the number of units of each size of each class complete and in place.

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

BASIS OF PAYMENT

605.05.01 PAYMENT

A. Payment shall conform to Subsection 601.05.01, "Payment," and the requirements below.

B. The accepted quantities of thermoplastic pipe, measured as specified in Subsection 601.04.01, "Measurement," will be paid for at the contract unit price bid per linear foot for the types and sizes specified.

C. The contract unit price paid for thermoplastic pipe shall be full compensation for excavating trench, disposal of excess material, hauling, placing and compacting backfill, dewatering, compaction, shoring, furnishing and placing pipe, pipe fittings, video inspection, protection and restoration, if damaged, of all existing facilities and improvements required to remain in place, related items of work not otherwise provided for, and for all labor, tools and equipment necessary to complete the work as shown on the drawings, as specified herein, and as directed by the Engineer.

D. 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.

E. Compensation for supplying certified mandrels or other deflection testing devices shall be included in the contract unit price paid for the appropriate thermoplastic pipe item and no separate payment will be made therefor.

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

G. Payment will be made under:

PAY ITEM	**PAY UNIT**
(Size) Thermoplastic Pipe (type)	Linear Foot
(Size) Thermoplastic Pipe End Section (type) (only end sections 30-inch and less are allowed)	Each

SECTION 606

STRUCTURAL PLATE PIPE AND PIPE ARCH CULVERTS

DESCRIPTION

606.01.01 GENERAL

A. This work shall consist of furnishing and installing structural plate pipe and pipe arch culverts conforming to these specifications and consisting of the sizes and dimensions required in the plans, and installing the structures at locations designated in the plans or established by the Engineer, and in conformity with the lines and grades established by the Engineer.

B. The work shall also include the reinstallation of salvaged structural plate pipe and pipe arch culverts.

C. Plates for a pipe arch shall form a cross section made up of 4 circular arcs tangent to each other at their junctions and symmetrical about the vertical axis.

1. The top shall be an arc of not more than 180 degrees nor less than 155 degrees.
2. The bottom shall be an arc of not more than 50 degrees nor less than 10 degrees.
3. The top shall be joined at each end to the bottom by an arc having a radius between 16 inches and 21 inches and of not more than 87-1/2 degrees nor less than 75 degrees.

MATERIAL

606.02.01 GENERAL

A. Materials shall meet the requirements of AASHTO M167, "Structural Plate Pipe and Pipe Arches."

B. If called for in the bid schedule, plates for pipes and pipe arches shall be bituminous coated in accordance with AASHTO M190, Type A, B or C.

1. 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.
2. The portion of nuts and bolts used for assembly of bituminous coated structural steel plate pipes, arches, and pipe arches outside the pipe shall be bituminous coated after installation. The portion of the nuts and bolts inside the pipe need not be bituminous coated.
3. Damaged bituminous coating shall be repaired by the Contractor by applying bituminous material conforming to AASHTO M190 or other approved material.

C. The bottom plates of structural plate pipes and arches shall be 1 gauge heavier than the gauge specified in the bid schedule, which will apply to top and side plates. When 1 gauge is specified, the bottom plates shall also be 1 gauge.

D. Plates shall be shipped and handled in a manner to prevent bruising, scaling, or breaking of the spelter coating.

1. Damaged spelter coating in lieu of the requirements of AASHTO 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 2 coats of zinc oxide-zinc dust paint conforming to Federal Specification MIL-P-15145.

2. The paint shall be properly compounded in a suitable vehicle in the ratio of 1 part zinc oxide to 4 parts zinc dust by weight.

E. Planned lengths and sizes are approximate. The Contractor shall not order and deliver the plates until a list of sizes and lengths is furnished to the Contractor by the Engineer.

CONSTRUCTION

606.03.01 PLATE DESCRIPTION

A. Plates shall consist of structural units of galvanized corrugated metal.

1. Single plates shall be furnished in standard sizes to permit structure length increments of 2 feet.

2. Plates have approximately a 2-inch lip beyond each end crest, which results in the actual length of a given structure being approximately 4 inches longer than the nominal length, except when skewed or beveled.

B. The plates at longitudinal and circumferential seams shall be connected by bolts.

1. Joints shall be staggered so that not more than 3 plates come together at any 1 point.

2. Each plate shall be curved to 1 or more circular arcs.

606.03.02 FABRICATION

A. Plates shall be formed to provide lap joints.

1. 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.

2. Each plate shall be curved to the proper radius so that the cross-sectional dimensions of the finished structure will be as specified.

B. Bolt Hole Configuration:

1. 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 2 inches apart, with 1 row in the valley and 1 in the crest of the corrugations.

2. 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 12 inches.

3. The minimum distance from the center of hole to edge of the plate shall be not less than 1-3/4 times the diameter of the bolt.

4. The diameter of the bolt holes in the longitudinal seams shall not exceed the diameter of the bolt by more than 1/8 inch.

C. Burnt edges shall be free from oxide and burrs and shall present a workmanlike finish.

1. 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 24 hours after the cuts are made.

2. Each cut plate shall be legibly identified to designate its proper position in the finished structure.

606.03.03 FIELD INSPECTION

A. The Engineer shall be furnished with an itemized statement of the number and length of the plates in each shipment by the manufacturer.

B. Each plate included in a shipment shall conform to these specifications.

C. If 25 percent or more of the plates in any shipment fail to conform to the specifications, the entire shipment may be rejected.

606.03.04 EARTHWORK

A. Excavation and backfill shall conform to Section 206, "Structure Excavation," and Section 207, "Structure Backfill," or Section 208, "Trench Excavation and Backfill," when the culvert is placed in a trench.

B. The pipe shall be laid in a trench excavated to the lines and grades established by the Engineer.

C. The bottom of the trench shall be graded and prepared to provide full contact with the pipe throughout its entire length.

D. 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.

E. 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.

F. When the pipe is laid in 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 hard material.

G. When sand or compacted fill is used, the depth of the sand or compacted fill below the pipe shall not be less than 1/3 the inside diameter of the pipe with a minimum of 4 inches and a maximum of 12 inches with the exception that an extra 1/2 inch shall be added for every foot the trench exceeds 16 feet in depth. This bed shall extend at the sides of the pipe at least a distance of 1/4 the outside diameter of the pipe.

H. When no bedding is specified, the requirements for Normal bedding as shown in the Standard Drawings shall apply.

606.03.05 ASSEMBLING

A. The structural plate structures shall be assembled in accordance with the manufacturer's assembly instructions.

1. The unsupported edges of all plates shall be held in position by temporary props.
2. Each row of side plates shall extend far enough to support the plate above until the first complete ring has been assembled.
3. A sufficient number of bolts shall be progressively installed to hold the plates in position.
4. Bolts shall not be tightened until tightening will not interfere with the adjustment and matching of additional plates and sections.

5. 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 no additional cost to the Contracting Agency.

6. After all plates are in place, the bolts shall be progressively and uniformly tightened from 1 end of the structure, and the tightening operation repeated to be sure that all bolts are tight.

7. Bolts shall be tightened to a minimum of (a) 100 foot-pounds of torque for plates of 7 gauge and lighter, and (b) 150 foot-pounds of torque for plates of 5 gauge and heavier, and shall be rechecked and retightened as necessary just prior to backfilling.

B. The elliptical-shaped pipes shall be installed with their long diameter vertical.

C. Pipe arches shall be installed with their span width horizontal.

606.03.06 STRUTTING

A. When specified, structural plate pipes that are not fabricated out-of-round before erection shall be timber strutted vertically 3 percent out-of-round before placement of the embankment.

B. The pipe shall be deformed to the required degree by means of suitable jacks.

1. The method of jacking shall be approved by the Engineer.

2. A tolerance of 25 percent above or below the specified deformation will be permitted.

C. Strutting shall be carried uniformly from end to end of the pipe.

D. The struts shall be left in place until the embankment is complete and compacted, unless otherwise ordered by the Engineer.

E. In lieu of strutting structural plate pipe, the Contractor may furnish structural plate pipe with the vertical axis fabricated out-of-round 5 percent of the nominal diameter from end to end of the pipe.

1. A tolerance of 25 percent above or below the specified deformation will be permitted.

2. The deformation shall be made by approved shop methods, and any coating damaged or destroyed shall be repaired or replaced satisfactorily.

606.03.07 WORKMANSHIP

A. In addition to compliance with the details for construction, the completed pipe shall show careful, finished workmanship in all particulars.

B. Structural plates on which the spelter coating has been bruised or broken or which show defective workmanship shall be rejected, except as otherwise specified.

1. The requirement applies not only to the individual plates, but to the shipment on any project as a whole.

2. 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 center line.

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

A. Where shown on the plans, inlet and outlet headwalls shall be constructed or installed in connection with structural plate pipe.

B. 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.

C. Headwalls shall be constructed to conform to Section 501, "Portland Cement Concrete," and Section 502, "Concrete Structures."

606.03.09 EXTENDING EXISTING STRUCTURAL PLATE PIPE AND PIPE ARCH CULVERTS

A. 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:

1. Punching any necessary bolt holes.
2. Furnishing bolts, nuts, and washers.
3. Changing location of individual plates on pipe arches.
4. Providing any other work required in the completion of the connection in a workmanlike manner.

B. In all cases where an existing headwall is in place, the concrete shall be completely removed in accordance with Section 202, "Removal of Structures and Obstructions."

METHOD OF MEASUREMENT

606.04.01 MEASUREMENT

A. The materials to be paid for under these specifications will be listed in the contract items by the various sizes, types, and gauges necessary for identification.

B. 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.

C. 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 the respective sections of these specifications.

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

BASIS OF PAYMENT

606.05.01 PAYMENT

A. 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.

B. 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.

C. The gauge of metal in the bottom plates of pipes and pipe arches shall be of a gauge 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 for supplying the heavier gauge, but compensation therefor shall be considered an integral part of the contract price paid for the gauge specified.

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

E. Payment will be made under:

PAY ITEM	PAY UNIT
(Size) Structural Plate Pipe (type) (gauge)	Linear Foot
(Size) Structural Plate Pipe Arch (type) (gauge)	Linear Foot

SECTION 607

UNDERDRAINS

DESCRIPTION

607.01.01 GENERAL

A. This work shall consist of constructing underdrains using pipe and drain backfill in accordance with these specifications and in conformity with the lines and grades shown on the plans or established by the Engineer.

MATERIAL

607.02.01 GENERAL

A. Materials shall meet the requirements specified in the following subsections:

Materials	Subsection
Corrugated Metal Pipe for Underdrains	709.03.08
Bituminous Coated Corrugated Metal Pipe for Underdrains	709.03.09
Perforated Concrete Pipe	708.03.03
Clay Pipe	708.03.04
Drain Backfill	704.03.02

B. 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 material quality requirements. This can be the basis for acceptance of manufacturing lots as to quality.

C. Materials will be subject to inspection for acceptance as to condition at the latest time the Engineer has the opportunity to check for compliance prior to or during incorporation of materials into the work.

D. The Contractor shall not order and deliver the pipe until a list of sizes and lengths is furnished to the Contractor by the Engineer.

E. Corrugated metal pipe shall be shipped and handled in such a manner as to prevent bruising, scaling, or breaking of the spelter coating.

F. Corrugated metal pipe with damaged spelter coating may be repaired in accordance with Subsection 604.02.01, "General."

G. Concrete or clay pipe which is cracked, checked, spalled, or damaged shall be rejected.

H. Pipes which show defects shall be rejected at the site of the installation regardless of prior acceptance.

CONSTRUCTION

607.03.01 EARTHWORK

A. Excavation and drain backfill shall conform to Section 206, "Structure Excavation," and Section 209, "Drain Backfill," with the following modifications:

1. Trenches shall be excavated to the dimensions and grade required by the plans or as directed.
2. A minimum 3-inch bedding layer of drain backfill shall be placed in the bottom of the trench for its full width and length.
3. The space below the pipe shall be filled with the required drain backfill throughout its entire length and brought to a uniform grade.
4. All material excavated from trenches, not suitable for use, shall be removed and disposed of by the Contractor.
5. If an item for grouting drain backfill is shown in the proposal, drain backfill shall be covered with a thick grout not less than 1 inch in thickness.
   a. The grout shall be composed of 1 part Portland cement and 5 parts sand.
   b. This grout shall be thoroughly tamped to provide an impervious layer over the entire surface of the drain backfill.

607.03.02 LAYING PIPES

A. 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.
   1. Pipe shall be laid true to line and grade with a uniform bearing under the full length of the barrel.
   2. The pipe joints shall then be covered with 2-ply tar paper strips not less than 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 for a distance of 3 inches.

B. Perforated pipe shall be laid with the perforations at 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

A. Trenches for underdrain outlets shall be excavated to the width and depth shown on the plans.

B. Pipe shall be laid in the trench with all ends firmly joined by the applicable methods and means.

C. 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."

607.03.04 BLIND DRAINS

A. Trenches for blind drains shall be excavated to the width and depth shown on plans, or established by the Engineer.

B. The trench shall be filled with drain backfill material to the depth required by the plans.

C. Any remaining upper portion of trench shall be filled with either granular or impervious material as may be specified.

METHOD OF MEASUREMENT

607.04.01 MEASUREMENT

A. The materials to be measured for payment under these specifications will be listed in the contract items by size, class, type of gauge, or whatever information is necessary for identification.

B. The quantity of underdrain pipe measured for payment will be the actual number of linear feet of pipe completed and in place. Underdrain pipe bends, wyes, tees, and other branches will be measured along center lines to the point of intersection.

C. 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.

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

BASIS OF PAYMENT

607.05.01 PAYMENT

A. 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.

B. 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.

C. Structure excavation and drain backfill will be measured and paid for as separate items as provided in Section 206, "Structure Excavation," and Section 209, "Drain Backfill."

D. Provisions for handling of whatever water may be encountered at the site shall be an obligation of the Contractor and payment thereof shall be considered subsidiary to the items involved and no further compensation will be allowed therefor.

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

F. 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
Grouting Drain Backfill (width)	Linear Foot

SECTION 608

DOWNDRAINS

DESCRIPTION

608.01.01 GENERAL

A. 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

A. The materials used shall be those specified for the finished work and shall conform to the following sections and subsections:

Materials	Section/Subsection
Corrugated Metal Pipe for Downdrains	709.03.07
Surfacing Miscellaneous Areas	401.03.16
Grouted Riprap	610.03.04
Concrete	501
Reinforcing Steel	505
Frames for Grates	609

B. Pipe for crossbars shall be unpainted standard weight black pipe conforming to ASTM A53 or ASTM A120.

C. Downdrains 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 manufacturer's standard jigs and templates in the fabrication. Metal shall not be less than the gauge shown on the plans.

D. Corrugated metal parts with damaged spelter coating shall be repaired in accordance with Subsection 604.02.01, "General."

CONSTRUCTION

608.03.01 METAL DOWNDRAINS

A. 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.

B. Embankment protectors shall be installed at an outside edge of the embankment gutters or in the shoulder dikes to carry drainage from the roadbed down the embankment slopes to protect the slopes and shoulders from erosion.

1. The entrance device shall be installed to prevent water from percolating around the structure and care shall be taken to prevent the structure from being undermined.

2. The seal between the structure and the surrounding earth shall be made watertight.

3. The embankment protectors shall be placed so that the lower edge of the opening will be from 3 inches to 6 inches below the bottom of the gutter flow lines.

608.03.02 BITUMINOUS MIXTURES AND GROUTED RIPRAP

A. Bituminous mixture and grouted riprap downdrains, when called for, shall be placed in accordance with the provisions in Subsection 401.03.16, "Surfacing Miscellaneous Areas," or Subsection 610.03.04, "Grouted Riprap."

METHOD OF MEASUREMENT

608.04.01 MEASUREMENT

A. The materials to be measured for payment under these specifications will be listed in the contract item by size, type, and so forth, or whatever information is necessary for identification.

B. The quantity of embankment protectors, slip joints, and anchor assemblies will be measured as units complete and in place.

C. 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.

D. Type 2 embankment protectors shall include the length of tapered section and a 5-inch flume stub and the stub will not be measured as flume downdrain.

E. 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 2 pipe stakes with necessary clip brackets and bolts.

F. 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 to the entrance taper as provided above for entrance tapers.

   1. Pipe placed in excess of the length designated will not be measured for payment unless pipes are cut to fit a structure or slope.

   2. 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 2-foot increments.

G. 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 stub in the Type 4 embankment protector.

H. 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.

I. The quantity of corrugated metal flume downdrain measured for payment will be the number of linear feet complete and in place.

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

BASIS OF PAYMENT

608.05.01 PAYMENT

A. The accepted quantities of embankment protectors, slip joints, and anchor assemblies measured as specified in Subsection 608.04.01, "Measurement," will be paid at the contract unit price bid per each for the types and sizes specified.

B. 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.

C. 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.

D. Plantmix bituminous mixture used in downdrains will be paid for as provided in Section 401, "Plantmix Bituminous Pavements – General."

1. 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."

2. Drainage excavation will not be paid for on plantmix bituminous downdrains.

E. Quantities of grouted riprap placed for downdrains will be paid for according to the provisions of Section 610, "Slope and Channel Protection."

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

G. 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

A. 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

A. Materials shall conform to the following sections and subsections:

Materials	Section/Subsection
Portland Cement Concrete	501
Reinforcing Steel	505
Miscellaneous Metal	712
Gray Iron Castings	712.03.02

B. 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.

1. Casting shall be boldly filleted at angles and the arises shall be sharp and perfect.
2. Casting shall be sand blasted or otherwise effectively cleaned of scale and sand so as to present a smooth, clean, and uniform surface.

C. The Contractor shall obtain from the fabricator of the structural steel grates, frames, and gray iron castings a Certificate of Compliance stating that the fabrications meet these specifications, and giving certified shop weights for the fabrications.

D. Mortar for setting grates shall be mixed in the proportions of 1 part cement to 3 parts of fine aggregate.

E. Pipe crossbars for drop inlets shall be unpainted standard weight black pipe conforming to ASTM A53. Straps shall be unpainted ASTM A36 steel.

CONSTRUCTION

609.03.01 GENERAL

A. Catch basins, inlets, and manholes shall be constructed in accordance with Section 501, "Portland Cement Concrete."

B. Inlet and outlet pipes shall be placed prior to pouring concrete.

C. 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.

D. Concrete covers, when indicated on the plans, shall be constructed to fit snugly and be readily removable.

E. Structural steel grates shall be painted as specified in Section 614, "Painting."

F. 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 conduit, and the masonry shall be carefully constructed around the pipe or tile to prevent leakage around their outer surfaces.

G. 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.

H. Frames and grates shall be matchmarked in pairs before delivery to the work and grates shall fit into the frames without rocking.

609.03.02 ADJUSTING CATCH BASIN, MANHOLE, AND INLET COVERS

A. Unless otherwise provided on the plans or by the contract, existing covers including frames, grates, and lids shall be adjusted to the required elevation.

B. Remove the existing covers and adjust the top of the existing structures by removing or adding concrete, brick masonry, concrete block masonry, high density polyethylene adaptor rings, or steel or cast iron adaptor rings, as applicable.

C. Reinstall the fixtures by supporting them on a satisfactory collar of concrete constructed to hold the fixtures firmly in place.

609.03.03 CLEAN OUT

A. 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 accumulations at the time of final inspection.

609.03.04 EARTHWORK

A. Structure excavation and structure backfill shall conform to Section 206, "Structure Excavation" and Section 207, "Structure Backfill."

METHOD OF MEASUREMENT

609.04.01 MEASUREMENT

A. The quantities of castings and structural steel grates measured for payment will be the number of pounds complete and in place.

1. The weight of castings shall be computed from the dimensions shown on the approved shop drawings, assuming the cast iron to weigh 450 pounds per cubic foot with an allowance of 10 percent for fillets and overrun.

2. The weight of structural steel grates shall be computed from the dimensions shown on the approved shop drawings and in accordance with Section 506, "Steel Structures."

3. Certified shop weights will be acceptable in lieu of computed weights.

B. Adjusting covers for catch basins, manholes, and inlets will be measured per each complete and in place.

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

D. 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

A. 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.

B. 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 shall be full compensation for furnishing all materials, tools, incidentals, and labor required to adjust the covers.

C. Portland cement concrete used in new structures of catch basins and inlets will be paid for as specified in Section 502, "Concrete Structures."

D. Reinforcing steel in catch basins and inlets will be paid for as specified in Section 505, "Reinforcing Steel."

E. 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.

F. Structure excavation and structure backfill for catch basins and inlets will be paid for as specified in Section 206, "Structure Excavation," and Section 207, "Structure Backfill."

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

H. 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

SLOPE AND CHANNEL PROTECTION

DESCRIPTION

610.01.01 GENERAL

A. This work shall consist of constructing slope and channel protection structures to the lines and grades established by the Engineer using riprap or wire mesh gabions in accordance with the design shown on the plans and these specifications.

B. Riprap construction shall consist of furnishing and placing riprap (with or without grout) or sacked Portland cement concrete riprap.

C. Wire mesh gabion construction shall consist of furnishing, assembling, tying, and filling open mesh wire baskets with stone.

MATERIALS

610.02.01 GENERAL

A. All materials shall conform to the following sections and subsections:

Materials	Section/Subsection
Water	722
Portland Cement	701
Grout and Mortar Sand	706.03.04
Riprap Grout	706.03.05

B. When so provided and with prior approval of the Engineer, crushed concrete may be substituted for the above designated stone. In such a case, the concrete shall be sound and meet all requirements as specified for stone.

610.02.02 GROUT

A. Grout shall be composed of 1 part by volume of Portland cement and 3 parts by volume of sand and shall be of such consistency that it will fill all voids in the riprap.

B. Comply with Subsection 706.03.05, "Riprap Grout."

610.02.03 SACKED CONCRETE

A. Sacked concrete shall be composed of sacks filled with Portland cement concrete.

1. The mixed concrete shall contain a minimum of 376 pounds (4 sacks) of Portland cement per cubic yard.

2. The amount of water added at the time of mixing shall be such as will produce a mixture with a slump of from 3 inches to 5 inches.

B. 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 gradation requirements.

1. Passing a 2-inch sieve: 80 to 100 percent.

2. Passing a No. 200 sieve: 0 to 4 percent

C. Sacks for concrete riprap shall be made of at least 10 ounce burlap, and shall be approximately 19-1/2 inches by 36 inches measured inside the seams when the sack is laid flat.

1. The capacity of each sack shall be approximately 1.25 cubic feet.

2. Sound reclaimed sacks may be used.

610.02.04 STONES FOR RIPRAP

A. Stones used for riprap shall be hard, durable, angular in shape, resistant to weathering and erosion, and free from spoils, cracks, and organic matter.

1. The stone for non-grouted riprap shall have a minimum of 2 fractured faces with neither width nor thickness of a single stone less than 1/3 its length.

2. The specific gravity of the riprap shall not be less than 2.45.

3. The nominal stone size shall be as follows:

RIPRAP GRADATIONS

Percent Passing By Mass	Riprap D50=12" (Inches)	Heavy Riprap D50=18" (Inches)
100	20	30
70-85	18	27
35-50	12	18
5-15	5	7
0	2	3

B. This stone shall conform to the following requirements:

Source Requirements Test	Test Method	Requirements
Percent of Wear (500 Rev.)	ASTM C131	45% Maximum
Bulk Specific Gravity	ASTM C127	2.5 Minimum

C. Control of gradation will be by visual inspection.

1. Upon request by the Engineer, the Contractor shall provide a sample of stone of at least 5 tons meeting the gradation for each location riprap is indicated.

2. Each sample shall be located at the construction site near the location where the riprap is to be placed.

3. The sample shall be used as a frequent reference for judging the gradation of the riprap supplied.

4. The sample riprap shall be in place and acceptable to the Engineer before riprap placing work begins.

5. The Contractor shall maintain the placed riprap until the project is completed and any material displaced by any cause shall be repaired to the lines and grades indicated on the plans.

D. Caliche stone or cementitious materials meeting the requirements of this section may be used as riprap with prior approval of the Engineer.

1. The riprap shall be fully cemented material. Only materials designated as hard (scratches leave only dust, requires many hammer blows to break) or very hard (difficult to scratch or break) shall be utilized.

2. Moderately hard (crumbles with several hammer blows) or partially cemented materials are not acceptable.

E. The Contractor may be required to provide riprap test results from an approved testing laboratory and a Certificate of Compliance in accordance with Subsection 106.05, "Certificate of Compliance."

610.02.05 STONES FOR GABIONS

A. Stones for filling the gabions shall be well graded, hard stones, conforming to the testing requirements specified in Subsection 610.02.04, "Stones for Riprap."

B. Size and gradation shall be such that the predominant size is between 4 inches and 8 inches, 85 percent by weight.

1. Minimum stone dimensions shall be 3 inches and maximum stone dimension shall be 8 inches.

2. For gabion baskets less than 1 foot in height, the maximum stone dimension shall be 6 inches.

610.02.06 FILTER MATERIAL

A. When filter material is specified or shown on the plans, the material shall consist of mineral aggregate that is clean, hard, durable, and free of any deleterious matter or harmful adherent coatings.

B. Gradation of the filter material shall conform to the requirements specified by the Engineer or as shown in the Special Provisions.

610.02.07 FILTER FABRIC

A. When filter fabric is specified or shown on the plans, the fabric shall consist of a geotextile that is made from synthetic fibers.

B. The filter fabric shall be in accordance with AASHTO M288, Section A4, and shall conform to the requirements specified by the Engineer.

610.02.08 WIRE MESH GABIONS AND GABION MATTRESSES

A. Wire mesh gabions and gabion mattresses shall be fabricated from either twisted wire mesh or welded wire mesh.

1. All wires shall be galvanized prior to fabricating the mesh and in compliance with ASTM A90.

2. Only 1 type of wire mesh may be used in any 1 structure.

B. Gabion and gabion mattress dimensions of width, height, and length shall be as shown on the plans.

1. Each gabion unit shall not vary more than 5 percent from the dimensions shown on the plans.

2. Gabions come 1 foot or greater in height, 3 feet in width, and are compartmentalized into cells not larger than 3 feet by 3 feet by attaching to the base single diaphragm panels made of the same type and size mesh as the gabion panels.

3. Gabion mattresses come 9 inches or less in height, 6 feet in width, and are compartmentalized into cells not larger than 6 feet by 3 feet by attaching to the base single diaphragm panels made of the same type and size mesh as the gabion mattress panels.

C. The baskets shall be assembled with the necessary panels and diaphragms secured to the base in accordance with ASTM A975-97, Table 2 requirements. Pleating the base panel to obtain the diaphragms is prohibited.

D. Fabrication of the wire mesh gabions and gabion mattresses shall be as follows:

1. Twisted Wire Mesh Gabions and Gabion Mattresses:

a. Gabion panels for the twisted mesh style shall be manufactured from galvanized steel wire, Class 3, soft temper, conforming to ASTM A641, or from aluminized steel wire, soft temper, conforming to ASTM A809.

1) The wire shall have a minimum tensile strength of 60,000 psi when tested in accordance with ASTM A370.

2) Twisted wire mesh gabions and gabion mattresses shall comply with ASTM A975-97 standards.

b. The mesh shall be formed with non-raveling double twists by twisting each pair of wires through two 360-degree turns. The mesh openings shall be hexagonal in shape and uniform in size and shall comply with the mesh dimensions and requirements shown on Table 1 and Table 2 below.

c. All perimeter edges of the mesh panels forming the gabion basket shall be securely tied to a selvedge wire so that the selvedge-to-mesh connection has at least the same strength as the body of the mesh. Selvedge wire shall be the same kind and type of material used for the mesh, except that wire diameters shall be as shown on the tables below.

d. When specified by the Engineer, the galvanized or aluminized wire shall be coated with a polyvinyl chloride (PVC) material. The coating shall be accomplished by using either extruded or extruded and bonded PVC material, and shall be applied before twisting the wire into mesh panels.

e. All wire used for twisted mesh gabions and gabion mattresses shall meet the following nominal requirements:

Table 1 - Nominal Requirements for Twisted Wire Mesh Gabions

Type of Basket	Mesh Size	Mesh Wire	Selvedge Wire
Baskets 1 foot or greater in height	3.25-inch by 4.5-inch	0.120 inch	0.148 inch
Baskets 1 foot or greater in height with PVC coating	3.25-inch by 4.5 inch	0.106 inch, plus the PVC coating	0.134 inch, plus the PVC coating

Table 2 - Nominal Requirements for Twisted Wire Mesh Gabion Mattresses			
Type of Basket	**Mesh Size**	**Mesh Wire**	**Selvedge Wire**
Baskets 9 inches or less in height	2.5-inch by 3.25 inch	0.087 inch	0.106 inch
Baskets 9 inches or less in height with PVC coating	2.5-inch by 3.25 inch	0.087 inch, plus the PVC coating	0.106 inch, plus the PVC coating

2. Welded Wire Mesh Gabions and Gabion Mattresses:

   a. Gabion panels for the welded mesh style shall be manufactured from welded wire fabric conforming to ASTM A185 and ASTM A974-97, Type 1.

   b. Galvanized wire shall have a Class 3 coating as indicated in ASTM A641.

   c. Aluminized wire shall have a minimum coating as indicated in ASTM A809.

   d. The wire shall be soft tempered with a minimum tensile strength of 60,000 psi when tested in accordance with ASTM A370.

   e. Welded wire mesh gabions and gabion mattresses shall comply with ASTM A974-97 standards.

   f. The mesh shall form a square or rectangular grid pattern with the maximum diagonal dimension of any grid opening not to exceed 4.5 inches.

   g. The welded wire mesh shall be galvanized or aluminized prior to welding into mesh and shall comply with the dimensions and requirements shown on Table 3 and Table 4 below.

   h. When specified by the Engineer, the welded wire mesh shall be coated with a polyvinyl chloride material. The PVC coating shall be fusion bonded to the galvanized or aluminized wire after fabrication of the gabion mesh panels.

   i. All wire used for welded mesh gabions and gabion mattresses shall meet the following nominal requirements:

Table 3 - Nominal Requirements for Welded Wire Mesh Gabions		
Type of Basket	**Mesh Size**	**Mesh Wire**
Baskets 1 foot or greater in height	3-inch by 3-inch	0.120 inch
Baskets 1 foot or greater in height with PVC coating	3-inch by 3 inch, plus the PVC coating	0.106 inch, plus the PVC coating

Table 4 - Nominal Requirements for Welded Wire Mesh Gabion Mattresses		
Type of Basket	**Mesh Size**	**Mesh Wire**
Baskets 9 inches or less in height	1.5-inch by 3-inch	0.087 inch (2.21 mm)
Baskets 9 inches or less in height with PVC coating	1.5-inch by 3-inch, plus the PVC coating	0.087 inch, plus the PVC coating

   j. For polyvinyl chloride coated either twisted or welded mesh gabions and gabion mattresses, the PVC coating shall have a nominal thickness of 0.020 inch and a minimum thickness of 0.015 inch. The coating shall be grey, silver, green, or black and conform to the following:

      1) Specific Gravity: In the range of 1.20 to 1.40, ASTM D792.

2) Abrasion Resistance: The percentage of weight loss shall be less than 12 percent, when tested according to ASTM D1242, Method B at 200 cycles, CSI-A Abrader Tape, 80 Grit.

3) Brittleness Temperature: Not higher than 15 degrees F, ASTM D746.

4) Tensile Strength: Extruded Coating - Not less than 2,980 psi, ASTM D412. Fusion Bonded Coating - Not less than 2,275 psi, ASTM D638.

5) Modulus of Elasticity: Extruded Coating - Not less than 2,700 psi, at 100 percent strain, ASTM D412. Fusion Bonded Coating - Not less than 1,980 psi. at 100 percent strain, ASTM D638.

6) Ultraviolet Light Exposure: A test period of not less than 3,000 hours, using apparatus Type E at 145.4 degrees F, ASTM G23.

7) Salt Spray Test: A test period of not less than 3,000 hours, ASTM B117.

610.02.09 INTERNAL CONNECTING WIRES

A. Internal connecting wires to reinforce the side panels of individual gabion baskets shall meet the same specifications as the wire used in the gabion body, except wire nominal diameter shall be 0.087 inches or larger. Alternate preformed stiffeners acceptable to the gabion manufacturer and the Engineer may also be used.

610.02.10 LACING WIRE

A. Lacing wire to assemble, interconnect, and close the gabion baskets shall meet the same specifications, as the wire used in the gabion body except its nominal diameter shall be 0.087 inches.

610.02.11 WIRE FASTENERS

A. Machine formed spiral wire binders with a 3-inch pitch and 2.5-inch inside diameter maximum are the standard fastener for welded wire mesh gabions and gabion mattresses, and shall be formed from wire meeting the same quality and coating thickness requirements as specified above for the gabions and gabion mattresses.

B. As an alternative to lacing wire and spiral binders, wire fasteners including interim fasteners, interlocking ring fasteners, overlapping (hog) ring fasteners, and twist ties may be used, subject to the approval of the Engineer.

C. The Contractor shall demonstrate that:

1. The proposed fastener can consistently resist an opposed tension force of at least 600 pounds without pulling apart.

2. The proposed fastener system can consistently produce a joint with strength of at least 1,400 pounds per linear foot while encompassing the number of wires as intended for its use. When PVC coated wire is used, the joint strength shall be at least 1,200 pounds per linear foot.

3. The proposed fastener system does not cause damage to the protective coating on the wire.

4. The Contractor has the proper equipment and trained employees to correctly install the fasteners.

5. Proper installation can be readily verified by visual inspection.

D. The Contractor shall provide a complete description of the fastener system, including the number of fasteners required, the number and size of wires that the fastener is capable of properly joining, and a description of a properly installed fastener, including drawings or photographs, if necessary.

E. Properly formed fasteners shall meet the following requirements:

1. Each interlocking fastener shall be locked and closed.
2. Each overlapping ring fastener shall be closed and the free ends shall overlap a minimum of 1 inch.
3. Spiral binders shall be crimped to secure the spiral in place.
4. Twist ties shall have a minimum of 2 complete revolutions.

F. If gauges or other aids are needed to verify the proper installation of the fasteners, the Contractor shall furnish the Engineer the gauges or aids in numbers as may reasonably be required.

1. If more than 1 wire fastener is proposed, e.g. different gauge or length of wire, for different joints, the fasteners shall be readily distinguishable.
2. Wire fasteners shall not be used to join more wires, or larger wires, than for which they were tested and approved.
3. As a minimum, a fastener shall be installed at intervals of 4 inches to 6 inches at the location where mesh wire meets selvedge or edge wire.

G. Fastener Materials:

1. Galvanized wire fasteners shall be used with galvanized gabions.
2. Aluminized wire fasteners shall be used with aluminized gabions.
3. Stainless steel overlapping rings or interlocking rings shall be used for stainless steel gabions.
4. PVC coated wire spiral binders shall be used for PVC coated gabions.

H. Fastener Properties:

1. Galvanized wire fasteners shall conform to ASTM A764 with Type III coating.
2. Aluminized wire fasteners shall conform to ASTM A809 for wire diameter and coating, with tensile strength equal to ASTM A764, Table 2.
3. Stainless steel wire fasteners shall conform to ASTM A313, Grade 302.
4. Spiral binder fasteners shall be formed with wire having at least the same thickness and coating as the basket mesh wire.
5. Twist tie fasteners shall meet the requirements of lacing wire, as specified in Subsection 610.02.10, "Lacing Wire."

CONSTRUCTION

610.03.01 EARTHWORK

A. The areas where riprap or wire mesh gabions are to be placed shall be graded to the required lines and grades as shown on the plans or as directed by the Engineer.

B. Any excavations or backfill required to achieve such grade shall conform to the provisions of Section 206, "Structure Excavation," and Section 207, "Structure Backfill."

610.03.02 FILTER PLACEMENT

A. Filter material shall be spread uniformly on the prepared foundation surface in a manner satisfactory to the Engineer, and to the slopes, lines, and grades as shown on the plans or as specified by the Engineer.

1. Placing of a filter material by methods that will segregate particle sizes will not be permitted.
2. Any damage to the foundation surface during filter placement shall be repaired before proceeding with the work.
3. The filter materials shall be placed and placement shall be approved and accepted before proceeding with the work.
4. The filter materials shall be placed and finished to present a reasonably even surface free from mounds or windrows.
5. Compaction of the filter materials shall conform to the requirements shown on the plans or as outlined in the Special Provisions.

B. Filter fabric shall be installed in accordance with the manufacturer's recommendations and in manner that will not tear, puncture, or shift the fabric.

C. Joining edges of the filter fabric shall be overlapped a minimum of 18 inches.

D. Filter fabric placed behind and/or beneath gabion or gabion mattress structures shall have a minimum permeability of 0.15 inch/second and shall be designed to retain the fine particles of the subsoil while releasing any hydrostatic pressure buildup.

610.03.03 RIPRAP

A. Stone for riprap shall be placed in a manner that will produce a well-graded mass of stone with a minimum percentage of voids.

1. The entire mass of stone shall be placed in conformance with the lines, grades, and thicknesses shown on the plans.
2. Riprap shall be placed to its course thickness in 1 operation and in such a manner as to avoid displacing underlying material.
3. When filter fabric is used under the riprap, the height from which the stone is dropped shall be minimized to avoid fabric damage.
4. Placement of stones shall begin at the bottom of the slope and proceed upward to the top.

B. The large stones shall be well distributed and the entire mass of stone shall conform to the gradation specified.

1. All material placed as riprap protection shall be so placed and distributed that there is no large accumulation of either the larger or smaller sizes of stone.
2. Placing of riprap in layers, or by dumping into chutes, or by similar methods likely to cause segregation will not be permitted.

610.03.04 GROUTED RIPRAP

A. When grouted riprap is specified, the stone shall be laid as set forth above for riprap.

B. The spaces between the stones shall then be filled with grout as directed, and in accordance with Subsection 706.03.05, “Riprap Grout.”

C. Sufficient grout shall be used to completely fill all voids, except that the face surface of the stone shall be left exposed.

D. After grouting is completed, the surface shall be cured as specified in Section 502, "Concrete Structures" for a period of at least 3 days.

610.03.05 SACKED CONCRETE RIPRAP

A. The sacks shall be filled with concrete, loosely placed, with enough room left at the top to fold to retain the concrete at the time of placing.

   1. Not more than 1 cubic foot of concrete shall be placed in each sack.

   2. Immediately after being filled with concrete, the sacks shall be placed and lightly trampled to cause them to conform with the earth face and to adjacent sacks in place.

B. The slopes on which the sacked concrete riprap is to be placed shall be finished true to line and grade.

   1. The first course shall consist of a double row of stretchers laid in a neatly trimmed trench.

   2. The second course shall consist of a single row of headers.

   3. The third and remaining courses shall consist of stretchers.

   4. Courses shall be placed in such a manner that joints in succeeding courses are staggered.

   5. All dirt and debris shall be removed from the top of the sacks before the next course is laid thereon.

   6. Stretchers shall be placed so that the folded ends will not be adjacent.

   7. Headers shall be placed with the folds toward the earth face.

   8. Not more than 4 vertical courses of sacks shall be placed in any tier until initial set has taken place in the first course of any such tier.

C. When, in the opinion of the Engineer, there will not be proper bearing or bond for the concrete due to delays for any cause, a small trench shall be excavated back of the row of sacks already in place. The trench shall be filled with fresh concrete before the next layer of sacks is laid.

D. Sacked concrete riprap shall be cured in accordance with Section 702, “Concrete Curing Materials and Admixtures.”

610.03.06 WIRE MESH GABIONS AND GABION MATTRESSES

A. Prior to the assembly and placement of the wire mesh gabions, a representative of the gabion manufacturer shall be present at the construction site for 1 day of placement or construction to demonstrate the method of assembling, interconnecting, stone filling, and closing the gabion, unless otherwise specified in the Special Provisions.

B. Construction of the gabion structure shall not proceed until the Engineer approves the Contractor's assembly and placement methods.

C. Gabion baskets shall first be assembled as empty units.

1. The panels and diaphragms shall be connected to the base panel, rotated into position, and joined along the edges with lacing wire, spiral binders, or approved wire fasteners.

2. When joined with lacing wire, the lacing wire shall be tightly looped at intervals of not more than 6 inches along the seams so that single and double loops are alternated.

3. When joined with preformed spiral binders, thread the spirals along the panels' edges through every mesh and crimp the spirals ends to secure them in place.

4. When joined with alternate fasteners, the fasteners shall be properly installed as specified in Subsection 610.02.11, “Wire Fasteners.”

5. For either method, there shall not be any opening greater than 2 inches (maximum line dimension) along the joined edges or at the corner of the gabion basket.

D. Empty gabion baskets shall be placed into position, over the filter fabric when required, on the prepared foundation.

1. Empty gabion baskets shall be joined successively to the next empty gabion basket before filling with stone.

2. Each row, tier, and layer of baskets shall be reasonably straight and shall conform to the line and grade shown on the plans or established by the Engineer.

3. The empty gabion baskets shall be fastened to the adjacent baskets along the top and vertical edges.

4. Each layer shall be fastened to the underlying layer along the front, back, and ends.

5. Unless otherwise shown on the plans, the vertical joints between basket units of adjacent tiers or layers shall be staggered by at least one cell along the length of the structure.

E. All fastening of adjacent baskets shall be done with lacing wire, spiral binders, or approved wire fasteners in order to obtain a monolithic structure. The method of fastening shall meet the same requirements as that specified for assembling individual gabion baskets.

F. Fastening shall be made through selvedge-to-selvedge or selvedge-to-edge wire connection. Mesh-to-mesh or selvedge-to-mesh wire connection is allowed along vertical edges or in the case where baskets are offset or stacked, and selvedge-to-mesh or mesh-to-mesh wire connection would be necessary.

G. Before filling each gabion basket with stone, tension may be applied to the empty baskets to achieve a uniform alignment and shall be accomplished to prevent any possible unraveling.

1. Welded wire mesh gabions do not require stretching.

2. The finished gabion structure shall have no gaps along the perimeter of the contact surfaces between adjoining gabion basket units.

H. The gabion cells shall be carefully filled with stone placed by hand and/or machine so that the alignment of the structure will be maintained to avoid bulges and minimize voids.

1. All exposed stone surfaces shall have a reasonable smooth and neat appearance.
2. No sharp stone edges shall project through the wire mesh.

I. The gabion baskets stone-fill may be either cobbles or crushed stone.

1. The stone shall be clean, hard, durable, and of suitable quality to ensure suitable performance in the gabions or gabion mattresses.
2. The stone shall be free from cracks, seams, and other defects that would tend to increase its deterioration in the gabion baskets.
3. The inclusion of dirt, sand, clay, debris, and rock fines will not be permitted.
4. Stone-fill used in the gabions and gabion mattresses shall be a well-graded mixture with sizes ranging between 4 inches and 8 inches in diameter for gabions 1 foot or greater in height, and between 3 inches and 6 inches in diameter for gabion mattresses 9 inches or less in height.

J. The gabion cells in any row or layer shall be filled in stages so that local deformations may be avoided.

1. At no time shall any cell be filled to a depth exceeding 12 inches more than any adjacent cell.
2. The maximum height from which the stone may be dropped into the basket units shall be 3 feet.

K. During filling operations, internal connecting wires shall be placed in all exposed front and side gabion units in the following manner:

1. For gabion cells with a 36-inch height:
   a. Stone shall be placed to a depth of 1/3, 12 inches, after which a minimum of 2 equally spaced internal connecting wires shall be placed in each cell, connecting the front and back faces of the compartment.
   b. For corner units, internal connecting wires shall be placed in both directions.
   c. The connecting wires shall be looped around 2 twisted wire mesh openings, or a welded wire joint, at each basket face, and the wire terminals shall be securely wrapped to prevent their loosening.
      1) This operation shall be repeated when the cell is 2/3 full.
      2) In welded mesh gabions, these cross-ties or stiffeners are made from lacing wire and placed across the comers of the gabion cells at 12 inches from the comers, thus providing a diagonal bracing. Lacing wire or preformed hooked wire stiffeners may be used.
2. For thinner gabion cells:
   a. Internal connecting wires are not required except when 18 inch baskets are used to build exposed vertical surfaces.
   b. In this case, the procedures under Subparagraph 1. above shall be followed, except that the internal connecting wires shall be placed at 9 inches from the base.

METHOD OF MEASUREMENT

610.04.01 MEASUREMENT

A. The quantity of riprap, grouted riprap, and wire mesh gabions measured for payment will be the number of cubic yards or square yards complete and in place.

B. The quantity of sacked concrete riprap to be measured for payment will be the number of cubic yards at the mixer or the number of square yards of sacked riprap in the completed work.

C. 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

A. The accepted quantities of riprap, grouted riprap, sacked concrete riprap, and wire mesh gabions measured as provided in Subsection 610.04.01, "Measurement," will be paid for at the contract unit price bid per cubic yard or square yard for the type specified, which shall be full compensation for furnishing and placing stone, grout, concrete, wire mesh gabions, filter material, filter fabric, and all other miscellaneous items that are appurtenant to the construction of riprap or gabion structures, including the cost incurred for a manufacturer's representative at the construction site. The above prices shall also include all excavation, grading, and backfill necessary to complete the work.

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

C. Payment will be made under:

PAY ITEM	PAY UNIT
Riprap	Cubic Yard or Square Yard
Heavy Riprap	Cubic Yard or Square Yard
Grouted Riprap	Cubic Yard or Square Yard
Sacked Riprap	Cubic Yard or Square Yard
Wire Mesh Gabions	Cubic Yard or Square Yard

SECTION 611

CONCRETE SLOPE PAVING

DESCRIPTION

611.01.01 GENERAL

A. 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 and in accordance with the design shown on the plans.

MATERIALS

611.02.01 GENERAL

A. Materials shall conform to the following sections:

Materials	Section
Portland Cement Concrete	501
Reinforcing Steel	505

B. Concrete mortar slope paving shall consist of a mixture of 1 part Portland cement to 4 parts sand, thoroughly mixed in a dry state prior to mixing with water.

1. Measurement may be either by volume or weight.
2. Before placing, all lumps 3/8 inch and over shall be removed by screening.
3. Sand shall conform to Subsection 706.03.03, "Fine Aggregate."
4. An air-entraining admixture shall be added to the concrete mortar at a rate of 4 percent to 7 percent.

C. Mesh reinforcing for ditch lining and slope paving reinforcement shall be of the sizes shown on the plans, shall be fabricated of cold drawn steel wire, and need not be galvanized. Mesh reinforcing shall conform to ASTM A185.

D. Header boards consisting of 2-inch by 4-inch redwood lumber furnished and placed in the 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.

E. Nails used in construction of header boards shall be commercial quality galvanized nails.

CONSTRUCTION

611.03.01 EARTHWORK

A. 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.

B. The subgrade shall be thoroughly compacted.

1. Any soft, spongy, or other unsuitable material shall be removed to the depth directed by the Engineer, backfilled with suitable material, and thoroughly compacted.

2. Water shall be sprinkled on the subgrade during compaction.

3. The subgrade shall be sufficiently moist prior to placing concrete or mortar to prevent absorption.

C. Excavations for trenches, footings, cutoff walls, and so forth shall conform to Section 206, "Structure Excavation." Gradation and compaction requirements on structure backfill will not apply.

611.03.02 GENERAL

A. Concrete, after placing, shall be tamped until it is thoroughly consolidated and mortar flushes to the surface.

1. 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 1/4-inch thick troweled on immediately.

2. The mortar shall consist of 1 part Portland cement and 3 parts clean, sharp sand.

3. The mortar surface shall be considered as a part of the concrete and no additional allowance will be made therefor.

B. After striking off to grade, the concrete shall be hand floated with wooden floats not less than 4 inches in width and not less than 30 inches in length.

1. Care shall be taken to prevent rotary marks of the hand floats.

2. The entire surface shall be broomed with a fine texture hair push broom to produce a uniform surface and eliminate float marks.

3. 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.

4. Joints shall be edged with a 1/4 inch radius edger prior to the brooming.

C. Materials for mortar that have been mixed for more than 45 minutes and have not been incorporated in the work shall not be used unless otherwise permitted by the Engineer.

D. 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, "Portland Cement Concrete," except concrete or mortar shall be maintained at a temperature of not less than 50 degrees F for 72 hours after placing and at not less than 40 degrees F for an additional 4 days.

E. The slope paving shall be constructed without expansion joints.

F. The mesh reinforcing shall be placed in the approximate center of the concrete mortar.

G. All joints shall be lapped 6 inches and run continuously throughout paving or between headers.

H. Concrete slope paving, aprons, and cutoff walls shall be cured as specified in Section 502, "Concrete Structures."

METHOD OF MEASUREMENT

611.04.01 MEASUREMENT

A. 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 or square yards complete and in place.

1. The quantity will be computed from measurements of the actual areas placed based on the theoretical thickness shown on the plans.

2. No additional allowance will be made for additional concrete placed due to low subgrades.

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

BASIS OF PAYMENT

611.05.01 PAYMENT

A. The accepted quantities of concrete slope pavement 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 or square yards for the material and class specified, which shall be full compensation for excavation, backfill, furnishing and installing redwood headers, concrete or mortar; 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.

B. Reinforcement shall be measured and paid for as specified in Section 505, "Reinforcing Steel."

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

D. Payment will be made under:

PAY ITEM	PAY UNIT
(Class) Concrete Slope Pavement	Cubic Yard or Square Yard
(Class) Concrete Aprons	Cubic Yard or Square Yard
Concrete Mortar Slope Pavement	Cubic Yard or Square Yard

SECTION 612

PNEUMATICALLY PLACED CONCRETE MORTAR

DESCRIPTION

612.01.01 GENERAL

A. 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.

B. 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.

MATERIALS

612.02.01 GENERAL

A. The materials used shall be those prescribed for the several items which constitute the finished work and shall conform to all the requirements for the materials as set forth in this specification and in Division III, "Material Details."

B. Cement shall conform to Section 701, "Hydraulic Cement."

C. Sand shall conform to Subsection 706.03.03, "Fine Aggregate."

D. The dry mixture shall consist of 1 part Portland Cement to 4 parts sand, thoroughly mixed in a dry state.

   1. Measurement may be either by volume or weight.

   2. Before placing the proportioned materials in the hopper of the application gun, all lumps 3/8 inch and over shall be removed by screening.

E. The premixed mortar shall contain not less than 610 pounds of Portland cement per cubic yard fine aggregate and water. A maximum of 30 percent size #89 aggregate as defined in ASTM D448 may be substituted for fine aggregate.

F. Mesh reinforcing for ditch lining and slope paving reinforcement shall be of the sizes shown on the plans, shall be fabricated of cold drawn steel wire, and need not be galvanized. Mesh reinforcing shall conform to ASTM A185.

G. Header boards consisting of 2-inch by 4-inch 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.

H. Nails used on construction of header boards shall be commercial quality galvanized nails.

CONSTRUCTION

612.03.01 PREPARATION OF SUBGRADE

A. The subgrade for paved ditches and slope paving shall be formed by excavation 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.

B. The subgrade shall be thoroughly compacted.

1. Any soft, spongy, or other unsuitable material shall be removed to the depth directed by the Engineer, backfilled with suitable material, and thoroughly compacted.

2. Water shall be sprinkled on the subgrade during compaction.

3. The subgrade shall be sufficiently moist prior to placing concrete mortar to prevent absorption.

612.03.02 PLACING

A. 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.

1. The final panel shall be at least 4 feet by 6 feet in size.

2. The panels shall be constructed at the construction site and shall be placed by a method to be used in placing slope pavement.

B. The Engineer shall be the sole judge of compliance of the test panel construction with these specifications.

C. Header boards shall be installed to conform to the grades of the slope paving and to the dimensions, spaces, and layout shown on the plans.

D. Header boards shall be held in position with stakes of suitable size and length as shown on the plans.

E. A constant pressure of not less than 45 psi shall be maintained in the placing machine where the hose length is 100 feet or less and the pressure shall be increased at least 5 psi for each additional 50 feet of hose or fraction thereof.

F. Water used for hydration at the nozzle shall be maintained at a uniform pressure, which shall not be less than 15 psi greater than the air pressure at the machine.

G. The nozzle shall be held at a distance and in a position so that the flowing stream of material will impinge, as nearly as possible, at right angles to the surface being covered.

1. Any deposits of loose sand shall be cut out.

2. All rebound materials shall be wasted.

H. The Contractor shall do this work only with experienced personnel.

I. Materials that have been mixed for more than 45 minutes and have not been incorporated in the work shall not be used, unless otherwise permitted by the Engineer.

J. Mortar shall not be placed against frosted or frozen surface. If mortar is placed during the cold weather, it shall be heated and protected during placing and curing as set forth in Section 501, "Portland Cement Concrete," except mortar shall be maintained at a temperature of not less than 50 degrees F for 72 hours after placing and at not less than 40 degrees F for an additional 4 days.

K. The ditch lining and slope paving shall be constructed without expansion joints. Suitable forms shall be used where necessary to ensure full dimensions as shown on the plans at the perimeter of the lining.

L. The mesh reinforcing shall be placed in the approximate center of the pneumatically placed concrete mortar. All joints shall be lapped 6 inches and run continuously throughout paving or between headers.

M. After the work is completed, the Contractor shall remove all debris from the work.

612.03.03 FINISHING

A. After the mortar has been placed to the required depth, the surface shall be checked with a straightedge, and any low spots or depressions shall be brought up to grade by placing additional mortar so that the finished surface will be smooth and uniform for the type of work involved.

B. Loose areas of air-blown mortar shall be removed and replaced by the Contractor at no additional cost to the Contracting Agency. The surface finish of the exposed slope paving shall be the equivalent of a wood float finish, unless otherwise specified.

C. Immediately after completion, the surface shall be covered with wet burlap or wet cotton mats and the mats kept wet for at least 72 hours. When approved by the Engineer, mortar may be cured by the use of a waterproof or liquid membrane conforming to Section 702, "Concrete Curing Materials and Admixtures," and these specifications.

METHOD OF MEASUREMENT

612.04.01 MEASUREMENT

A. 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

612.05.01 PAYMENT

A. 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 shall be full compensation for excavation, backfill, furnishing and installing redwood headers, and mortar; for all labor, tools, equipment, and incidentals; and for doing all the work involved in placing the pneumatically placed mortar, including subgrade preparation, forming, and curing, complete in place, as shown on the plans and as specified herein, and as directed by the Engineer.

B. Mesh reinforcement may be measured and paid for as specified in Section 505, "Reinforcing Steel," unless otherwise specified.

C. 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.

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

E. Payment will be made under:

PAY ITEM	PAY UNIT
Pneumatically Placed Concrete Mortar (inch depth)	Square Yard

SECTION 613

CONCRETE CURB, WALK, GUTTERS, DRIVEWAYS AND ALLEY INTERSECTIONS

DESCRIPTION

613.01.01 GENERAL

A. Concrete curb, walk, gutters, cross gutters, driveways, and alley intersections shall be constructed of Portland cement concrete prepared as prescribed in Section 501, "Portland Cement Concrete."

MATERIALS

613.02.01 GENERAL

A. Materials shall conform to the applicable requirements of Section 501, "Portland Cement Concrete," Section 502, "Concrete Structures," and Section 505, "Reinforcing Steel."

CONSTRUCTION

613.03.01 GENERAL

A. The thickness of Type I or II aggregate base under concrete curbs, gutters, walks, driveways, and alley intersections shall be as shown on the plans or Standard Drawings or as specified in the Special Provisions.

B. The subgrade shall be constructed true to grade and cross sections as shown on the Plans or as established by the Engineer.

C. The subgrade shall be watered and compacted until the subgrade reaches the compaction required for the adjacent roadway or base course.

613.03.02 DIMENSIONS

A. The dimensions of the concrete curbs, gutters, walks, driveways, and alley intersections shall be as shown on the Plans or Standards Drawings or as specified in the Special Provisions.

613.03.03 DRAINAGE OUTLETS THROUGH CURB

A. The Contractor shall provide suitable outlets through new curb for all existing building drains along the line of the work. The Contractor shall place outlets opposite any low area on adjacent property, the drainage of which will be affected by the new work.

B. Where sidewalk or curb will be higher than adjacent property, the Contractor shall provide at least one 4-inch diameter opening through the curb for each parcel when directed by the Engineer.

613.03.04 DRIVEWAY ENTRANCES AND ALLEY INTERSECTIONS

A. Driveway entrances and alley intersections shall be provided in new curb at all existing driveways and alley intersections along the line of the work at locations shown on the plans or Standard Drawings, or as specified in the Special Provisions.

613.03.05 STANDARD FORMS

A. Form material shall be free from warp, with smooth and straight upper edges and, if used for the face of curb, shall be surfaced on the side against which the concrete is to be placed.

B. Wooden forms for straight work shall have a net thickness of at least 1-1/2 inches; metal forms for such work shall be of a gauge that will provide equivalent rigidity and strength.

C. Curb face forms used on monolithic curb and gutter construction shall be of a single plank width when the curb face is 10 inches or less, except for those used on curb returns.

   1. Wooden forms used on curb returns shall be not less than 3/4 inch in thickness, cut in the length and radius as shown on the plans, and held rigidly in place by the use of metal stakes and clamps.

   2. The curb face shall be cut to conform exactly with the curb face batter as well as being cut in the required length and radius.

   3. Forms shall be of sufficient rigidity and strength, and shall be supported to adequately resist springing or deflection from placing and tamping the concrete.

   4. Metal forms shall not be used for curb returns or on curves of less than 250-foot radius.

D. Form material shall be clean at the time it is used, and shall be given a coating of light oil or other equally suitable material, immediately prior to the placing of the concrete.

E. All forms, except back planks of curb, shall be set with the upper edges flush with the specified grade of the finished surface of the improvement to be constructed, and all forms shall be not less than a depth equivalent to the full specified thickness of the concrete to be placed.

F. Back forms shall be held securely in place by stakes driven in pairs at an interval not to exceed 4 feet, 1 at the front form and 1 at the back.

   1. Clamps, spreaders, and braces shall be used as necessary to ensure proper form rigidity.

   2. Forms for walk, gutter, and similar work shall be firmly secured by stakes driven flush with the upper edge of the form at intervals not to exceed 5 feet.

   3. Form stakes shall be of sufficient size and be driven to adequately resist lateral displacement.

G. Commercial form clamps for the curb and gutter may be used, provided the clamps fulfill the requirements specified herein.

613.03.06 SLIP FORMS

A. At the option of the Contractor and with the approval of the Engineer, slip form equipment may be used for the construction of concrete curb and gutter and concrete curb, gutter, and sidewalk except for commercial driveways and curb returns with cross gutters.

B. If machines designed specifically for such work and approved by the Engineer are used, the results shall be equal to or better than that produced by the use of forms.

   1. If the results are not satisfactory to the Engineer, the use of the machines will be discontinued.

2. All applicable requirements of construction by use of forms shall apply to the use of machines.

C. Slip form equipment shall be provided with traveling side and top forms of suitable dimensions, shapes, and strength to support the concrete for a sufficient length of time during placement to produce curb and gutter of the required cross section. The equipment shall spread, consolidate, and screed the freshly placed concrete in such a manner as to provide a dense and homogeneous product.

D. Any curb, except on structures, may be placed by using an extrusion machine provided the finished curb is true to line and grade and the concrete is dense and of the required surface texture and strength. The combined aggregate for the concrete placed by the extrusion method shall be of such size that the percentage composition by weight will conform to the grading limits of combined aggregates as specified in Subsection 706.02.01, "General," for the 3/4-inch maximum grading.

E. The grading limits shall be further restricted, if necessary, to produce concrete that after extrusion has well defined web marks of water on the surface and is free from surface pits larger than 3/16 inch in diameter.

F. The concrete shall be of such consistency that after extrusion, the concrete will maintain the shape of the curb section without support. The concrete shall contain the maximum amount of water that will permit this result.

G. In lieu of placing dowels and bar reinforcing steel and in advance of placing curbs on existing pavement or base, the surface shall be thoroughly cleaned and the adhesive specified below shall be applied.

1. Cleaning of the pavement or base shall be accomplished by wire brushing or by blast cleaning if the latter method is ordered by the Engineer.

2. The cleaned surface shall be free from dust, loose material, and oil.

H. The adhesive shall consist of 2 components which shall be mixed together at the site of the work and shall conform to Subsection 728.03.11, "Binder (Adhesive), Structural Epoxy."

I. The grade for the top of the curb shall be indicated by an offset guide line set by the Contractor from survey marks established by the Engineer.

1. The forming tube portion of the extrusion machine shall be readily adjustable vertically during the forward motion of the machine to provide, when necessary, a variable height of curb conforming to the predetermined curb grade.

2. A grade line gauge or pointer shall be attached to the machine in such manner that a continual comparison can be made between the curb being placed and established curb grade as indicated by the offset guide line.

J. In lieu of the above method for maintaining the curb grade, the extrusion machine may be operated on rails or forms set at uniform depth below the predetermined finished top of the grade.

K. The top and face of the finished curb shall be true and straight, and the top surface of curbs shall be of uniform width, free from humps, sags, or other irregularities. When a straightedge 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 0.01 foot from the edge of the straightedge, except at grade changes or curves.

L. Extrusion Machines:

1. Crawler track driven extrusion machines shall not be used on finished course plantmix surface.
2. Concrete shall be fed to the machine at a uniform rate.
3. The machine shall be operated under sufficient uniform restraint to forward motion to produce a well compacted mass of concrete free from surface pits larger than 3/16 inch in diameter and requiring no further finishing, other than light brushing with a brush filled with water only.
4. Finishing with a brush application of grout will not be permitted.

M. Expansion joints shall be required at EC and BC of curb returns, and also along the line of work at regular intervals not to exceed 300 feet.

N. Unless otherwise specified, transverse weakened plane joints on curb and gutter produced by an extrusion machine shall be constructed at 10-foot intervals along the line of the work.

O. Weakened plane joints shall be constructed as specified in Subsection 613.03.10, "Weakened Plane Joints."

P. Expansion joints shall be constructed as specified in Subsection 613.03.09, "Expansion Joints."

Q. Curing of slip form curb, gutter, and sidewalk shall be done as specified in Subsection 613.03.15, "Curing."

613.03.07 PLACING CONCRETE

A. Concrete shall be placed on a subgrade sufficiently dampened to ensure that no moisture will be absorbed from the fresh concrete.

B. Concrete shall be placed in curb, gutter, and curb and gutter forms in horizontal layers not exceeding 6 inches in thickness, each layer being spaded along the forms and thoroughly tamped. Concrete may be placed in layers of more than 6 inches in thickness only when authorized by the Engineer and when the spading and tamping is sufficient to consolidate the concrete for its entire length.

C. After the concrete for walk has been placed, a strike-off shall be used to bring the surface to the proper elevation when compacted. The concrete shall be spaded along the form faces and tamped to ensure a dense and compact mass, and to force the larger aggregate down while bringing to the surface not less than 3/8 inch of free mortar for finishing purposes.

D. Concrete shall be placed in cross gutters in horizontal layers of not more than 4 inches in thickness, each layer being spaded along the form faces and thoroughly tamped into a dense and compact mass. If internal vibrators are used, the full specified thickness may be placed in 1 operation.

E. After the concrete has been placed and tamped, the upper surface shall be struck off to the specified grade.

613.03.08 JOINTS

A. Joints in concrete curb, gutter, and walk shall be designated as expansion joints and weakened plane joints.

613.03.09 EXPANSION JOINTS

A. Expansion joints shall be constructed in curbs, walk, and gutter as shown on the plans, Standard Drawings, or as specified herein.

1. The joints shall be filled with pre-molded joint filler conforming to Section 707, "Joint Material."

2. No expansion joints shall be constructed in cross gutters, alley intersections, or driveways except as approved by the Engineer.

B. One-half-inch joints shall be constructed in curb and gutter at the end of all returns except where cross gutter transitions extend beyond the curb return, in which case the joints shall be placed at the ends of the cross gutter transition.

1. No joints shall be constructed in returns.

2. Where monolithic curb and gutter is constructed adjacent to concrete pavement, no expansion joints will be required except at EC and BC of curb returns.

C. Expansion joint filler 1/2-inch thick shall be placed in walk at the EC and BC of all walk returns, around all utility poles that project into the concrete along the line of the work, and in walk returns between the walk and the back of curb returns when required by the Engineer.

1. At the EC and BC and around utility poles, the joint filler strips shall extend the full depth of the concrete placed.

2. Joint filler strips between walk and curb shall be the depth of the walk plus 1 inch with the top set flush with the specified grade at the top of curb.

D. All expansion joint filler strips shall be installed vertically, shall extend to the full depth and width of the work in which they are installed, and shall be constructed perpendicular to straight curb or radially to the line of the curb constructed on a curve.

1. Expansion joint filler materials shall completely fill these joints to within 1/4 inch of any surface of the concrete.

2. Excess filler material shall be trimmed off to the specified dimension in a neat and workmanlike manner.

3. During the placing and tamping of the concrete, the filler strip shall be held rigidly and securely in proper position.

613.03.10 WEAKENED PLANE JOINTS

A. Weakened plane joints shall be straight and constructed in accordance with paragraphs D or E below, unless otherwise shown on the plans.

B. In walks, joints shall be transverse to the line of work and at regular intervals not exceeding 10 feet. At curves and walk returns, the joints shall be radial.

C. In gutters, including gutters integral with curb, joints shall be at regular intervals not exceeding 10 feet. Where integral curb and gutter is adjacent to concrete pavement, the joints shall be aligned with the pavement joints where practical.

D. **Control Joint.**

1. After preliminary trowelling, the concrete shall be parted to a depth of 2 inches with a straightedge to create a division in the coarse aggregate.

2. The concrete shall be refloated to fill the parted joint with mortar.
3. Headers shall be marked to locate the weakened plane for final joint finishing, which shall be accomplished with a jointer tool having a depth of 1/2 inch and a radius of 1/8 inch.
4. The finished joint opening shall not be wider than 1/8 inch.

E. **Plastic Control Joint.**

1. The joint material shall be a T-shaped plastic strip at least 1 inch deep, having suitable anchorage to prevent vertical movement, and having a removable stiffener with a width of at least 3/4 inch.
2. After preliminary trowelling, the concrete shall be parted to a depth of 2 inches with a straightedge.
3. The plastic strip shall be inserted in the impression so that the upper surface of the removable stiffener is flush with the concrete.
4. After floating the concrete to fill all adjacent voids, the removable stiffener shall be stripped.
5. During final trowelling, the edges shall be finished to a radius of 1/8 inch using a slit jointer tool.

613.03.11 FINISHING

A. Finishing shall be completed as specified herein for the type of work being performed.

613.03.12 CURB

A. The front forms may be stripped as soon as the concrete has set sufficiently.

B. The face and top of the curb shall be carefully trowelled to a smooth and even finish; the top shall be finished to a transverse slope of 1/4 inch toward the gutter, with both edges rounded to a radius of 3/4 inch.

C. The trowelled surface shall be finished with a fine hair broom applied parallel with the line of the work.

D. The edge of the concrete at all expansion joints shall be rounded to a 1/4-inch radius.

E. The surface of the work shall be finished as prescribed, after which the name of the Contractor, together with the year in which the improvement is constructed, shall be stamped therein to a depth of 1/4 inch in letters not less than 3/4 inch high, at BC and EC curb returns.

613.03.13 WALK

A. The forms shall be set to place the finished surface in a plane sloping up from the top of curb at a rate of 1/4 inch to 1 foot when measured at right angles to the curb.

B. Following placing, the concrete shall be screeded to the required grade, tamped to consolidate the concrete and to bring a thin layer of mortar to the surface, and floated to a smooth, flat, uniform surface. The concrete shall then be edged at all headers, given a preliminary trowelling, and provided with weakened plane joints.

C. Walks shall be steel trowelled to a smooth and even finish.

1. All formed edges shall be rounded to a radius of 1/2 inch.

2. Edges at expansion joints shall be rounded to a radius of 1/8 inch.

3. Preliminary trowelling may be done with a long-handled trowel or "Fresno," but the finish trowelling shall be done with a hand trowel.

4. After final trowelling, walks on grades of less than 6 percent shall be given a fine hair broom finish applied transverse to the centerline.

5. On grades exceeding 6 percent, walks shall be finished by hand with a wood float.

6. Walks shall be remarked as necessary after final finish, to ensure neat uniform edges, joints, and weakened plane lines.

D. Weakened plane lines, where required, shall have a minimum depth of 1-1/2 inch and a radius of 1/8 inch.

1. When longitudinal weakened plane lines are required, the lines shall be parallel to, or concentric with, the lines of the work.

2. Walks 20 feet or more in width shall have a longitudinal center weakened plane line.

3. In walk returns, 1 weakened plane line shall be made radially midway between the BCR and ECR.

4. When directed by the Engineer, longitudinal and transverse weakened plane lines shall match the adjacent walk.

5. The Contractor shall have sufficient metal bars, straightedges, and joint tools on the project.

E. Headers shall remain in place for at least 16 hours after completion of the walk but shall be removed before the work is accepted.

F. The name of the Contractor, together with the year in which the improvement is constructed, shall be stamped therein to a depth of 1/4 inch in letters not less than 3/4 inch, at intervals of not less than 200 feet.

1. A metal identification plate with the exposed face set flush with the finished surface of the concrete, anchored to a depth of not less than 1-1/2 inches, may be substituted for the stamping in the concrete.

2. At least 1 such stamping or identification plate shall be made on each cement concrete job at the project.

613.03.14 GUTTER

A. After the concrete has been thoroughly tamped in such manner as to force the larger aggregate into the concrete and bring to the top sufficient free mortar for finishing, the surface shall be worked to a true and even grade by means of a float, trowelled with a long-handled trowel (or "Fresno") and wood float finished.

1. The flow line of the gutter shall be trowelled smooth for a width of approximately 4 inches for integral curb and gutter and 4 inches on either side of the flow line on cross and longitudinal gutters.

2. The outer edges of the gutter shall be rounded to a radius of 1/2 inch.

B. Side forms shall remain in place for at least 24 hours after completion of the gutter, but shall be removed before the work will be accepted.

C. Median island paving shall be as shown on the Standard Drawings.

613.03.15 CURING

A. Immediately after finishing operations are completed, the exposed surfaces shall be cured in accordance with Section 502, "Concrete Structures."

613.03.16 REPAIRS AND REPLACEMENTS

A. Any new work found to be defective or damaged prior to its acceptance shall be repaired or replaced by the Contractor at no additional cost to the Contracting Agency and in accordance with Subsection 105.12, "Removal of Unacceptable and Unauthorized Work."

613.03.17 BACKFILLING AND CLEANUP

A. Backfilling to the finished surface of the newly constructed improvement shall be complete before acceptance of the work.

B. Upon completion of the work, the surface of the concrete shall be thoroughly cleaned and the site left in a neat and orderly condition.

613.03.18 DETECTABLE WARNINGS

A. In accordance with the Americans with Disabilities Act (ADA), detectable warnings shall be constructed on all sidewalk ramps.

B. Detectable warnings shall provide a tactile surface which visually contrasts with ramp and street surfaces to assist visually impaired persons in the identification of street and driveway crossings.

C. Detectable warnings shall be constructed at the bottom of sidewalk ramps to a minimum depth of 24 inches and extending the full width of the ramp in accordance with the Standard Drawings.

D. The materials and method of constructing the warning strips shall be as directed by the Engineer of the entity having jurisdiction over the ramp.

E. Additional information on detectable warning materials and applications is available from the U.S. Access Board.

METHOD OF MEASUREMENT

613.04.01 MEASUREMENT

A. The quantity of curb, gutter, 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.

B. The quantity of sidewalk, driveway, and alley intersections shall be measured for payment by area in square feet.

C. In the case of integral curb and walk, the width of the walk shall extend to the back face of the curb.

D. All quantities measured for payment herein will be complete and in place.

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

BASIS OF PAYMENT

613.05.01 PAYMENT

A. 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 feet for curb, gutter, curb and gutter and per square foot for sidewalks, driveways, cross gutters, and alley intersections.

B. 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.

C. 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.

D. 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.

E. All payments shall be made in accordance with Subsection 109.02, "Scope of Payment."

F. Payment will be made under:

PAY ITEM	PAY UNIT
Type A Curb	Linear Foot
Type L Island Curb and Gutter	Linear Foot
Type L Curb and Gutter	Linear Foot
Concrete Sidewalk	Square Foot
Concrete Driveway	Square Foot
Concrete Sidewalk and Driveway	Square Foot
Concrete Alley Intersection	Square Foot
Concrete Cross Gutter	Square Foot
Concrete Commercial Driveway	Square Foot

SECTION 614

PAINTING

DESCRIPTION

614.01.01 GENERAL

A. 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

A. Materials shall meet or exceed the minimum standards hereinafter set forth.

B. **Materials:**

1. The raw materials for use in the various paint formulas shall conform to the specifications designated by Federal or Military serial number or paint material code number under the various paint classifications hereinafter specified.
2. Subsequent amendments to the specifications quoted shall apply to all raw materials and finished products.
3. No "or equal" substitutions for any specified material shall be made without written consent of the Engineer.

C. **Manufacturing and Packaging:**

1. All manufactured paint shall be prepared at the factory ready for application.
2. The addition of thinner or other material to the paint after the paint has been shipped will not be permitted, unless so specified.
3. The finished paint shall be furnished in new, round steel containers of not more than 6-gallon capacity and of metal not thinner than 0.024-inch nominal thickness.
   a. The containers shall have lug type crimp lids with ring seals and be equipped with ears and bails.
   b. The containers shall meet U.S. Department of Transportation Hazardous Material Shipping Regulations.
   c. The containers shall be lined if necessary to prevent attack by the paint.
   d. The lining shall not come off the can as skins.
4. No finished paint shall be used until at least 7 days have elapsed from the date of its manufacture.
5. All containers of paint shall be labeled showing the exact title of the paint specification, California State specifications number, manufacturer's name, date of manufacture, and manufacturer's batch number.
6. Precautions concerning the handling and the application of paint shall be shown on the label of paint and solvent containers.

614.02.02 NUMBER OF COATS

A. Unless otherwise required in the contract documents, the number and kinds of coats of paint shall be as set forth in Section 714, "Paint and Pavement Markings."

CONSTRUCTION

614.03.01 WEATHER CONDITIONS

A. Paint shall be applied only on thoroughly dry surfaces and during periods of favorable weather.

1. Except as provided below, painting will not be permitted when weather conditions during applications are such that the atmospheric temperature is at or below 40 degrees F 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 40 degrees F during the drying period.

2. If fresh paint is damaged by the elements, the paint shall be replaced by the Contractor at no additional cost to the Contracting Agency.

B. Subject to the approval of the Engineer in writing, the Contractor may provide suitable enclosures to permit painting during inclement weather.

1. Provisions shall be made to control atmospheric conditions artificially inside the enclosures within the limits suitable for painting throughout the painting operation.

2. 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

A. Painting shall be done in a neat and workmanlike manner.

B. Unless otherwise specified, paint shall be applied by brush, roller, or spray methods.

1. Brushes shall have sufficient body and length of bristle to spread the paint in a uniform coat.

2. In general, the primary movement of the brush shall be such as to fill thoroughly all irregularities in the surface, after which the coating shall be smoothed by a series of parallel strokes.

3. Paint shall be evenly spread and thoroughly brushed out.

4. If a considerable amount of brush marks appear, it will be considered that the paint has been improperly applied.

5. Rollers shall be of a type that do not leave a stippled texture in the paint film.

C. Work that is defective shall be refinished or repainted as directed at no additional cost to the Contracting Agency.

D. On surfaces that are inaccessible for brushing, the paint shall be applied by sheepskin daubers or by other means approved by the Engineer.

E. If spray methods are used, the operator shall be 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.

F. Mechanical mixers shall be used to mix the paint.

1. The paint shall be mixed to thoroughly blend the pigment and vehicle together.

2. Paint shall be kept mixed while being applied.

G. Paint specified or formulated shall be ready for application and thinning will be allowed only on direction of the Engineer.

H. The Contractor shall protect all parts of the structure being painted against disfigurement by spots of paint or paint materials.

1. When paint is being applied on structures carrying public traffic, the Contractor shall be responsible for damage caused by Contractor's operations to passing vehicles or persons.

2. The Contractor shall use shields or other protective means to guard against such damage.

I. Paint stains that result in unsightly appearance shall immediately be removed by the Contractor at no additional cost to the Contracting Agency.

614.03.03 SURFACE PREPARATION OF STEEL

A. The following methods of surface preparation apply to steel surfaces. Unless otherwise specified, the sand blasting method shall be used.

B. **Sand Blasting:**

1. Dirt, mill scale, rust, stain, old paint, and other foreign material shall be removed from steel surfaces by an approved blast cleaning apparatus.

2. Blast cleaning shall be sufficient to give the surface the appearance of unpolished cast aluminum.

3. Abrasives used for blast cleaning shall be 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.

4. The use of abrasives other than those specified herein will not be permitted unless approved in writing by the Engineer.

5. When sand blasting is being performed on structures open to traffic, the Contractor shall provide suitable protective devices to prevent damage to traffic.

6. When sand blasting is being performed near machinery, all journals, bearings, motors, and moving parts shall be sealed against entry of sand dust before sand blasting begins.

7. Unless otherwise authorized by the Engineer, sand blasted surfaces shall be primed or treated the same day sand blasting is done.

8. If cleaned surfaces rust before painting is accomplished, the surfaces shall be recleaned by the Contractor.

C. **Washes:**

1. Rust-inhibitor chemical washes shall be applied to freshly sand blasted steel surfaces prior to the application of the first undercoat of paint, except when the first undercoat of paint is applied to the cleaned surfaces within a 4-hour period after cleaning, washes will not be required.

2. Washes shall be applied in not more than 4-hour intervals.

3. If, in the opinion of the Engineer, atmospheric conditions are such that corrosion forms on freshly sand blasted surfaces in less than 4 hours, treatment may be required at more frequent intervals.

4. Rust-inhibitor chemical washes may be applied by brush or spray, and the washes shall be applied in a careful manner to ensure that all surfaces are covered.

5. During the application of the rust-inhibitor chemical wash, no sand blasting will be permitted in the areas being treated.

6. No paint shall be applied until the treated surfaces have dried.

7. The first undercoat of paint shall be applied to the treated surfaces the same day that cleaning and washing have been done.

D. **Steam Cleaning:**

1. Dirt, grease, loose chalky paint, and other foreign material that has accumulated on the previously painted surfaces shall be removed with an approved steam cleaning apparatus which shall precede all other phases of cleaning.

2. It is not intended that sound paint be removed by this process.

3. Subsequent painting shall not be performed until the cleaned surfaces are thoroughly dry and in no case in less than 24 hours after cleaning.

4. A detergent soap consisting of 45 percent sodium metasilicate, 43 percent sodium sesquisilicate, 10 percent sodium tetraphosphate, and 2 percent Naccanol shall be added to the feed water of the steam generator at the approximate rate of 1 pound of detergent per 200 pounds of water.

5. Any residue that may accumulate on cleaned surfaces shall be removed by flushing with fresh water, but washing down the cleaned surfaces will not otherwise be required.

E. **Hand Cleaning:**

1. Dirt, loose rusts, mill scale, dead paint, or paint that is not firmly bonded to the metal surfaces shall be removed by hand or powered wire brushes, hand scraping tools, or sandpaper.

2. Pneumatic chipping hammers will not be allowed unless authorized in writing by the Engineer.

3. Hand cleaning shall be sufficient to remove all loose material that would prevent the bond of succeeding coats of paint.

F. If the amount of steel to be painted exceeds 100 tons, the surface shall be prepared by method B, "Sand Blasting"; however, if the amount to be painted is 100 tons or less, the surface may be prepared by method E, "Hand Cleaning."

614.03.04 PAINTING STRUCTURAL STEEL

A. **Paint:**

1. Unless otherwise required in the contract documents, the paints to be applied to steel surfaces shall conform to Section 714, "Paint and Pavement Markings."

2. The undercoats shall consist of a minimum dry film thickness of 1 mil per coat.

3. The finish coat shall consist of a minimum dry film thickness of 1 mil.
4. The total thickness of all coats shall be not less than 3 mils.
5. Excessively thick coats of paint will not be permitted.
6. The thickness of each coat shall be limited to that which will result in uniform drying throughout the paint film.

B. **Field Cleaning:**

1. Unless otherwise specified in the contract documents, after erection and riveting or welding, all surfaces of unpainted structural steel that will be exposed to air shall be sand blasted in accordance with Subsection 614.03.03, "Surface Preparation of Steel."
2. 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:**

1. Painting of structural steel prior to erection will be limited to surface preparation and one undercoat of paint.
2. 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.
3. Surfaces exposed to the atmosphere that would be inaccessible for painting after erection shall be painted the full number of coats prior to erection.
4. The surface of the paint coat being covered shall be free from moisture, dust, grease, or any other deleterious material that would prevent the bond of the succeeding paint coats.
5. In spot painting, any old paint that lifts after application of the first spot coat shall be removed by scraping and the area repainted before application of the next coat.
6. The application of the finish coat will be permitted until the required total film thickness of the undercoats of paint, as described in A, above, is obtained.
7. Open seams at contact surfaces of built-up members that would retain moisture shall be caulked with red lead paste before applying the second undercoat of paint.
8. Metal surfaces embedded in concrete need not be painted.

D. **Machine Finished Surfaces:**

1. 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 that can be easily removed.
2. Surfaces of iron and steel castings that have been machine finished shall be painted with a coat of shop paint.

E. **Frames and Grates:**

1. Prior to installation, all surfaces of frames and grates exposed to the atmosphere shall be painted with 2 coats of paint.
2. Unless otherwise specified in the contract documents, the exposed surfaces shall be painted after installation with 1 finish coat as specified for structural steel.

614.03.05 PAINTING TIMBER

A. **Paint:**

1. New timber requiring painting shall be painted with 3 coats of paint.
2. The paint used for various coats will be as specified in these specifications or in the contract documents.

B. **Preparation of Surfaces:**

1. 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.
2. Unpainted timber shall be thoroughly dry before paint is applied.

C. **Painting:**

1. When permitted in writing by the Engineer, the first coat of paint may be applied prior to erection.
2. After the first coat has dried and the timber is in place, cracks, checks, nail holes, and so forth shall be puttied flush with the surface and allowed to dry before the second coat is applied.
3. Skips, holidays, thin areas, or other deficiencies in any coat of paint shall be corrected to the satisfaction of the Engineer before the succeeding coat is applied.
4. The surface of the paint coat being covered shall be free of any deleterious material before any additional paint is applied.

METHOD OF MEASUREMENT

614.04.01 MEASUREMENT

A. The quantities of painting, cleaning structural steel, and preparing surfaces for painting will not be measured for payment as such.

BASIS OF PAYMENT

614.05.01 PAYMENT

A. No direct payment will be made for painting, cleaning structural steel, and preparing surfaces for painting.

B. 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

A. This work shall consist of preservative treatment for lumber, timber, and piles as herein specified.

MATERIALS

615.02.01 GENERAL

A. The materials used shall be those prescribed for the several items that constitute the finished work and shall comply with all the requirements for such materials as set forth in these specifications.

B. Comply with Section 719, "Timber Preservatives."

CONSTRUCTION

615.03.01 TREATMENT

A. All structural timber, piling, and other lumber shall be thoroughly seasoned or conditioned before treatment.

B. The method of seasoning, conditioning, and treating used shall conform to the Federal Specification TT-W-571.

615.03.02 AMOUNT OF PRESERVATIVE

A. The minimum amount of preservative retained per cubic foot of timber, lumber, or piling shall conform to the minimum requirements of Federal Specification TT-W-571.

B. Unless otherwise specified, material treated with pentachlorophenol shall have a minimum retention of 8 pounds unless it is to be painted, then 6 pounds will be the minimum retention.

C. 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

A. When called for on the plans, all lumber and timber to be treated by the hot-cold soaking method shall be well seasoned and free from outer and inner bark, dirt, grease, or other objectionable matter that will in any way hinder the free penetration of the preservative.

B. All lumber and timber of 2 inches dimensional stock or larger shall be incised.

C. The preservative used shall be a 5 percent concentration of pentachlorophenol.

D. The tanks used shall be of sufficient size to permit complete submergence of the largest timber of any operation and to allow free circulation of the liquid around the timber being treated.

   1. Sufficient liquid shall be maintained in the tank to completely submerge the timber to a minimum depth of 6 inches.

2. When a number of pieces are being treated at 1 time, each piece shall be separated from the others on all sides by spacers not less than 1/4 inch in least dimension.

3. Suitable weights or cross bracing shall be provided to keep the material submerged.

E. The timber or lumber shall be submerged in the cold solution as previously described.

1. The temperature shall be slowly increased for a period of not less than 5 hours to a minimum temperature of 180 degrees F and not exceeding 210 degrees F.

2. After 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.

F. Timber for minor irrigation structures, unless otherwise shown on the plans, shall be the No. 1 Common Grade of the species permitted, and shall be treated in accordance with the Hot-Cold Soak Process.

G. The species permitted and the minimum retention in pounds per cubic foot required are as follows:

Species	Minimum Retention Per Cubic Foot (Pounds)
Douglas Fir (Rocky Mt., Inland, 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

A. 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.

B. 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.

C. All materials and processes used in the manufacture of material shall be subject to inspection, acceptance, or rejection at the manufacturer's plant, which shall be equipped with all the necessary gauges, appliances, and facilities to enable the inspector to verify that the requirements of the specifications have been fulfilled.

D. The treated timber and piling shall be free from heat checks, water bursts, excessive checking, results of chafing, and other damage or defects that would impair its usefulness and durability.

METHOD OF MEASUREMENT

615.04.01 MEASUREMENT

A. No measurement will be made for treatment of lumber, timber, and piles as such.

BASIS OF PAYMENT

615.05.01 PAYMENT

A. Full compensation for treatment of lumber, timber, and piles as specified shall be considered as included in the price paid for 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

A. 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.

B. 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.

C. Chain-link fence shall consist of galvanized or aluminum-coated 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

A. Materials shall conform to the requirements specified in Section 724, "Fence Materials," and Section 501, "Portland Cement Concrete."

CONSTRUCTION

616.03.01 GENERAL

A. All trees, brush, and other obstructions which interfere with proper construction of fences shall be removed and disposed of in accordance with Section 201, "Clearing and Grubbing," of these specifications, except that no payment will be made for such work.

B. When constructing chain-link fence, rocks and other surfaces irregularities that require moving in order to maintain a nearly smooth surface shall be removed and no direct payment will be made therefor.

C. Fence construction operations shall be conducted to prevent the escape of livestock.

1. Existing cross fences shall be connected to the new fence.
2. Corner posts, with braces for each direction of strain, shall be placed at the junction with existing fences and the wire in both fences properly fastened to the posts.
3. 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 a manner that permits the free passage of livestock through or under the structure.

D. 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.

E. Post holes for metal posts that are drilled or dug shall be backfilled with concrete.

F. Galvanized pipe brace rail shall not be spliced.

G. 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-gauge galvanized steel wire or 9-gauge aluminum hog rings.

H. Intermediate Braced Post Assemblies - Timber:

1. The horizontal brace shall be placed 6 inches below the tops of the brace posts and properly fitted and connected to the posts by two 3/8-inch by 4-inch steel dowels.

2. The dowel pins shall extend 2 inches into each brace and brace post.

3. Two strands of 8-gauge galvanized wire shall be run as a brace diagonally from 4 inches above ground line on each brace post to 4 inches below the top of the other brace post.

4. An extra loop shall be made around each post at the point of attachment and the wire firmly stapled to the post.

5. These brace wires shall then be twisted until the assembly is rigid.

I. 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.

J. 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.

1. All other timber posts shall be installed in drilled or dug holes and tamped firmly in place.

2. Round timber posts installed in drilled or dug holes shall have the butt end placed downward.

3. Timber line posts that are to be driven shall be machine pointed at the plant before being treated.

4. The small end of driven round timber posts shall be pointed.

K. 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.

L. Staples shall be set to hold the wire securely, but shall not be buried in the post in a manner that severely nicks or bends the wire.

616.03.02 STANDARD FENCE

A. Standard fencing shall be designated by types as follows:

1. Metal posts - Type A.

2. Wood posts - Type B.

3. Combination metal and wood posts - Type C.

B. The type of fence construction shall be as shown on the plans and indicated in the proposal.

1. Posts shall be firmly set or driven into the ground and spaced as indicated on the plans.

2. Each end, corner, and gate post shall be firmly braced and shall be set in concrete when required.

3. Posts shall be braced as indicated in the plans.

C. Standard fencing will be designated not only by type, but also by a symbol indicating the fencing required.

1. Type A-832-3B will designate a fence composed of metal posts, 32-inch woven wire (farm fencing), and 3 barbed wires.

2. Type C-726-4B will designate a fence composed of a combination of metal and wood posts, 26-inch woven wire, and 4 barbed wires, and so forth.

3. The figures 832 and others, when they appear in the symbol, correspond to design numbers set forth in the Standard Drawings.

D. In general, in determining the post spacing, measurements shall be made parallel to the slope of the natural ground.

1. 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.

2. All intervals shall be measured center to center of adjacent posts.

E. Changes in line where the angle of deflection is 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 15 degrees and less than 30 degrees shall be considered as alignment angles, and adjacent posts shall be made fast to the angle posts with wire or, if such method is impracticable in the opinion of the Engineer, such posts shall be braced as specified above for bracing gate, end, and corner posts.

F. 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 with a double strand of 9 gauge 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 100 pounds, buried in the ground not less than 2 feet. The fencing shall be pulled snug close to the ground before being snubbed or guyed.

G. 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

A. 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.

B. Changes in line where the angle of deflection is 30 degrees or more shall be considered as corners and corner posts shall be installed.

C. Between posts, chain-link fences shall be fastened to a bottom tension wire and a top tension cable.

1. The bottom tension wire shall be at least 7-gauge galvanized coil spring wire of good commercial wire.

2. The top tension cable shall be at least 3/8-inch diameter galvanized 7-strand cable conforming to ASTM A475 common grade.

D. Line posts shall be spaced at not more than 10-foot intervals, measured from center to center of posts.

1. In general, in determining the post spacing, measurements will be made parallel to the slope of the natural ground.

2. 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.

E. All metal posts shall be set in a Portland cement concrete footing crowned at the top to shed water. Depths of footings shall be as shown on the plans.

F. 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 500 feet, shall be braced and trussed in both directions as shown on the plans.

G. The fabric shall be stretched taut and securely fastened to the posts. 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.

1. Tension cable and wire shall be stretched tight with truss tightener as shown on the plans.

2. 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.

H. The fabric shall be fastened to the end, corner, and gate posts with 1/4-inch by 3/4-inch steel stretcher bars and not less than 1/8-inch by 3/4-inch steel stretcher bar bands placed at 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 14 inches and on tension cable and tension wires approximately 18 inches.

I. All posts shall be fitted with tops designed to fit securely over the posts and carry the top tension cable, except that the top of the C-section posts may be open-slotted to securely hold the top tension cable in position without vertical movement.

1. The slotting shall allow removal and replacement of a post without disturbing the top tension cable.

2. Tubular posts shall be fitted with watertight tops.

616.03.04 RECONSTRUCT FENCE

A. Reconstructed fences shall be carefully erected using salvaged materials and shall be similar in type to the original construction.

B. New materials necessary to rebuild the fence shall be furnished by the Contractor and shall be of the same kind as those in the original fence. The cost of such new materials shall be included in the contract price for the work.

C. The resulting reconstructed fence shall be equal to or better than before removed.

D. In reconstructed fences, the Contracting Agency reserves the right to furnish the Contractor with such new materials as the Contracting Agency deems advisable, and these materials shall be used in the reconstruction of the fence in lieu of salvaged materials which the materials replaced.

616.03.05 GATES

A. 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 72 inches nor less than 48 inches.

B. The wire mesh filler shall be rectangular or 2-inch diamond mesh for standard fencing and chain-link fence fabric for chain-link fencing.

C. Walk gates shall be of the width shown on the plans or in the Special Provisions and of a height corresponding to the adjacent fence height.

D. The gates shall be hung by steel or malleable iron hinges designed to securely fasten to the gate posts and permit the gate to swing back against the fence.

E. 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.

F. Missouri gates shall be constructed as shown on the standard plans.

METHOD OF MEASUREMENT

616.04.01 MEASUREMENT

A. 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.

B. The quantity of reconstructed fence measured for payment will be the number of linear feet, including used gates complete and in place.

C. The quantity of new gates measured for payment will be the number of gates complete and in place. If more than 1 size or type of gate is involved, separate measurement will be made for each size and type given.

D. Missouri gates, regardless of width, shall be measured for payment as units.

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

BASIS OF PAYMENT

616.05.01 PAYMENT

A. 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.

B. 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.

C. The above prices shall be full compensation for furnishing hardware, cement concrete, framing, erecting, connecting fence, and all incidentals necessary to complete the work.

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

E. 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

A. 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 ordered by the Engineer.

MATERIALS

617.02.01 GENERAL

A. All materials shall conform to the requirements specified in the following sections:

Materials	Section
Portland Cement Concrete	501
Reinforcing Steel	505
Steel Structures	506
Hardware	723
Painting	614
Paint and Pavement Markings	714
Timber	718

B. All hardware shall be galvanized steel.

C. 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

A. Structure excavation and backfill shall conform to Section 206, "Structure Excavation," and Section 207, "Structure Backfill."

617.03.02 GENERAL

A. Cattle guards shall be constructed in accordance with the details and dimensions shown on the plans.

B. Concrete and metal reinforcement construction shall conform to Section 502, "Concrete Structures," and Section 505, "Reinforcing Steel," respectively.

C. Steel member connections shall be welded and constructed conforming to Section 506, "Steel Structures."

D. The wing posts and wheel guards shall be given a preservative treatment conforming to Section 719, "Timber Preservatives." Treated timber and lumber shall not be painted.

E. Timber and lumber shall be assembled and placed in conformance with Section 507, "Timber Structures."

F. Painting shall be in accordance with recognized high standards of workmanship and in conformance with Section 614, "Painting."

METHOD OF MEASUREMENT

617.04.01 MEASUREMENT

A. The quantity to be measured for payment will be the number of cattle wings and steel cattle guards complete and in place. If more than one size of cattle guard is involved, separate measurement will be made of each size given.

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

BASIS OF PAYMENT

617.05.01 PAYMENT

A. 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.

1. The cost of cattle guard wings shall be included in the contract unit price for cattle guards; however, where wings alone are required, the wings will be paid for at the contract unit price each for cattle guard wings.

2. The above prices shall be full compensation for furnishing hardware, cement concrete, steel, timber and lumber, structure excavation and backfill, furnishing and applying paint, framing, erecting, adjusting fence, and all incidentals necessary to complete the work.

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

C. 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

A. 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.

B. This work shall also consist of furnishing and installing reflector plates as shown on the plans.

MATERIALS

618.02.01 GENERAL

A. All material shall conform to the requirements specified in the following sections:

Materials	Section
Timber	718
Timber Preservatives	719
Guardrail Materials	720
Galvanizing	715

B. Guardrail posts and blocks shall be rough construction grade and shall comply with the grading requirements of Subsection 718.03.02, "Grades."

C. Cable end anchor assemblies for metal beam guard railing shall be constructed as shown on the plans and shall conform to Subsection 720.03.04, "Cable End Anchor Assemblies."

D. Each post shall be given a preservative treatment by pressure processes with 1 of the following in accordance with Section 615, "Preservative Treatments for Timber."

E. The minimum retention of preservative in pounds per cubic foot of wood shall be as follows:

1. Creosote - 8 pounds per cubic foot.
2. Creosote-Petroleum - 8 pounds per cubic foot.
3. Pentachlorophenol - 8 pounds per cubic foot.

F. Guardrail quantities shown on the plans are approximate.

1. 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.
2. Should the Contractor elect to order guardrail materials prior to receiving this revised list from the Engineer, the Contractor shall be completely responsible for furnishing the amount of guardrail and appurtenances required by the list.

3. Should additional quantities be required to meet the requirements of the list, there shall be no additional compensation allowed above the unit price and no compensation shall be allowed for surplus materials in excess of the requirements of the list.

618.02.02 REFLECTORS

A. Reflector plates for guardrail shall be fabricated from 11-gauge steel sheet.

1. Nails for fastening reflector plates to the guardrail post shall be either galvanized metal or aluminum.

2. Steel reflector plates shall be galvanized.

3. Reflectorized material for reflector plates shall conform to Subsection 721.03.03, "Reflectors."

B. Reflector plates shall be constructed and erected on guardrail in accordance with the details shown on the plans and as specified, and shall be spaced as follows:

1. 50 feet on tangents and curves of 700 feet radius or greater.

2. On curves with less than 700 feet radius, markers shall be placed on the post nearest the spacing shown for guide posts as shown in the plans.

3. At interchanges, guardrail markers with amber reflectors shall be installed at a maximum spacing of 50 feet along acceleration and deceleration lanes, and in accordance with above subparagraph 2 on turning ramps and roadways.

C. Reflectors shall be white except as noted in subparagraph 3 above.

CONSTRUCTION

618.03.01 GENERAL

A. 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.

1. Post spacing shall be as shown and guardrails shall be constructed in accordance with the design shown on the plans.

2. The use of more than 1 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.

B. Posts shall be set plumb, except on superelevated curves where the posts shall be set perpendicular to the roadbed.

1. Front faces of posts shall form a straight line, except on curves where the posts shall be a uniform distance from the centerline of the roadway.

2. 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.

C. Guardrail beam elements may be furnished in 12-foot 6-inch or 25-foot lengths at the option of the Contractor, and shall conform to AASHTO M180, "Corrugated Sheet Steel Beams for Highway Guardrail," requirements for Class A, Type 2 guardrail.

D. Cable end anchor assemblies for metal beam guard railing shall be constructed as shown on the plans and as specified herein.

E. Cable clips and a cable thimble shall be used to attach cable to the anchor rod.

F. 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 C203, "Standard for Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot Applied."

G. Metal components of the anchor assembly shall be fabricated in conformance with good shop practices and shall be hot-dip galvanized in accordance with Section 715, "Galvanizing."

H. Anchor blocks shall be constructed of concrete conforming to the provisions in Section 501, "Portland Cement Concrete," and Section 502, "Concrete Structures."

I. Concrete shall be placed against undisturbed material of the excavated holes for anchor blocks. The top 12 inches of holes shall be formed, if required by the Engineer.

J. Surplus excavated material remaining after the guard railing has been constructed shall be disposed of in a manner satisfactory to the Engineer.

K. The overall length of each anchor cable assembly shall be a minimum of 10 feet.

L. Framing shall be done and fittings attached so that the rail, after erection, shall be true to line and grade and shall have the proper tension in the rail plates.

1. Care shall be taken to prevent the disturbance of posts during the erection of the rail.

2. When necessary, temporary braces shall be installed to ensure against post displacement.

618.03.02 PAINTED GUARDRAIL

A. **Field Painted:**

1. After the posts are set, the exposed portions shall be wrapped or otherwise protected to the satisfaction of the Engineer so that the posts shall remain free from paint, road oil, and other objectionable material.

   a. After all other work is completed and prior to the semi-final inspection, the wrapping or protection shall be removed.

   b. 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 no additional cost to the Contracting Agency.

2. All exposed surface of the metal guardrail that has become soiled or marred shall be cleaned or repainted by the Contractor as required by the Engineer, at no additional cost to the Contracting Agency.

3. 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.

4. New guardrail beam elements shall be galvanized both sides, cleaned, primed, and painted on the side facing traffic.

5. After erection, all metals parts and fittings shall be free from coatings of any kind, including dirt, rust, and oil and grease, and shall be given 3 coats of paint as specified in Section 714, "Paint and Pavement Markings."

6. Parts shop prime coated by the manufacturer shall conform to Subsection 614.03.04, "Painting Structural Steel," and Section 714, "Paint and Pavement Markings."

7. Posts shall not be painted.

8. All beams shall be cleaned prior to priming by wiping down the surface with solvents such as naphtha, white (lead-free) gasoline, or detergent.

   a. Detergents may be of the type commonly used in washing machines.

   b. If detergent is used, it shall be thoroughly rinsed from the rail with clear water.

9. All loose white deposit shall be removed with a stiff brush (not steel), steel wool, or sandpaper. Care shall be exercised not to remove zinc coating.

10. Prime coat may be applied in the field and shall conform to MIL-P-21035.

11. Intermediate and finish coats shall conform to MIL-P-21035.

12. Surfaces to be painted shall be dry and the temperature during priming, painting, and for 6 hours thereafter shall not be below 50 degrees F.

B. **Prepainted:**

1. Guardrail beam elements may be cleaned, primed, and prepainted on the side facing public traffic by the manufacturer prior to delivery to the jobsite as hereinafter specified.

2. **Cleaning:**

   a. All beam elements shall be alkaline cleaned, mechanically brushed, rinsed, given a zinc phosphate coating with a nominal coating weight of 200 mg per square foot, rinsed, and neutralized.

   b. Metal preparation shall comply with Military Specification MIL-T-12879, Type I, Class 1.

3. **Priming and Painting:**

   a. Prime coat shall be vinyl type, containing corrosion inhibiting pigment, applied at a nominal dry film thickness of 0.50 mil.

   b. Finish coat shall be a high gloss white thermosetting acrylic, baked enamel, applied at 1.0 mil nominal. The white pigment shall be non-chalking type.

   c. All exposed surface of the metal guardrail that has become soiled or marred shall be cleaned or repainted by the Contractor as required by the Engineer, at no additional cost to the Contracting Agency.

618.03.03 RECONSTRUCTED GUARDRAIL

A. Reconstructed guardrail shall be carefully erected using salvaged materials and shall be similar in type to the original construction.

B. Any new materials necessary to rebuild the guardrail shall be furnished by the Contractor and shall be of the same kind as those in the original if available. The cost of such new materials shall be included in the contract price for the work.

C. The Contracting Agency reserves the right to furnish the Contractor with such materials as the Contracting Agency deems advisable, and these materials shall be used in the reconstruction of the guardrail in lieu of salvage materials which the materials replaced.

D. Reconstructed guardrail shall be painted with 1 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

A. 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 connections, as applicable, complete and in place. In the case of new guardrail, an allowance of 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.

B. The quantity of cable end anchors constructed will be measured for payment as units.

C. The quantity of guardrail expansion joints constructed will be measured for payment as units.

D. 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.

E. Breakaway cable terminals will be measured for payment as units.

F. Where breakaway cable terminals are installed, guardrail measurements will not include the terminal ends.

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

BASIS OF PAYMENT

618.05.01 PAYMENT

A. 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.

B. The above prices shall be full compensation for furnishing hardware, reflectors, erecting, painting, galvanizing, and all incidentals necessary to complete the work.

C. The accepted quantity of Cable End Anchors measured as provided above will be paid for at the contract unit price bid per each, which 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.

D. The accepted quantity of Guardrail Expansion Joints measured as provided will be paid for at the contract unit price bid per each, which 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.

E. The accepted quantity of (Type) Guard Rail Beam Elements measured as provided above will be paid for at the contract unit price bid per linear foot (meter) of double beam rail, which 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.

F. Breakaway Cable Terminal will be paid for at the contract unit price bid per each, which 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, and redwood, and for doing all the work involved to install the breakaway cable terminal complete in place in the accepted work.

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

H. Payment will be made under:

PAY ITEM	PAY UNIT
Painted Guardrail	Linear Foot
Reconstruct Guardrail	Linear Foot
Cable End Anchors	Each
Guardrail Expansion Joints	Each
(Type) Guard Rail Beam Elements	Linear Foot
Breakaway Cable Terminal	Each

SECTION 619

OBJECT MARKERS AND GUIDE POSTS

DESCRIPTION

619.01.01 GENERAL

A. 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

A. Materials shall conform to Section 721, "Object Markers and Guide Posts."

CONSTRUCTION

619.03.01 GENERAL

A. Target members, object markers, 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.

B. All fastenings shall be tight.

619.03.02 RESET

A. Reset object markers and guide posts shall be erected, using salvaged materials, and shall be similar in type to the original construction.

B. Any new materials necessary to rebuild the markers shall be furnished by the Contractor, shall be the same as those in the original, if available, and the cost thereof shall be included in the contract price for the work.

C. The Contracting Agency reserves the right to furnish the Contractor with such new materials as the Contracting Agency deems advisable, and these materials shall be used in the resetting of the markers in lieu of salvage materials which the materials replaced.

METHOD OF MEASUREMENT

619.04.01 GENERAL

A. 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.

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

BASIS OF PAYMENT

619.05.01 PAYMENT

A. 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 shall be full compensation for furnishing hardware, erecting, and incidentals to complete the work.

B. When the Engineer orders guide posts placed for the protection of the public traffic, and the Engineer's order is prior to the time the Contractor would normally install the guide posts, 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 price for both the damaged posts and the posts replaced.

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

D. 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

A. This work shall consist of furnishing and erecting metal posts and plates 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

A. All materials shall conform to the requirements specified in Section 721, "Object Markers and Guide Posts."

CONSTRUCTION

620.03.01 GENERAL

A. Right-of-way markers shall be constructed in accordance with the details and dimensions shown on the plans.

B. The markers shall be set plumb.

C. The exact location of posts will be staked by the Engineer.

METHOD OF MEASUREMENT

620.04.01 MEASUREMENT

A. The quantity of right-of-way markers measured for payment will be the number of markers complete and in place.

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

BASIS OF PAYMENT

620.05.01 PAYMENT

A. 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.

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

C. Payment will be made under:

PAY ITEM	PAY UNIT
Right-of-Way Markers	Each

SECTION 621

MONUMENTS

DESCRIPTION

621.01.01 GENERAL

A. This work shall consist of furnishing and installing permanent survey monuments, constructed in accordance with the design and drawings shown on the plans or ordered by the Engineer.

B. Bronze discs as specified by the Contracting Agency shall be installed and inscribed in the monuments under the direct supervision of a Registered Land Surveyor.

C. The Contractor shall coordinate Contractor's work with the Registered Land Surveyor.

MATERIALS

621.02.01 GENERAL

A. Monuments shall be constructed of Portland cement concrete, and shall be of Type I, Type II, Type III, or Type IV as shown in the Standard Drawings.

CONSTRUCTION

621.03.01 INSTALLATION

A. The monuments shall be set to assist in reestablishment of the center line for future use and shall be set at the beginning and end of each project, at the beginning and end of each curve, at any angle point, at street intersections, and to replace or reference Section Corners or other Government Land Corners.

B. The monuments may perpetuate a point or reference a point.

C. An as-built set of plans for the project, showing the exact location of all monuments set, shall be prepared by a Registered Land Surveyor and filed with the County Surveyor prior to acceptance of the project.

METHOD OF MEASUREMENT

621.04.01 MEASUREMENT

A. The quantity of monuments measured for payment will be the number of units complete and in place.

BASIS OF PAYMENT

621.05.01 PAYMENT

A. The accepted quantity of monuments measured as provided in Subsection 621.04.01 will be paid for at the contract price bid per each.

B. Payments will be made in accordance with Subsection 109.02, "Scope of Payment."

C. Payment will be made under:

PAY ITEM	PAY UNIT
Monuments	Each

SECTION 622 - BLANK

SECTION 623

TRAFFIC SIGNALS AND STREET LIGHTING

DESCRIPTION

623 G.01.01 GENERAL

A. Electrical work shall consist of furnishing and installing, modifying or removing traffic signals, school flashers, flashing beacon systems, street and highway lighting systems, Intelligent Transportation Systems (ITS) facilities, 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 Drawings and as specified in these specifications and the Special Provisions.

B. The standards for street lighting and traffic signal installation and construction shall be the "Uniform Standard Drawings, Volumes I and II" and these specifications as adopted and approved by the Regional Transportation Commission of Southern Nevada (RTC).

C. For the purposes of this section, the Maintaining Agency of identified portions of the work described herein shall be the entity specified in the Contract Documents as being responsible for the operation and maintenance of those portions of the completed work. Unless otherwise specified, the Contracting Agency shall be considered the Maintaining Agency for all items of work.

D. Unless otherwise indicated on the Drawings or specified in the Special Provisions, all materials shall be new.

E. The locations of traffic signals, flashing beacons, street light and traffic signal poles, roadway lighting fixtures, traffic signs, traffic controller cabinets, electrical services, school flashers, and appurtenances shown on the Drawings are approximate and the exact locations will be established by the Engineer in the field.

F. All materials furnished and used shall conform to the provisions in Section 106, "Control of Materials." The materials shall be manufactured, handled, and used in a manner to ensure completed work with undamaged equipment and materials in accordance with the Drawings, specifications, and Special Provisions.

G. All systems shall be complete and in satisfactory operating condition at the time of acceptance of the contract.

H. Where an existing system is to be modified, the existing material shall be reused, salvaged and stockpiled, or abandoned as shown on the Drawings, as specified in the Special Provisions, or as directed by the Engineer.

623 G.01.02 REGULATIONS AND CODE

A. All electrical equipment shall conform to the standards of the National Electrical Manufacturers Association (NEMA), and listed by Underwriters Laboratories, Inc. (UL), or the Electronic Industries Association (EIA), wherever applicable.

B. In addition to the requirements of the Drawings, these specifications, and the Special Provisions, all materials and workmanship shall conform to the requirements of:

1. *National Electrical Code* (NEC).

2. National Electrical Testing Association (NETA).
3. *National Electrical Safety Code* (NESC).
4. Standards of ASTM International.
5. American National Standards Institute (ANSI) manuals.
6. International Municipal Signal Association (IMSA) cable specifications.
7. Institute of Electronic and Electrical Engineers (IEEE).
8. Illumination Engineering Society (IES).
9. Rural Electrification Association (REA).
10. Nevada Occupational Safety and Hazard Act (NOSHA).
11. National Board of Fire Underwriters (NBFU).
12. *Manual on Uniform Traffic Control Devices* (MUTCD).
13. *Uniform Standard Drawings*.
14. Any local ordinance which may apply.

C. Wire sizes shall be indicated in American Wire Gauge (AWG).

D. All work performed on any traffic signal component shall be under the direct on-site supervision of technician or electrician certified by IMSA for Level II Traffic Signals.

1. Actual trenching and foundation excavation activities are not considered construction labor involving traffic signal components until conduits or other electrical components are installed.
2. At a minimum, a supervisor with the IMSA Level II Traffic Signal certification shall oversee the installation of conduits and other electrical raceways.
3. Traffic signals are defined as all electrical equipment constructed in public right-of-way that are intended to provide control of traffic and shall include but not be limited to school flasher assemblies, advance warning beacons, traffic signal indications assigning right-of-way, school and other crosswalk signals, advance signal flashers, and intersection flashing beacons.

E. All work performed on any component of any electrical street lighting or traffic signal system shall be supervised by an electrician that is certified as a Journeyman Electrician. The company shall hold a valid state of Nevada recognized C-2 Electrical Contractor's license.

623 G.01.03 EQUIPMENT LIST AND DRAWINGS

A. Unless otherwise permitted in writing by the Engineer, the Contractor shall, within 15 days following approval of the contract, submit to the Engineer for approval a list of equipment and materials which the Contractor proposes to install.

1. The list shall be complete as to name of manufacturer, size, and identifying number of each item.
2. 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.

B. All submittal information shall be submitted for review, in quadruplicate. A minimum of 10 working days will be allowed for the review and return of the submittal documents.

C. When the Contractor provides a traffic signal controller cabinet, the circuit diagrams for detector plug connections, the peripheral equipment, and all external solid-state logic shall be provided.

1. The Contractor shall furnish traffic signal cabinet drawings and electrical schematics on CD in AutoCAD format, and 2 copies 24 inches by 36 inches in size.

2. The diagrams shall show the location of the installation and shall list all equipment installed in the cabinet.

D. The Contractor shall furnish a redlined set of the Drawings and revised Special Provisions to the Engineer prior to inspection showing actual conduit, pull box, and signal/lighting pole locations.

1. The redlined Drawings shall indicate any changes in the detector location, field wiring, signal phasing, and all other technical information for each traffic signal and street lighting installation.

2. The Contractor shall also furnish operation and maintenance manuals with each controller and all other electronic equipment furnished by the Contractor.

3. The manuals shall include any and all peripheral equipment specified herein or in the Special Provisions to be installed with the controller, including but not limited to preempt system, video detection system, loop detection amplifiers, conflict monitors, and modems.

4. As-built Drawings shall be required, and the final submittal requirements shall be as specified in the Contract Documents or directed by the Engineer.

E. 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.

1. This diagram shall show in detail all circuits and parts.

2. Such parts shown thereon shall be identified by name or number and in such manner as to be readily interpreted.

623 G.01.04 WARRANTIES, GUARANTEES, AND INSTRUCTION SHEETS

A. Manufacturers' warranties, guarantees, and certifications for materials used in the work and instruction sheets and parts list shall be supplied with materials and shall be delivered to the Engineer prior to acceptance of the project.

623 G.01.05 GLOBAL POSITIONING SYSTEM (GPS) COORDINATES

A. GPS coordinates shall be determined for all new and relocated traffic signal system, ITS, and street lighting facilities that are connected via the underground conduit system(s) and are visible at ground level, including but not limited to poles, pull boxes, splice vaults, cabinets, and service pedestals.

B. The GPS coordinates shall be submitted to the Engineer in a format specified in the Contract Documents or by the Maintaining Agency, at the end of the project prior to final acceptance. The Engineer will forward the data to the Maintaining Agency.

MATERIALS

623 G.02.01 CONDUIT

A. Underground conductors shall be installed in polyvinylchloride (PVC) conduit unless otherwise specified in the Special Provisions or the Drawings.

B. Conduit shall be listed by the Underwriters Laboratories, Inc., and shall bear the UL label on each length.

C. Signal conductors and low voltage conductors shall not be installed in high voltage light standards.

D. The conduit sizes to be used shall be as indicated in the Contract Documents.

1. Conduit sizes shall be 1-1/4 inches minimum nominal diameter for street light conduit, and 2 inches or larger minimum nominal diameter for all other conduit, unless the proposed raceway is attaching to an existing raceway that is smaller or as directed by the Engineer.

2. The size of the existing conduit shall always be matched when connecting conduit to an existing raceway.

3. Conduit reducers shall not be installed.

E. The Contractor may, at no additional cost to the Contracting Agency and with Engineer approval, use larger size conduit, and where used, it shall be for the entire length of the run from outlet to outlet with no reducing couplings permitted.

F. PVC coated rigid steel conduit shall consist of galvanized rigid steel conduit conforming to applicable federal specifications and Underwriters Laboratories.

1. The exterior surface of the conduit shall be acid-treated to provide an acceptable surface for plastic coating with a heat polymerizing lacquer with a thickness not to exceed 0.0005-inch thick.

2. A polyvinyl chloride compound shall then be bonded to the prepared conduit with a thickness not less than 0.035 inch for the full length of the conduit except the threads.

3. The bond between the metal and the plastic shall be equal to or greater than the tensile strength of the plastic coating.

4. In addition, the PVC compound shall have the following physical characteristics:

a. Hardness: 85+ Shore A Durometer

b. Dielectric Strength: 400 (Volts/mil @ 60 cycles)

c. Tensile Strength: 3,500 psi

G. All 90-degree elbows and all other conduit bends of 45 degrees or more installed as part of electrical raceways exceeding 300 feet in length and that are to be used as traffic signal or traffic signal interconnect components shall be PVC coated rigid steel, unless otherwise specified in the Contract Documents or directed by the Engineer. The minimum radius for 90-degree elbows (or equivalent combination of smaller bends) for traffic signal cables shall be 18 inches.

H. Bell end fittings shall be provided on PVC extensions to rigid steel conduit bends installed in traffic signal cabinets.

I. End caps with "J" hooks in place to secure the bonding ground wire shall be installed on all spare conduits as directed and to the satisfaction of the Engineer.

1. All traffic signal and street lighting conduits shall have at least one Green No. 8 AWG wire installed, as tracer wire.

2. ITS conduit shall have a 6-pair, REA Specification PE-39, No. 22 AWG Twisted Wire Pair cable installed, in lieu of the Green No. 8 AWG Bond Grounding conductor.

623 G.02.02 PULL BOXES

A. Pull boxes shall be precast reinforced concrete or composite boxes of the sizes and details shown on the Drawings and Standard Drawings.

1. Reinforcement shall have an H-20 rating.

2. Sides and/or ends of pull boxes shall not be tapered for additional strength.

3. Pull box dimensions shall be constant for the full depth of the pull box.

B. Steel, cast iron, or non-conductive lids shall be used as specified in the Contract Documents or directed by the Engineer.

1. Concrete pull box covers are not allowed.

2. Pull box covers shall be inscribed "TRAFFIC SIGNAL," "STREET LIGHTING," or "FIBER OPTIC" as appropriate, unless otherwise specified in the Contract Documents or directed by the Engineer.

3. Pull boxes intended for voltages over 600 volts shall be inscribed "HIGH VOLTAGE."

4. Pull box covers inscribed "ELECTRICAL" shall not be permitted.

5. Pull boxes for installation in bridges and bridge parapets shall conform to the dimensions and locations shown on the Drawings.

6. Boxes or vaults formed in concrete shall have metal frames and covers.

C. The dimensions of all pull boxes and covers shall be manufactured and delivered as shown in the Uniform Standard Drawings within a tolerance of 1/8 inch.

D. All ITS communication facilities shall be installed in accordance with Sections 680, "Fiber Optic Cable," and 681, "Fiber Optic Splice and Distribution Equipment."

E. Enclosures for termination of traffic signal electrical raceways that cross under all roadways shall be a bottomless 24-inch deep P-30 with a nonconductive lid, or a double stacked No. 7 pull box with grounded steel covers with the legend "TRAFFIC SIGNAL," as specified in the Contract Documents or as directed by the Engineer.

F. All metal parts shall have provisions for attaching a grounding conductor.

G. All metal pull box lids shall be connected to the bonding ground using bare 7-strand No. 4 AWG copper conductor.

1. The grounding conductor shall be welded to the underside of the metal pull box cover by the Contractor or manufacturer using an exothermal welding process unless otherwise specified in the Contract Documents.

2. The grounding conductor shall have a length of 24 inches above the surrounding grade line.

H. Existing soils may be used for pull box bedding, unless otherwise specified in the Contract Documents or directed by the Engineer.

I. Pull boxes installed in undeveloped areas shall have a minimum of an 8-inch concrete collar installed at the top of the pull box, at the final grade, as noted in the Uniform Standard Drawings.

J. Conduit ends shall be sealed with fittings, caps, or conduit sealant to prevent conduits from being filled with sand and gravel. Conduit ends, fittings, and duct seal to be used shall be reviewed and approved by the Engineer prior to installation.

K. The Contractor shall not modify pull boxes.

623 G.02.03 EXPANSION FITTINGS

A. Expansion fittings shall be installed where the conduit crosses an expansion joint in a structure.

B. Each expansion fitting shall be provided with a bonding jumper of No. 6 AWG copper wire, or equal, if the expansion fittings are attached to metal conduits that are grounded.

C. Expansion fittings to be used where the conduits exit a structure or bridge abutment shall be reviewed and approved by the Engineer prior to installation.

623 G.02.04 CONDUCTORS AND CABLE

A. Conductors and cable shall conform to the following specifications:

1. Copper wire shall conform to the applicable portions of ASTM D2220, ASTM B3, and ASTM B8.

2. Insulation for multiple circuit lighting conductors shall be rated at 600 volts, 194 degrees F minimum. Lighting conductors shall be 7-strand No. 4 AWG copper wire with THW-2 or XHHW-2 insulation, unless otherwise shown in the Drawings or indicated herein.

3. Conductors for series lighting shall be No. 6 AWG or No. 8 AWG stranded copper wire insulated with 10/64-inch FAA approved polyethylene compound and rated at 5,000 volts for underground circuits. Conductors for overhead series lighting shall be No. 6 AWG or No. 8 AWG solid, hard-drawn copper.

4. Electrical cable for traffic signals shall be IMSA 20-1 approved signal cable of proper size for the required installation unless otherwise specified in the Contract Documents. All traffic signal cable shall be 25-conductor, No. 12 AWG stranded or No. 14 AWG solid copper wire traffic signal cable as specified in the Contract Documents or directed by the Engineer.

5. All traffic signal field cables and conductors entering the traffic controller cabinet shall be permanently labeled in the cabinet with their purpose or function and which pole is being serviced.

   a. The wires shall be identified using 1-inch wide UV resistant marking tape and a black marker recommended by the tape manufacturer.

   b. The tape shall be secured in place using a clear heat-shrink tubing that extends 1 inch past the marking tape along the cable to prevent moisture and dirt penetration.

6. Interconnect cable shall be 6-pair, 22 AWG filled telephone cable in accordance with REA Specification PE-39, current edition, unless otherwise specified in the Contract Documents or directed by the Engineer.

   a. Splices in the interconnect cable are prohibited.

   b. The cable shall be terminated only in the traffic signal controller cabinet or separate interconnect pull box unless otherwise approved and directed by the Engineer.

   c. Intersection street light conductors shall be wired in accordance with the Contract Documents or directed by the Engineer.

7. Insulation for service feeds between the transformer and the service pedestal or pole shall be rated at 600 volts, 194 degrees F minimum.

   a. Conductors shall be a minimum stranded No. 3/0 AWG copper wire with THW-2 or XHHW-2 insulation, unless otherwise specified in the Contract Documents or directed by the Engineer.

   b. Copper wire shall conform to the applicable portions of ASTM D2220, ASTM B3, and ASTM B8.

8. Loop lead-in cable shall be IMSA 50-2, 12 AWG stranded tinned copper in accordance with ASTM B33.

   a. The insulation shall be high molecular weight polyethylene in accordance with ASTM D1248.

   b. One conductor shall have black insulation and the other shall have clear insulation.

   c. The shield shall be helically applied with stranded, tinned copper drain wire.

   d. The overall jacket shall be polyethylene with a 600-volt, 140 degrees F rating.

   e. The wires shall be twisted a minimum of once every foot of length in accordance with IMSA 50-2.

9. Loop wire other than preformed loops for installation in saw cuts shall meet IMSA 51-5.

   a. Loop wire shall be single conductor No. 14 AWG, copper wire with 19 strands.

   b. The insulation shall be 15 mils of black PVC complying with UL 62 with an overall jacket of clear nylon in accordance with ASTM D4066.

   c. The wire shall be rated for 600 volts and have a nominal OD of 0.25 inch.

   d. The cable-in-duct system shall meet the performance tests as specified in NEMA standards.

623 G.02.05 SERIES STREET LIGHTING

A. Overhead wire shall be No. 6 AWG Medium Hard Drawn (MHD) solid bare copper continuous from standard to standard with no splices.

B. Double wire circuits shall have pressed steel conductor arms at 45 degrees from the pole and 180 degrees from the direction of service.

C. Where overhead lines change direction, up to 45 degrees, the lines shall be bisected by rotating feeder arms; for angles of change greater than 45 degrees, an additional set of feeder arms shall be provided to maintain proper wire separation.

D. Underground series wires shall be No. 6 AWG stranded copper with 10/64-inch FAA approved polyethylene compound rated for 5,000 volts.

623 G.02.06 COLOR CODING

A. For traffic signals and signs, insulation shall be of solid color, or of basic colors with a permanent colored stripe, to identify conductors as detailed below, unless otherwise specified.

CONDUCTORS COLORS AND SEQUENCE
I.M.S.A. SPECIFICATIONS 19-2 OR 19-1

Conductor	Base Color	First Tracer
1	Black	
2	White	
3	Red	
4	Green	
5	Orange	
6	Blue	
7	White	Black
8	Red	Black
9	Green	Black
10	Orange	Black
11	Blue	Black
12	Black	White
13	Red	White
14	Green	White
15	Blue	White
16	Black	Red
17	White	Red
18	Orange	Red
19	Blue	Red
20	Red	Green
21	Orange	Green
22	Black	
23	White	
24	Red	
25	Green	

623 G.02.07 ELECTRICAL SERVICE PEDESTALS

A. Electrical service pedestals to be installed for traffic signals or street lighting systems shall be 120/240-volt, 200-amp, 3-wire, single phase with a 4-jaw meter socket, unless otherwise specified in the Contract Documents.

B. The main breaker shall be rated for 200 amps, unless otherwise specified in the Contract Documents, or as directed by the Engineer.

C. The main enclosure of the pedestal shall be a rainproof NEMA Type 3R cabinet with construction complying with UL 50 requirements.

D. The main body of the pedestal shall be fabricated of 12 gauge metal, corrosion resistant, zinc plated steel with a vandal resistant main door to provide interior access to the breaker compartment and vandal-resistant hood door for access to the meter.

1. A dead-front door shall be provided behind the main door to enclose the internal wiring compartment.

2. Both the main and dead-front doors shall be connected to the main body or frame of the service pedestal by use of stainless steel piano hinges.

3. A twisting lock mechanism shall be provided to secure the dead-front door to the main frame.

4. The hood door protecting the service meter shall be hinged to the main body of the pedestal with a stainless steel piano hinge and include an exterior handle to assist in lifting the hood.

5. The hood door and both hinged doors shall be constructed from 14 gauge, corrosion resistant, galvanized steel.

6. A padlock hasp shall be provided for securing the hood door and the main door.

E. The overall dimensions of the enclosure shall be 16-1/2 inches wide, 48 inches high, and 17-1/2 inches deep.

F. A removable utility door shall be provided in the back of the pedestal to allow service to the utility landing lugs. A padlock hasp shall be provided to lock the door in place.

G. The overall exterior dimensions of the service pedestal shall be 48 inches tall, 16 inches wide, and 18 inches deep.

1. The dimensions of the pedestal shall be within a tolerance of 15 percent.

2. The anchor bolt pattern shall be 14-1/2 inches wide and 12-1/2 inches deep with a 1/2-inch tolerance.

H. A photocell window shall be provided on the side of the main section of the service pedestal with a clear plastic window material. A protective cover or louvered vents shall be provided for the photocell window to protect the window from vandalism yet allow the PEC to function properly.

I. All fasteners including rivets, screws, nuts, and bolts shall be stainless steel.

1. Pedestal anchor bolts shall be hot dip galvanized 3/8 inch by 18 inches by 2 inches with corrosion resistant washers and nuts.

2. Anchor bolts shall be interior to the main body of the pedestal.

J. The main body of the pedestal, the hood, and the main door shall be as specified in the Contract Documents or as directed by the Engineer.

1. The dead-front door shall be polyurethane powder coated inside and out with a gloss white coating.

2. All finishes shall consist of Federal specification 595 polyurethane, industrial grade powder paint with 1.7-mil thickness minimum.

K. The internal wiring shall be completed with copper conductors rated for 194 degrees F, THW-2 or XHHW-2 insulation, and rated for 600 volts. The wire shall be sized in

accordance with the *National Electrical Code* and Underwriters Laboratories, Inc., except that wire to the street light contactors shall be No. 4 AWG stranded copper with THW-2 or XHHW-2 insulation and wired at the factory.

L. The pedestals shall be assembled by a manufacturer recognized and endorsed by Underwriters Laboratories, Inc. and shall be marked with the UL stamp of approval on the inside of the main door.

M. The pedestals shall incorporate a copper main load center, which may be raw copper or tinned.

1. Bus bars for grounding and neutral connections shall be raw copper or aluminum, with facilities for landing a minimum of two No. 1/0 AWG conductors, six No. 2 AWG to No. 12 AWG conductors, and twelve No. 4 AWG to No. 14 AWG conductors.

N. The pedestal shall be designed to accept GE type THQL or equivalent breakers and shall be equipped as specified in the Contract Documents or directed by the Engineer.

O. The pedestal shall incorporate a single photocell for controlling both 2-pole, 60-amp lighting circuits.

1. Each lighting circuit shall have a separate test toggle switch (or toggle switch position) rated for 15 amps with sealed leads for testing the circuit during maintenance activities.

2. The test switch shall be affixed to the frame of the pedestal and extend through the dead-front door to be accessible by opening only the main door.

3. The photocell shall be Area Research Lighting model SST-VP-IES, or approved equal.

P. The utility landing lugs shall be raw copper, aluminum, or zinc coated, as specified in the Contract Documents or directed by the Engineer, and shall be capable of receiving the appropriate sized wire from the transformer as noted on the Drawings.

Q. When specified, double meter service pedestals shall conform to all requirements of the standard pedestals for each side of the metered section. The overall dimensions of the enclosure shall be 24 inches wide, 48 inches high, and 17 inches deep.

R. Appropriate labels shall be attached to the inside of the main door including a listing of circuit breakers from various manufacturers that are interchangeable with those supplied in the cabinet. A circuit diagram shall be attached to the front door.

S. An instruction manual shall be provided with the service pedestal.

1. The manual shall include installation and maintenance instructions and shall contain a wiring diagram of the pedestal and a listing of available circuit breakers to be used in the pedestal.

2. A holding compartment shall be provided on the inside of the door to contain the manual and other plans.

3. A resealable plastic storage bag to hold the manual safe from the environment shall be provided.

CONSTRUCTION

623 G.03.01 MAINTENANCE OF EXISTING AND TEMPORARY ELECTRICAL SYSTEMS

A. Existing electrical systems including but not limited to traffic signals, ramp metering, highway and street lighting, flashing beacons, school flashers, ITS communications facilities, 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, unless prior written authorization is provided by the Engineer to allow for alterations or final removal of the systems.

1. Traffic signal shutdown shall be as directed by Engineer and in the presence of the Maintaining Agency representative.
2. Lighting system shutdowns shall not interfere with the regular lighting schedule, unless prior authorization is provided by the Engineer.
3. The Contractor shall request permission from the Engineer and notify the Maintaining Agency in writing 5 normal working days, excluding legal holidays, prior to performing any work on existing electrical systems, including traffic signals and street light systems.
4. Contractors shall not access traffic signal control cabinets without obtaining permission from the Maintaining Agency.

B. The Contractor shall submit three 24-hour telephone numbers of responsible Contractor personnel to be contacted in the event there are conflicts while the electrical system is being modified.

C. The Contractor shall repair or replace any damages caused by Contractor's construction activities to the existing electrical systems and to other public owned facilities in the area, at the direction of the Engineer.

1. These damaged facilities shall be repaired promptly and at the expense of the Contractor in accordance with the Contract Documents, and as directed by the Engineer.
2. Should the Contractor fail to perform the required repairs or replacements, the cost of performing such repairs or replacements will be deducted from any monies due or to become due the Contractor or related performance bond.
3. The cost of repairs may include reimbursement of Contracting and Maintaining Agency personnel wages and materials and/or the cost of other contractors hired by the Contracting Agency to repair the damages caused by the Contractor.

D. The exact location of existing conduits and pull boxes shall be ascertained by the Contractor before using equipment that may damage such facilities or interfere with any system.

E. 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.

F. Temporary electrical installations shall be kept in effective operation until the temporary installations are no longer required for the traveling public.

G. These provisions will not relieve the Contractor in any manner of Contractor's responsibilities as provided in Subsections 107.11, "Responsibility for Damage Claims," and 107.16, "Contractor's Responsibility for the Work and Materials."

H. A temporary overhead cable system may be used for the existing signal system circuitry in lieu of maintaining the underground installations during construction, if authorized in writing by the Engineer.

I. Where an existing system is being modified, work not shown on the Drawings or specified in the Special Provisions and which is determined by the Engineer as extra work

necessary to keep all or any part of the existing system in effective operation and safe to the public and maintenance personnel shall be measured and paid for in accordance with Subsection 109.03, "Extra and Force Account Work."

623 G.03.02 MAINTAINING EXISTING INTELLIGENT TRANSPORTATION SYSTEM (ITS) FACILITIES

A. ITS communications facilities including, but not limited to, copper wire, fiber optic, microwave, radio systems and the electrical services supplying power to same shall be maintained at all times.

1. Any damage to the ITS system of communication cable is considered to be an emergency and liquidated damages of $2,500 per day for copper cable and $7,500 per day for fiber optic breaks shall be assessed to the Contractor by the Contracting Agency beginning 24 hours after the conduit or cable damage.

2. The outer jacket of cable insulation shall remain intact without nicks or scrapes or other damage that may compromise the insulating qualities to avoid replacement of the entire interconnect cable.

B. A conduit break may be considered the same as a cable break.

1. Conduit breaks shall be repaired by first removing the entire length of interconnect cable before repairing the conduit as directed by the Engineer.

2. The interconnect conduit may then be replaced in the electrical raceway after proven to be undamaged by testing as specified herein for new line installations.

C. The exact location of existing ITS communications system conduits and pull boxes shall be determined by the Contractor before using any equipment that may damage ITS facilities or interfere with Contracting Agency, Maintaining Agency, or FAST operations. Any damage to any ITS communications cable is considered by the Contracting Agency to constitute an emergency.

D. Where damage to ITS facilities is caused by the Contractor's operations, the Contractor shall, at no additional cost to the Contracting Agency, begin temporary repairs immediately after the damage occurs and shall proceed with repairs expeditiously until complete.

1. All fiber optic repairs shall be performed in accordance with Sections 680, "Fiber Optic Cable," and 681, "Fiber Optic Splice and Distribution Equipment."

2. Damaged ITS communications infrastructure shall be repaired by the Contractor within 24 hours of discovery.

3. If the Contracting Agency or the Regional Transportation Commission of Southern Nevada (RTC) determines that the need for repairs are critical, the Contracting Agency or the RTC may begin the work of repairing any damage to the ITS communications facilities within the 24 hours of discovery. The Contracting Agency or the RTC may seek direct reimbursement from the Contractor causing the damage to recover the costs in repairing the damaged ITS communications infrastructure.

E. Should the Contractor fail to perform the required repairs or replacements to ITS communications infrastructure within the 24-hour period, the Contracting Agency or the RTC may elect to repair the damage using any means possible and the cost of performing such repairs or replacements will be deducted from any monies due or to become due the Contractor, including performance bonds. The Contracting Agency or the RTC may seek

direct reimbursement from the Contractor to recover the costs in repairing the damaged ITS infrastructure.

F. No splices shall be permitted, unless otherwise permitted in writing by the Engineer in consultation with the FAST Director or designee.

G. The No. 22 AWG copper interconnect cable shall meet the FAST Specification with a DC resistance of 17.4 ohms/1,000 feet at 68 degrees F. Any cable exhibiting a DC resistance in excess of 18.3 ohms/1,000 feet at 68 degrees F in more than 1 pair of conductors shall be deemed to be damaged when tested and shall be replaced.

H. Temporary repairs of damage to an extended length of ITS cable or damage at more than a single discrete point may consist of placing cable overhead until permanent replacement is completed.

1. The Contractor shall provide temporary overhead interconnect if necessary while the permanent cable is being relocated or replaced.

2. All temporary aerial installations shall be approved by the Maintaining Agency and FAST and shall be installed as directed by the Engineer.

I. Permanent restoration of a damaged ITS copper wire interconnect shall be made by removing the damaged cable and replacing with a new cable conforming to REA Specification PE-39, 22 AWG, between the nearest existing terminal boards housed in traffic signal controller cabinets, junction cabinets, or an engineering office at each end of the damaged cable run as determined by the Engineer. The new cable shall be tested after installation for acceptable conductance and continuity to ensure no insulation damage occurred during the installation process.

J. All damaged ITS cable removed from the system under any of the restoration methods shall be removed from the conduit in continuous lengths, wound on a reel, and returned to the Maintaining Agency.

K. All cable repairs or restoration to ITS facilities shall be made under inspection by FAST or personnel from the Maintaining Agency in whose jurisdiction the repair is being made.

L. All materials, equipment, and workmanship incorporated into any cable repair or restoration of ITS facilities shall be guaranteed for a period of 1 year after the final acceptance of the work or equipment.

1. If during the guarantee period any defects or faulty materials are found, the Contractor shall immediately, upon notification by the Engineer, proceed at Contractor's own expense to replace and repair the defective materials and faults.

2. The Contractor shall also be responsible for complete repair to damage of all finishes, fixtures, equipment, and furnishings that may be damaged as a result of this defective equipment and/or workmanship including but not limited to removal and replacement of sidewalks, curb and gutter, and roadway pavement.

623 G.03.03 SCHEDULING OF WORK

A. 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.

B. Traffic signals shall not be placed in operation until all discrepancies are corrected, all appropriate roadway pavement markings and signs are in place, and the roadways to be controlled are open to public traffic, unless otherwise directed by the Engineer.

C. Roadway lighting and traffic signals shall not be placed in operation, including flashing operation, prior to delivery of a full set of redlined drawings to and the successful completion of required tests performed in the presence of the Maintaining Agency's authorized representative. This does not preclude the preparation and submittal of as-built Drawings.

D. Any fault in any material or in any part of the installation revealed by these tests shall be replaced or repaired by the Contractor or vendor immediately.

1. Electrical equipment and components shall not be energized until properly grounded as shown in the Contract Documents or directed by the Engineer.

2. All repairs and material replacements shall be completed as directed by the Engineer.

E. Conductors shall not be pulled into conduit until pull boxes are set to grade, conduit trenches backfilled and compacted, crushed rock sumps installed, and metallic conduits properly grounded.

F. Under-Deck Lighting and Lighting for Pedestrian Structures:

1. Under-deck lighting for vehicular under-crossings shall be placed in operation as soon as practicable after false work has been removed from the structure.

2. Lighting for pedestrian structures shall be placed in operation prior to opening the structure to pedestrian traffic.

3. If the Engineer orders under-deck lighting or lighting for pedestrian structures placed in operation before permanent electrical service is available, the cost of installing and removing temporary electrical service will be paid for as extra work as provided in Subsection 104.03, "Extra Work."

G. Traffic and pedestrian signals that have been installed and have not yet been energized shall be covered with durable, reusable bright orange traffic and pedestrian head covers, unless otherwise specified in the Contract Documents or directed by the Engineer.

1. Plastic bags shall at no time be used to cover traffic or pedestrian heads.

2. At no time shall traffic and/or pedestrian signals that have been installed and are not in operation remain uncovered.

3. Emergency signals that have not been energized shall also be covered.

4. The color of the signal section shall be visible when energized for testing.

5. Covers shall be mechanically fastened; however, Velcro is not acceptable.

6. The temporary coverings remain the property of the Contractor until the signal is energized and accepted by the Maintaining Agency, at which time the coverings become the property of the Maintaining Agency.

7. The Contractor shall maintain the coverings in proper condition at all times until final acceptance.

8. Coverings that are ripped, torn, shredded, or otherwise allowing any portion of the signal lens to be seen by the public shall be immediately replaced.

9. Coverings that are not replaced immediately shall be replaced by the Contracting Agency and the cost of the covering replacement shall be deducted from any unpaid invoices that have been or will be submitted to the Contracting Agency by the Contractor.

623 G.03.04 HIGH VOLTAGE SAFETY PRECAUTIONS

A. Before starting work on existing series street lighting circuits, the Contractor shall obtain a daily safety circuit clearance from the Maintaining Agency.

B. The electrical bypass control shall be switched to the "off" position, fuses shall be removed, and signs posted at the switch box before any work is done.

C. The Occupational Safety and Health Administration (OSHA) procedure for "lock-out, tag-out" shall be followed in strict compliance for all series street lighting circuits.

623 G.03.05 EXCAVATING AND BACKFILLING

A. Excavations required for the installation of conduit, foundations, and other facilities shall be performed in a manner to cause the least possible damage to the streets, sidewalks, and other improvements, including private property.

1. Excavations shall not be larger than necessary for the proper installation of conduit, electrical facilities, and foundations.

2. Excavating shall not be performed until immediately before installation of conduit, facilities, and foundations.

B. Excavations shall not remain open overnight except as approved by the Engineer and only when adequate protection for the public, including pedestrians, is provided.

C. The material from the excavation shall be placed in a position where the least disruption and obstruction to vehicular and pedestrian traffic will be realized and the least interference with surface drainage will occur.

D. Surplus excavated material shall be removed and disposed of by the Contractor outside of the right-of-way.

E. At the end of each day's work, and at other times when construction operations are suspended, equipment and other obstructions shall be removed from the right-of-way.

F. Structural excavation and backfill shall conform to the requirements of Sections 206, "Structure Excavation," and 207, "Structure Backfill."

G. Trench excavations shall be backfilled in conformance with the requirements of Section 208, "Trench Excavation and Backfill."

H. Backfilled excavations shall be kept well filled and maintained in a smooth and well-drained condition, until permanent resurfacing is completed as specified in Subsection 208.03.21, "Cutting and Restoring Street Surfacing."

I. Unless otherwise specified in the Contract Documents, excavation in the street and highway shall be performed in such a manner that not more than 1 lane of traffic is restricted in either direction at any time, or as approved by the Engineer.

J. All streets upon or within which any work is being done shall be kept open to all traffic by the Contractor, as specified in Subsection 104.04, "Maintenance of Traffic," unless otherwise provided in the Special Provisions, or as approved by the Engineer.

K. Surface and underground materials, irrigation systems, utilities, and other constructions shall be restored in kind to or exceeding the original conditions by the Contractor as part of the excavation and backfilling operations.

L. Barricading shall conform to the latest editions of the Traffic Control Plans for Highway Work Zones for the Clark County Area and the *Manual on Uniform Traffic Control Devices*.

623 G.03.06 REMOVING AND REPLACING IMPROVEMENTS

A. Improvements, such as sidewalks, curbs, gutters, Portland cement concrete and asphalt concrete pavement, bituminous surfacing, base material, and other improvements removed, broken, or damaged by the Contractor, shall be replaced or reconstructed in compliance with the applicable sections of these specifications.

B. Whenever a part of a square or slab of existing concrete sidewalk or driveway is broken or damaged, it shall be repaired in accordance with Subsection 202.03.02, "Removal."

C. The outline of all areas to be removed in Portland cement concrete sidewalks and in pavements shall be cut to a minimum depth of 1-1/2 inches with an abrasive type saw prior to removing the sidewalk and pavement material.

1. Cut for the remainder of the required depth may be made by any method satisfactory to the Engineer.

2. Cuts shall be neat and true with no shatter outside the removal area.

623 G.03.07 FOUNDATIONS

A. Foundations for traffic signal and lighting poles, traffic signal cabinets, and service pedestals shall be concrete conforming to Section 501, "Portland Cement Concrete."

B. For posts, poles, and pedestals, a 4-inch minimum foundation cap or crash cap consisting of grout or concrete as specified in the Contract Documents or directed by the Engineer shall be poured after the post, pole, or pedestal is in proper position.

1. Grout shall not contain coarse aggregate and shall conform to Subsection 501.03.12, "Mortar."

2. Grouting material to be used for the crash cap may be mixed by the Contractor on-site as directed by the Engineer.

C. The bottom of concrete foundations shall rest on firm, undisturbed ground.

1. In addition, for traffic signal foundation installations, the bottom 2/3 of the concrete foundation shall be poured against undisturbed soil.

2. If the signal foundation is to be placed in an area which has been filled, the fill shall be compacted to 95 percent of the original compaction as specified elsewhere in these specifications and the bottom 2/3 of the foundation shall be poured in drilled 95 percent compacted fill.

3. Forms shall be true to line and grade.

4. Tops of footings for posts and poles, except special foundations, shall be finished 1 inch above grade of curb or sidewalk or as directed by the Engineer.

5. The exposed portions of the foundations shall be formed to present a neat appearance.

D. Forms shall be rigid and securely braced in place.

1. Conduit ends and anchor bolts shall be held in place by means of a template until the concrete sets.

2. Both forms and soil which will be in contact with the concrete shall be thoroughly moistened before placing concrete.

3. Forms shall not be removed until the concrete has thoroughly set.

E. Standard surface finish shall be applied to exposed surfaces of concrete. All top surface areas of traffic signal cabinet bases and service pedestals shall be smoothed finished with a trowel.

F. Where the edge of a concrete foundation extends within 18 inches of any existing concrete improvement, a slab with a minimum thickness of 4 inches shall be extended to meet the existing improvement.

G. Traffic signal cabinets shall have a 4-inch thick concrete slab installed in front of the cabinet.

1. The concrete slab shall be as wide as the signal cabinet foundation and a minimum of 4 feet in length from the cabinet base.

2. The cost of this concrete slab shall be incidental to the cost of the foundation.

H. Electrical service pedestals installed in remote locations where sidewalk does not exist shall also have a concrete slab.

1. The concrete pad shall be a minimum of 2 feet on each side of the pedestal foundation and 4 feet in front of the electrical service pedestal.

2. The concrete slab shall be 4 inches thick.

3. The cost of the concrete pad shall be incidental to the cost of the pedestal foundation.

I. Concrete for Type XX poles, XX-A poles, and XX-B poles shall set for a minimum of 10 days unless otherwise approved by the Engineer. Concrete for smaller bases shall set for a minimum time of 72 hours.

J. Concrete foundations shall be installed in accordance with all pertinent sections of these specifications and the Uniform Standard Drawings. Minimum concrete curing times before live loads can be set on the foundation shall be as specified therein and as directed by the Engineer.

K. Traffic signal and luminaire arms shall be considered live load and may be mounted on the poles only after the concrete foundations have set for the minimum curing times as prescribed in Sections 501, "Portland Cement Concrete," and 502, "Concrete Structures."

623 G.03.08 WIRING AND CONDUIT

A. Wiring shall conform to appropriate articles of the latest version of the *National Electrical Code* (NEC).

1. Wiring within cabinets, junction boxes, and so forth shall be neatly arranged.

2. Powdered soapstone, talc, or other approved lubricant shall be used when installing conductors in conduit.

3. Any excess lubricant shall be removed as directed by the Engineer.

4. All conduits shall be PVC unless otherwise specified in the Contract Documents.

B. Each conductor shall have a minimum of 18 inches of slack coiled within each standard and at least 2 feet of slack coiled in each pull box. The length of slack shall be that amount of extra conductor that is available to be pulled completely out of the pole shaft or pull box.

C. Series lighting cable shall be installed without splices from luminaire to luminaire and from service to luminaire unless otherwise specified.

1. Multiple lighting conductors may be spliced in the base of standards or in pull boxes adjacent thereto.

2. Signal cable shall run from terminal to terminal without splices unless otherwise indicated on the Drawings.

D. Splices for street light cables shall be split bolt or "gel-cap" type unless otherwise specified in the Contract Documents or directed by the Engineer.

1. The gel-cap type shall consist of a kit containing a high abrasive and impact resistant clear elastomer cap factory-filled with cross-linked silicon gel for environmental sealing.

2. The silicon gel shall not become hard or brittle and shall have a temperature tolerance of -40 degrees F to +221 degrees F.

3. The cap, clamp, and gel used for the gel-type splice kit shall be UV-resistant.

4. Kits shall contain a split bolt connector and shall accommodate range of cable sizes specified in the Contract Documents or directed by the Engineer.

5. Gel-cap-type connection shall also permit removal and re-entry of wiring for maintenance purposes without damage to the splice kit.

E. Conductor connector types to be used shall be approved by the Engineer prior to installation.

F. When conductors and cables are pulled into the conduit, all ends of the conductors and cables shall be taped to exclude moisture. Ends of spare conductors shall be taped.

G. All new traffic signal and street lighting conduit for future use shall have a 8 AWG stranded copper conductor with green THW-2 or XHHW-2 insulation which is secured at both ends by a conduit cap with a J-hook.

1. A yellow polyethylene pull string shall also be installed in the conduits for future use.

2. The 8 AWG green conductor shall remain in the conduit at all times for locating and grounding purposes.

3. All splices shall be performed using waterproof methods.

H. The outer jacket of insulation for all multi-conductor traffic signal cable shall be removed from the cable that is interior to the signal poles beginning at the base handhole, unless otherwise directed by the Engineer.

1. The Contractor shall ensure that the proper length of each color of wire is available to route to the appropriate terminal.

2. Splices and/or wire jumpers between adapter terminals shall not be permitted.

3. Wiring shall be installed as specified in the Contract Documents or directed by the Engineer.

I. The Contractor shall always install wire between the pole-mounted "J" box and all spare traffic signal tenons on traffic signal mast arms.

1. These conductors shall be 14 AWG UF wire, and shall be uniquely identified in the J-box.

2. A minimum of 6 conductors shall be installed for the 2 end spare tenons and 4 conductors for tenons elsewhere on traffic signal mast arms.

3. All unused tenons shall be sealed with 10 mil tape.

J. Conductors shall run from terminal to terminal without splices unless otherwise indicated in the Contract Documents or directed by the Engineer.

1. The ends of all conduits shall be well reamed to remove burrs and rough edges.
2. Field conduit cuts shall be made square and true so that the ends will butt or come together for the full circumference in the couplings or adapters.
3. Slip joints or running threads shall not be permitted for coupling metal conduit.

K. Couplings for steel conduit shall be tightened until the ends of the conduits are brought together, so that a good electrical connection will be made throughout the entire length of the conduit run.

L. Conduit ends shall be threaded and capped with standard pipe caps until wiring is installed. Approved conduit bushings shall be installed when the caps are removed.

M. Manual or power-operated equipment normally used for cutting rigid steel conduit is acceptable for use in cutting PVC coated rigid steel conduit.

1. PVC shall not be peeled back before cutting and all cuts shall be reamed.
2. Threading shall be the same as for non-coated rigid conduit.
3. All scarred and grip marked areas shall be touched up with approved heavy consistency coating compound approved by the Engineer.

N. All couplings and threaded fittings for PVC coated rigid steel shall be hand tightened prior to using a wrench.

1. All wrench marks and scores shall be recoated and joints shall be sealed with heavy consistency PVC compound.
2. The Contractor shall ensure that the final installation does not have exposed metal areas.

O. Standard field bending techniques shall be used which typically use a shoe 1 size larger to accommodate the larger pipe diameter.

1. Rigid steel conduits shall be bent without crimping or flattening.
2. No single run shall include more than two 45-degree bends and two 90-degree bends without prior approval by the Engineer.

P. PVC coated rigid steel conduit, 2 inches in diameter or larger, shall be used for all bends, except for 90-degree bends at street light pole and service pedestal foundations where separation to the intended pull box, cabinet, service pedestal, or traffic signal pole is more than 50 feet. The radius of all 90-degree elbows for traffic signal and ITS conduits shall be a minimum of 24 inches.

Q. Conduit terminating in pedestals, cabinets, traffic signal poles, and lighting poles shall be a minimum of 2 inches in diameter, unless otherwise specified on the Drawings, and shall extend 2 to 3 inches above the foundation or crash cap, whichever is higher.

1. The conduits shall be straight.
2. Conduits shall not extend above the lower handhole rim or grounding connection, whichever is lowest.

R. Traffic signal and roadway lighting conduit shall enter concrete pull boxes from the bottom and shall terminate at least 2 inches inside the box wall and 4 to 6 inches above the bottom of the pull box.

1. There shall be at least 6 inches of clearance between the top of the conduits and the bottom of the pull box cover.

2. The conduits shall be installed to facilitate pulling of conductors.

3. Conduit entering the bottom of a pull box shall be located near the end walls to leave the major portion of the box clear.

4. At all outlets, conduit shall enter from the direction of the run.

5. ITS communications installations may allow entry in the side of the pull box or communications vault.

S. Conduits shall be lowered as necessary in the vicinity of poles, posts, pull boxes, electrical vaults, and other electrical enclosures for the conduits to facilitate entrance into the enclosure.

1. The Contractor shall not modify traffic signal/roadway lighting pull boxes, electrical vaults, signal or lighting poles or posts, cabinets, pedestals, or any other electrical device for the purpose of entering the device with the conduits without written approval of the Engineer.

2. ITS communications installations may be field modified only with the approval of and as directed by the Engineer.

3. All entry points shall be sealed and form fitted with grout or other acceptable material approved by the Engineer.

T. Existing underground conduit to be incorporated into a new system shall be cleaned by blowing out with compressed air, or by other methods required by the Engineer.

U. Conduit runs shown on the Drawings are for bidding purposes only and may be changed with the approval of the Engineer to avoid underground obstructions.

623 G.03.09 ELECTRICAL SERVICE

A. Electrical service points, when required for street lighting, traffic signals, and other electrical constructions in the road right-of-way, shall be as indicated on the Drawings.

B. Electrical service points for electrical systems, including but not limited to traffic signals, street lighting, school flashers, pedestrian crossing flashers, emergency signals, sign lighting, and high mast lighting, shall be coordinated with the power company by the Contractor and constructed where indicated on the Drawings.

1. Alternate service locations approved by the power company may be adopted as directed by the Engineer.

2. Traffic signal electrical services shall be as shown on the Drawings unless otherwise approved and directed by the Engineer.

3. Street lighting electrical services shall be as close to the center of the circuit or system as possible.

C. Pad-mount services, when called for, shall conform to the Uniform Standard Drawings as applicable.

D. The Contractor shall furnish and install conduit and conductors to the service point as shown on the Drawings or as required to complete the installation, but under no circumstances shall the conduit and conductor sizes be less than the minimum sizes shown in the Uniform Standard Drawings. A No. 5 pull box shall be installed directly in front of the service pedestal with conduit stubbed from the load side of the pedestal.

E. Electrical conductors for service shall have THW-2 or XHHW-2 insulation and shall be 3/0 AWG, stranded, copper wire unless otherwise specified in the Contract Documents or directed by the Engineer.

F. Electrical service shall be inspected, approved, and "tagged" by a representative of the Agency authorized to order electrical service.

1. The Contractor shall complete all utility connections, wiring, crash cap, grounding, and bonding within the service pedestal prior to calling for inspection.

2. The Contractor shall conform to the inspection process of the Agency authorized to order electrical service.

623 G.03.10 PULL BOXES

A. A minimum of 6 inches of clearance shall be maintained between the top of the conduits and the bottom of the pull box cover.

B. A minimum of 4 inches of conduit shall extend into the pull box.

C. Conduit caps shall be installed to help prevent the entry of foreign material into the electrical raceway.

D. Traffic signal and roadway lighting pull boxes shall not be modified by the Contractor.

1. Entry holes into pull boxes and electrical vaults shall be cut or "knock-outs" provided by the manufacturer as designated in the Drawings.

2. ITS communications pull boxes and vaults may be field modified only with the approval of and as directed by the Engineer.

3. All entry points shall be sealed and form fitted with grout or other acceptable material approved by the Engineer.

623 G.03.11 SIGNS ON TRAFFIC SIGNALS

A. All 24-inch by 30-inch or larger traffic signs mounted on traffic signal mast arms shall include a wind brace, unless otherwise specified in the Contract Documents or directed by the Engineer.

B. The wind brace shall be equal to a minimum of 1-inch wide by 3/16-inch thick aluminum sheeting material connected to the top and bottom of the sign and wrapped around the mast arm.

C. There shall be a wind brace installed every 12 inches on the sign panel.

623 G.03.12 ITS COMMUNICATIONS INFRASTRUCTURE

A. Communications infrastructure installed for the use of the FAST shall meet the following specifications:

1. The communications conduit shall run straight through the pull box, entering the side of the box near the bottom, to allow for a continuous fiber optic pull of no more than 6,000 feet.

2. The cover depth from the finish grade of all conduits shall be a minimum of 30 inches with allowances for conduit to rise near pull boxes for entry points. If conduit exists adjacent to the proposed conduit installation, the depth and location of the end of the new conduit shall be required to match the existing conduit.

3. The installation of a Type 200 Splice Vault as shown in the Uniform Standard Drawings with the letters "FIBER OPTIC" inscribed on the lid shall be as shown on the Drawings. At these splice point locations, a "sweep" with radius of 24 inches minimum shall be installed with the angle of entry/exit conducive to pulling fiber optic cable directly out the lid of the vault without the use of pulleys inside the vault.

4. Innerduct shall not be used unless specifically required in the Contract Documents. If innerduct is proposed, the specific use of each innerduct cavity shall be as identified in the Contract Documents or approved by the Engineer.

5. All buried conduits shall have underground marking tape placed 12 inches above the installed conduit and marked with the letters "FIBER OPTIC." GPS coordinates shall be determined for all new and relocated traffic signal system and street lighting facilities that are connected via the underground conduit system and are visible at ground level as specified in Subsection 623 G.01.05, "Global Positioning System (GPS) Coordinates."

6. For roadway projects where the sidewalk, curb, and gutter are already installed and communications facilities are required, the appropriate size conduit may be installed at the lip of gutter as shown on the drawings or as approved by the Engineer.

7. Installation of fiber optic cable shall conform to Section 680, "Fiber Optic Cable."

8. Conduit caps with J-hooks to support the interconnect cable shall be installed for all spare conduit openings to prevent the entrance of debris into the electrical raceway.

9. A 6-pair, 22 AWG interconnect cable, complying with REA Specification PE-39, current edition, interconnect cable shall be installed in all ITS conduit runs.

TRAFFIC SIGNAL SECTION

DESCRIPTION

623 T.01.01 GENERAL

A. Traffic signal construction shall consist of furnishing, installing, modifying, or removing traffic signals, school flashers, flashing beacons, changeable message signs, traffic count stations, conduits for future traffic signals, and other electrical installations in the roadway right-of-way as shown and specified in the Contract Documents.

B. The locations of traffic signal poles, controller cabinets, electrical services, and other associated equipment shown on the Drawings are approximate. The Engineer will confirm exact locations of these items in the field.

C. All materials furnished and used shall be manufactured, handled, and used in a manner to ensure completed work with undamaged equipment and materials in accordance with the Drawings, specifications, and Special Provisions. Engineer approval of all materials shall be required prior to installation.

D. All systems shall be complete and in satisfactory operating condition at the time of acceptance including successful completion of all testing required by these specifications.

E. All work performed on any traffic signal component shall be under the direct on-site supervision of an electrician or technician certified by IMSA for Level II Traffic Signals.

1. Actual trenching and foundation excavation activities are not considered construction labor involving traffic signal components until conduits or other electrical components are installed.

2. An electrician with IMSA Level II Traffic Signal certification shall supervise the installation of electrical raceways.

3. Traffic signals are defined as all electrical equipment constructed in public right-of-way or easements that are intended to provide control of traffic and shall include but not be limited to school flasher assemblies, advance warning beacons, traffic signal indications assigning right-of-way, school and other crosswalk signals, advance signal flashers, and intersection flashing beacons.

F. The Contractor is responsible for locating and protecting all underground and aerial utilities and constructions.

1. The exclusion of utilities and other structures on the Drawings or in the Special Provisions does not limit the Contractor's responsibility for these construction elements.

MATERIAL

623 T.02.01 TRAFFIC SIGNAL CONTROLLER CABINETS

A. The type of traffic signal controller cabinet to be furnished shall be a Type VIII cabinet, and shall conform to Drawing No. 404.307, sheet 1 of 1, in Volume II of the Uniform Standard Drawings.

1. This is commonly referred to as an "R" cabinet.

2. The cabinet shall be fabricated of sheet aluminum.

3. All external seams exposed to the outside shall be 100 percent welded (no gaps).

B. All cabinets shall be provided as a complete unit to include all shelves, foundations, anchor bolts with template, a standard number 2 traffic signal cabinet lock, interior cabinet lights, termination strips, cable harnesses, convenience outlets, circuit breakers, load switches, transfer relays, jumpers, completely wired back panel, video and loop detection interface panel and harnesses, loop detector amplifiers, and emergency vehicle detection equipment and interfaces, as a minimum.

C. Each cabinet shall be weatherproof, properly ventilated, and have at least two 110 CFM ventilation fans, with each fan having an independent thermostat.

D. The Contract Documents shall specify whether the cabinet finish is painted or polished aluminum.

1. If a painted finish is required, the cabinet finish shall consist of Federal Specification 595 polyurethane, industrial grade pure white powder paint with 1.7 mil thickness minimum or approved equal.

2. The cabinet shall be finished both inside and out.

E. Lifting tabs shall be provided on the center and top of both side panels to assist in the placement of the cabinet by overhead supports. The lifting tabs shall not be fillet welded permanently in place.

F. Cabinets shall be designed to use fully adjustable shelf-mounting rails of uni-strut design.

1. The rails shall be mounted on the interior of each side panel of the cabinet and shall use spring nuts in the rail channels to tighten the bolts that support the shelves.

2. Cabinets that use carriage bolt assemblies are not acceptable.

3. There shall be 3 shelves provided with all cabinets.

4. Each shelf shall be 12 inches deep and the full width of the cabinet.

5. The middle shelf of the cabinet shall have a 30-inch wide, pullout shelf mounted below for use as a laptop computer table.

6. The pullout shelf shall be manufactured of the same material and shall be the same depth as the supporting shelf.

7. The pullout computer shelf shall have a compartment for storing cabinet prints that is accessed by lifting the shelf top.

8. The compartment shall be the full depth of the pullout computer shelf and shall be a minimum of 1-1/2 inches and a maximum of 2 inches in height.

G. An emergency access shall be provided in the front of the door to allow police personnel to place the signal indications in the red flashing mode of operation. The police panel door shall be hinged to the main door using a stainless steel piano hinge and shall be keyed with a standard police key lock.

H. All cabinets shall have the door mounted with a stainless steel piano hinge welded or bolted to door and jamb.

1. There shall be a standard multi-point door stop to lock the door open at 45, 90, and 180 degrees and a supplemental, single-arm door stop to add stability to the door when locked open.

2. The 3-position doorstop shall be mounted at the bottom of the cabinet door and the single-arm door support shall be mounted at the top of the cabinet.

3. Each doorstop shall be fully retractable so as not to interfere with the door's closing and opening operation.

4. When specified, a rear access door shall be provided.

I. Anchor bolt holes in each cabinet shall conform to the anchor bolt pattern specified in Standard Drawing 404.213.

1. All cabinets shall be supplied with completely galvanized anchor bolts and foundation/ bolt template in accordance therewith.

2. Modification of the controller cabinet to fit alternate anchor bolt patterns shall not be allowed without prior approval by the Engineer.

J. Cabinets shall have 2 fluorescent light fixtures with lamps mounted in the cabinet interior.

1. One light shall be mounted over the door, at a location least likely to be damaged, and shall be a minimum of 20 inches in length.

2. The second fluorescent fixture shall be 15 watt and shall be attached to the bottom of the lowest shelf above the back-panel and field terminals.

3. Both fixtures shall be switched automatically by the door to illuminate the lights when the door is opened, and de-energize them when the door is closed.

K. The back panel in each cabinet shall be wired to the NEMA TS 2 Type 2 standard inputs and outputs.

1. Standard NEMA A, B, and C connectors shall be provided for connection to the controller.

2. The wiring harness for each connector shall provide a termination point onto the back panel for all pins of each connector, including spares or unassigned pins.

3. The terminals shall be clearly marked as to their associated function, with silk-screened letters and numbers on both sides of the back panel or other pre-approved method of marking.

L. All traffic signal controller cabinets shall comply with the following conditions:

1. All cabinet harnesses and wiring shall be neatly and firmly laced or bound together (with tie-rap or other pre-approved equivalent).

2. Every terminal shall be numbered and identified in accordance with the cabinet wiring diagrams and prints.

3. Cabinet wiring diagrams shall be supplied with the cabinet that show and identify the connectors for all equipment, and for all switches, terminal blocks, relays, flashers and signal control bases. Supply 2 complete sets of wiring diagrams on 36-inch by 24-inch size paper. A compact disc (CD) with the wiring diagram and cabinet schematic drawn in AutoCAD format shall also be supplied.

4. The cabinet wiring diagram shall have an intersection sketch with signal heads and push-buttons identified as related to phasing.

5. The following equipment shall be furnished and wired in all cabinets:

a. Three single-pole, surface-mount circuit breakers shall be installed in the controller cabinet to protect the different circuits indicated below.

1) The circuit breakers shall accommodate a No. 1/0 AWG, 7-strand, copper, 600-volt service conductor.

2) A supplemental terminal block may be installed if needed to accommodate the smaller terminal lug sizes.

a) One 20-amp circuit breaker to operate all the electronic equipment including the controller, conflict monitor, detection equipment, and preemption equipment and the upper utility plug.

b) One 15-amp circuit breaker for the fan, light, and lower utility plug.

c) One 40-amp circuit breaker to provide power to illuminate all the field indications at the intersection external from the cabinet.

b. There shall be a specific unfused, raw copper terminal, able to accept 1/0 AWG, 7-strand, copper 600-volt power conductor, for the neutral conductor of the power supply line. This terminal point shall be in the Buss 16204-3 terminal block, or approved equivalent, on the side panel of the cabinet.

c. There shall be a specific unfused, raw copper terminal, able to accept 1/0 AWG, 7-strand, copper 600-volt power conductor, for the chassis ground wire. This terminal point shall be in the Buss 16204-3 terminal block, or approved equivalent, on the side panel of the cabinet.

d. The terminal blocks for connecting the pedestrian and vehicle field wires which illuminate the independent signal heads shall be Thomas and Betts No. 35301, or approved equivalent. The mounting height to the bottom of these terminal blocks shall be between 14 and 18 inches from the bottom of the cabinet base.

e. Terminal blocks Cinch 12-142 with Thomas and Betts chair lugs, or approved equivalent, shall be used for connection of pedestrian push button field conductors.

f. Terminal blocks shall be provided for all pins on wiring harnesses and for all connectors of the cabinet equipment.

1) Separate terminal blocks for termination of the wiring harnesses for the controller, conflict monitor, loop and video detection systems, and emergency vehicle preemption system shall be provided.

2) All connector pins shall be wired to the harnesses and terminated on the appropriate block.

g. A minimum of two 16-terminal, compression type, copper ground strips shall be mounted to each side of the interior cabinet wall for connection of all neutral conductors.

1) These terminal strips shall not be grounded and will be connected to the terminal block that accepts the #2 stranded wire for the neutral power supply wire.

2) The terminal strips shall be mounted from 2 inches to 4 inches up from the bottom of the cabinet.

h. A 24-position, compression-type, copper grounding strip shall be mounted on and grounded to each side of the cabinet wall for connection of all grounding conductors.

1) These terminal blocks shall be connected to ground and shall be connected to the terminal block that accepts the No. 2 AWG stranded wire for the grounding conductor of the power supply.

2) The grounding strips shall be mounted 4 inches above the bottom of the cabinet.

i. Two dual-circuit, solid state, NEMA jack-mounted flashers having a flash rate of 50 to 60 flashes per minute (see NEMA TS 1, Section 8, "Solid State Flashers") shall be installed.

1) The red position of the load switch bays shall be operated from the flasher contacts as follows:

a) Flasher 1, contact A - phases 1, 4, and OLA

b) Flasher 1, contact B - phases 5, 8, and OLB

c) Flasher 2, contact A – phases 2, 3 and OLC

d) Flasher 2, contact B – phases 6, 7 and OLD

2) The red transfer relays will be wired in such a manner that the field wire outputs shall be flashing when the relays are de-energized. These transfer relays shall be energized to operate the traffic signal with colors.

j. A single, duplex, U-ground type of convenience outlet shall be furnished for tools and lighting.

1) It shall have an integral ground fault protection device and be installed adjacent to the breakers in the lower portion of the cabinet on the right side panel.

2) The power source for this outlet shall be the 15-amp circuit breaker.

3) Two single, duplex, U-ground type of convenience outlets shall be furnished for video equipment and other electronic test equipment.

a) Neither shall have an integral ground fault protection device.

b) The outlets will be located no more than 12 inches from the roof of the cabinet, on the right side panel of the cabinet interior.

c) The power source for these outlets shall be the 20-amp circuit breaker.

4) A fourth, single, duplex, U-ground type of convenience outlet shall be furnished for other electronic test equipment.

a) It shall not have an integral ground fault protection device.

b) This will be located no more than 12 inches from the roof of the cabinet, on the left side panel of the cabinet interior.

c) The power source for this outlet shall be the 20-amp circuit breaker.

k. Police Panel Switch:

1) There shall be a double-pole, double-throw switch behind the police auxiliary door.

2) This shall be identified "Auto/Flash."

3) The Flash position of the switch shall cause the following:

a) De-energize signal light power and place the intersection to red flashing operation through the Conflict Monitor (see d) below). The controller power, however, shall remain energized.

b) Activate the Stop Time function within the controller. This will be accomplished through the Conflict Monitor (see d) below).

c) Provide logic ground to inform the 2070N controller that the Police Flash Switch has been turned on to put the traffic signal on flash, on Pin AA, Controller Plug A.

d) De-energize +24v II to the Conflict Monitor to cause it to fail, which in turn causes the Conflict Monitor to provide a logic ground to Controller Plug A, Pin n, and Stop Time to controller. This circuit shall be diode-isolated.

4) When the police switch is placed back into Auto position, the intersection shall be transferred from red flashing operation to normal operation.

l. The following switches shall be installed at the center of the interior of the cabinet door and shall function as described.

1) The Controller Power switch shall be labeled "On-Off" and wired to de-energize only the controller power when switched to the Off position.

2) Tech Flash switch shall be labeled "Auto-Flash."

a) It shall be wired to remove the electrical power feeding the load switches and transfer relays when the switch is placed in the Flash position.

b) Placing the switch in Flash shall cause the intersection signals to flash red for all movements except the pedestrian movements which shall show no indication.

c) The controller, conflict monitor, and all other cabinet equipment shall remain energized.

d) A logic ground shall be applied to Controller Plug A, Pin AA to inform the controller that the Tech Flash switch has been put on flash.

e) The Controller shall not stop timing while the Tech Flash switch is in the Flash position.

f) The intersection shall return to normal operation when the Tech Flash switch is placed back into the Auto position.

3) Stop Timing switch (identified "On-Off") shall be wired to Stop Time ring 1 and ring 2 on the controller when switched to the On position.

4) The Interval Advance switch shall be a momentary, pushbutton switch.

a) The switch shall make electrical connection to the back panel through a 1/4-inch phone jack labeled "Interval Advance."

b) The Interval Advance switch shall be enabled by the Manual Control Enable (MCE) switch and wired to manually step the controller through intervals.

c) The Interval Advance switch shall have a guard to keep from accidentally advancing the controller.

5) The Manual Control Enable switch shall be labeled "MCE" and shall be wired to enable MCE in controller, while allowing the Interval Advance switch to operate.

6) Pedestrian and Vehicle Test switches shall be labeled "On/Off/Test" and shall be provided in each cabinet.

a) The switches shall be installed on a vehicle and pedestrian detector test panel located on the inside of the cabinet door with the other test switches for the cabinet.

b) Toggle switches shall be provided for 8 vehicle and 8 pedestrian phases and wired independently to the terminal blocks.

c) All possible vehicle and pedestrian detector circuits shall have a separate toggle switch.

d) The switches shall conform to the following conditions:

(1) The toggle switches shall permit detection calls to be forwarded to the controller from the vehicle and pedestrian detection source for normal operation when placed in the up (On) position.

(2) Each toggle switch shall disconnect the vehicle and pedestrian detection source when placed in the center (Off) position. No detections shall be allowed to enter the controller when placed in this position.

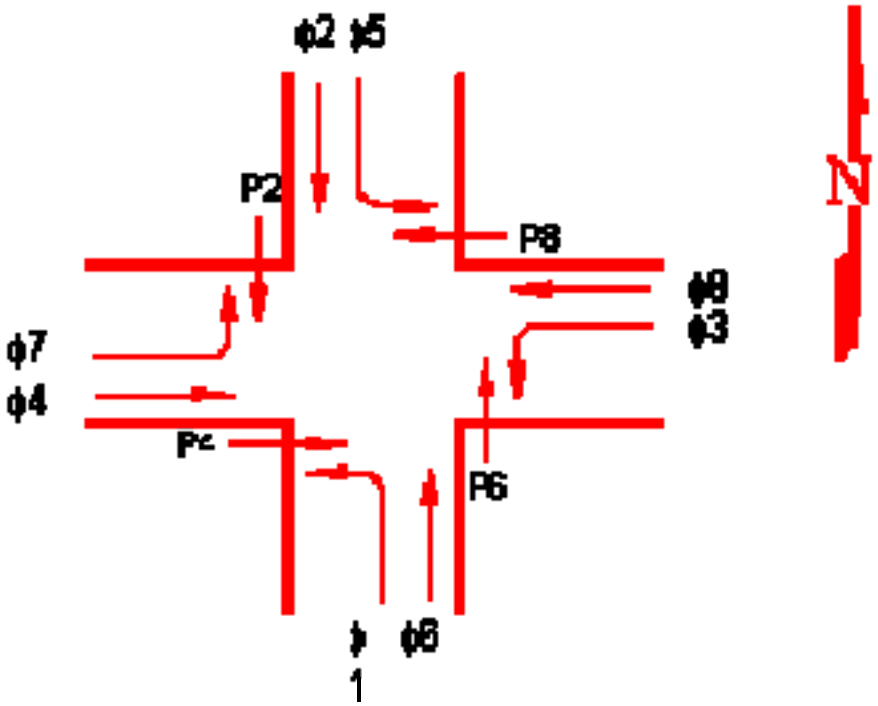
(3) The toggle switches shall place a call into the controller for the associated pedestrian or vehicular phase when placed in the down (Test) position. This position shall not be a momentary position. The switch shall be capable of being locked in Test position.

7) All switches shall be combined on a single panel and mounted on the inside cabinet door behind the police auxiliary panel.

m. Surge suppressors for electrical power shall be Model HS-P-SP-120A-60A-RJ, and for telecommunications line protection shall be Model MDF 6 95V or MF 25 95V.

6. All mechanical relays shall have clear dust covers.

7. The cabinet and controller phasing shall be referenced as follows:



a. Phase 6 shall be NB through

b. Phase 8 shall be WB through

623 T.02.02 TRAFFIC SIGNAL CONTROLLER CABINET EQUIPMENT

A. All traffic signal controller cabinets shall be furnished with the equipment specified below.

B. Solid State Load Switches, Red Transfer Relays, and Sockets:

1. All necessary cabinet wiring, connecting cables, terminal blocks, and sockets shall be provided for complete and proper functionality of an 8-vehicle, 4-pedestrian, and 4-overlap phase operation. A total of 16 NEMA load switches shall be provided with each cabinet.

2. Three wide-angle, high-intensity light emitting diodes (LED) of the corresponding colors RED, YELLOW, and GREEN shall be provided to indicate the status of each load switch input.

   a. The LEDs shall be clearly visible in bright sunlight.

   b. Refer to the latest NEMA standard publication for operational and dimensional requirements.

3. There shall be 2 discrete NEMA flashers accompanying each cabinet.

   a. Refer to the latest NEMA standard publication for operational and dimensional requirements.

   b. Two wide-angle, high-intensity LEDs, clearly visible in sunlight, shall be provided for each load switch and flasher to indicate the status of each device.

4. A minimum of 6 transfer relays shall be delivered with each cabinet.

   a. These shall conform to the latest NEMA TS 1 specifications.

   b. Load bay panels shall not exceed 0.125 inch of flex under 5 pounds of pressure.

C. Pedestrian Push Button Circuit Isolation:

1. Six solid state isolation circuits shall be provided in the cabinet to separate the pedestrian detector input circuits to the controller from the pedestrian push button circuits in the field. Isolation circuits 1, 2, 3, and 4 shall correlate to signal phases 2, 4, 6, and 8, respectively, and the wiring shall be appropriately terminated within the cabinet.

2. Circuits 5 and 6 shall be spares and shall be terminated to allow easy access from the front side of the detector panel. The Field push button circuits shall be energized by a 12 VAC source.

3. The isolation circuits shall be mounted on an edge connector-type PC board with all required components, including the transformer and integrated circuit chips, and shall display an LED indication showing status of field buttons.

D. Video Detection: All cabinets shall be wired for Video Detection in addition to the requirement for loop detection harnesses and equipment.

1. All cabinets shall have a discrete Video Detection Interface Panel (VDIP) installed and wired into the back-panel as appropriate.

   a. Phases 1 through 8 and overlaps A, B, C, and D green and red outputs and 24 VDC from the controller shall be wired to the VDIP from the back panel.

   b. The 16-vehicle and pedestrian phase detection inputs shall also be terminated on the VDIP.

2. The VDIP shall be installed on the upper left portion of the side panel within the cabinet where the terminal blocks are easily accessible. It shall be installed to permit wiring harnesses that accompany all Video Detection Systems to be connected to these independent termination points.

E. Loop Detection: If specified in the Contract Documents, all traffic signal cabinets shall be wired with four single-channel loop amplifier wiring harnesses and five 4-channel loop amplifier wiring harnesses.

1. Single-Channel Detectors:

a. There shall be 1 single-channel loop amplifier with wiring harnesses for each of the phases 2, 4, 6, and 8, for advance detection with added extension operation for the through phases.

b. These harnesses and plugs shall conform to the latest NEMA TS 1 specifications.

c. The harnesses shall be wired for the loops to be used as extension loops, with each conductor independently terminated onto an individual terminal.

d. The Relay Common (B pin) shall terminate before continuing to logic ground.

2. For 4-Channel Detectors:

a. There shall be 5 amplifiers with wiring harnesses installed and wired in the cabinet for the standard 4-channel detection unit specified in NEMA TS 1 standards, Section 11.2.28.2.

b. These detectors will be used for the presence detection at the intersection.

c. The harnesses shall be wired so the inputs of all channels are terminated directly to logic ground.

d. The number of detection outputs per phase shall be as indicated below with all harness wires being terminated on separate terminals.

1) 4-channel Amplifier A - phases (1, 6, 6, 6)

2) 4-channel Amplifier B - phases (3, 8, 8, 8)

3) 4-channel Amplifier C - phases (5, 2, 2, 2)

4) 4-channel Amplifier D - phases (7, 4, 4, 4)

5) 4-channel Amplifier E - phases (1, 3, 5, 7)

F. Optical Emergency Preemption:

1. All cabinets shall be equipped with encoded 3M Opticom compatible Emergency Preemption.

2. The phase selector(s) provided shall have the capability of providing traffic signal preemption for each intersection approach individually and separately from all other phases.

3. A minimum of 4 channels shall be provided.

4. Unless otherwise specified in the Contract Documents, each cabinet supplied shall be wired with an Optical Emergency Preemption Panel, and shall be marked accordingly.

a. The panel shall have termination points for 4 preemption outputs directly wired to the discriminator.

b. The M138 Emergency Preemption cable coming from the Optical Detectors shall be terminated to a terminal strip located on this panel.

5. The wiring from this panel to the back panel shall be as follows:

a. Channel A to Controller Plug A, Pin q.

b. Channel B to Controller Plug A, Pin y.

c. Channel C to Controller Plug B, Pin W.

d. Channel D to Controller Plug B, Pin X.

G. Supplemental 2070N D Plug Interface Panel:

1. If specified in the Contract Documents, the cabinet shall be equipped with a D panel complete with wiring harness for the D plug to be furnished with the controller.

2. The plug used for the D plug on the 2070N controller shall be an MS3116-24-61S.

3. The terminations for the harness shall have independent termination points as shown on the panel below.

4. All wiring on this panel, except for the D plug connector wiring harness itself, shall be performed by the Maintaining Agency's staff after delivery and acceptance of the controller cabinet.

H. Conflict Monitor Interface Panel:

1. Unless otherwise specified in the Contract Documents, all traffic control cabinets shall be supplied with a conflict monitor with a minimum of 12 channels.

2. If specified in the Contract Documents, an 18-channel monitor shall be supplied.

3. Twelve-channel conflict monitors shall be furnished with the program card fully programmed for standard NEMA 8-phase operation.

4. Twelve-channel monitor harnesses shall be wired in accordance with the diagram shown below.

5. Eighteen-channel conflict monitors shall be furnished unprogrammed and the harnesses shall be wired by Maintaining Agency technicians.

6. The wiring harness for the conflict monitor shall have independent termination points.

7. All conductors shall be terminated independently and separately onto a single terminal.

8. Appropriate conductors shall be landed on the back panel as necessary.

9. Unused wires shall be terminated on a separate terminal board that is easily accessible from the front of the cabinet without removing other panels.

10. There shall be no conductors hanging loose or not terminated.

I. All conflict monitors shall be NEMA standard, meeting all requirements of Section 6 of the latest edition of NEMA TS 1.

1. The conflict monitors shall also come equipped with PLUS options that are selected using dip switches or by use of the liquid crystal display (LCD) mounted on the front panel of the unit.

2. In addition, all monitors shall be equipped with the features defined below:

a. Conflict monitors shall be equipped with a front panel display that is menu driven.

1) The display shall be LCD and shall be temperature compensated to prevent screen blackout in extreme temperature conditions.

2) The LCD shall be backlit for night operation.

b. Minimum vehicle clearance time monitoring shall be programmable and shall be available on each channel separately and independently.

c. The LCD shall show separate indicators for activity on each of the red, amber, green, and walk inputs of each monitor channel.

d. The LCD shall have indicators showing active channel(s), date, time, and description of the current status, while showing a log of 6 or more of the most recent failures. All such data shall be stored in a non-volatile memory.

e. Failure status indicators shall be shown on the front panel to show the failure status for CVM, 24-1, 24-2, conflict, red failure, clearance failure, minimum green failure, dual indication, and program card ajar.

f. The monitor shall provide a front panel display of the approximate time and date of the occurrence of any power failure in excess of 500 milliseconds duration and the date and time of power restoration. The monitor program shall have computed and logged this data in non-volatile memory by the end of the power restart flash interval.

g. All conflict monitors shall have RS-232 capability.

h. The vendor shall supply software to interface between an IBM compatible computer and the monitor unit for downloading failure event information and other programmable events including but not limited to timing.

i. Front panel connectors A and B mounted directly to printed circuits will not be accepted.

623 T.02.03 TRAFFIC SIGNAL CONTROLLERS

A. Traffic signal controller assemblies shall conform to the following specifications.

B. General:

1. Controller Assemblies.

a. A controller assembly shall consist of a complete mechanism for controlling the operation of a traffic control signal, including the controller unit and all necessary auxiliary equipment, mounted in a traffic signal control cabinet.

b. All equipment required to provide the operation shown on the Drawings and specifications shall be provided.

2. Flashing Operations.

a. All controllers shall be equipped for flashing operation of signal lights.

b. Flashing operations, when required by railroad preemption, flashing emergency traffic control, or other causes, shall be set for flashing red on all approaches unless otherwise specified.

3. Wiring Diagrams.

a. A schematic diagram of the controllers and auxiliary equipment furnished under the contract shall be submitted at the time the controllers are delivered for testing or, on demand of the Engineer, prior to purchase.

b. This diagram shall show all circuits, all electronic elements including transistors, capacitors, inductors, resistors, integrated circuit chips, connectors and other parts in detail.

c. All parts, materials, and equipment shall be shown by name and number in such manner as to be readily identified.

d. This requirement may be waived at the discretion of the Maintaining Agency.

4. Operating Voltage.

a. All equipment including interconnection facilities, and excepting pedestrian push buttons and pressure detectors, shall be designed to operate on 120 volts, 60 Hz AC.

b. Operation shall be satisfactory at voltages from 105 to 130.

c. The voltage for pedestrian push buttons shall not exceed 24 volts AC.

5. Tests. Prior to completion of the work, the Contractor shall cause the following tests to be made on all electrical circuits, in the presence of the Engineer:

a. Test for continuity of each circuit.

b. Visual inspection for earth and system electrical grounds in each circuit. Electrical equipment and components shall not be energized until properly grounded to the system and to earth.

c. A flash test for traffic signal installations to verify the terminals and connections before turn-on.

d. A megohmeter test on each single conductor circuit between the circuit conductor and all other circuit and ground conductors in the conduits.

1) The insulation resistance shall not be less than 500 megohms when tested at 1,000 volts for 1 minute.

2) Individual conductors in traffic signal cable, other multi-conductor cables, and coaxial cables may be exempted from the megohm testing by the Maintaining Agency if a visual inspection of these cables shows no suspicious cuts, tears, or other damages to the cable or wire insulation.

e. A functional test in which it is demonstrated that each and every part of the system functions as specified or intended herein.

f. Any fault in any material or in any part of the installation revealed by these tests shall be replaced or repaired by the Contractor in a manner as directed by the Engineer, and the same test shall be repeated until no fault appears.

1) After testing of each traffic signal system, the system shall be activated and required to function without failure for a period of 14 calendar days.

2) Any fault or failure to the system during this period shall be corrected by the Contractor at no additional cost to the Contracting Agency, and the system will then be required to function for a period of 14 calendar days without failure.

3) This procedure will continue until the system successfully operates continuously without failure for 14 calendar days.

6. System Turn-On.

a. Contractor shall not energize any traffic signal equipment without the written approval of the Engineer.

b. The actual date and time of turn-on shall be coordinated with the Maintaining Agency.

c. Systems shall be permitted to be made operational only after on-site testing and certification by the Maintaining Agency.

d. The video detection manufacturer shall provide a technical representative at the intersection during the turn-on and testing period if required and directed by the Engineer.

e. The Contractor shall provide uniformed traffic control officers as required and directed by the Engineer to direct traffic during the turn-on period.

f. The Contractor shall immediately remove all conflicting traffic markings and signs prior to the successful turn-on of the traffic signal and dispose of all removed materials as specified in the Contract Documents.

C. Controller Construction Specification. When a 2070N controller is supplied, the following requirements are mandated:

1. The 2070N controllers supplied shall conform to the latest published revision of the California Department of Transportation (CALTRANS) Transportation Electrical Equipment Specifications (TEES) requirements published at time of bid. The following configuration will apply to any controller supplied.

a. A 2070-7 Async Serial Comm Module shall be supplied and installed in each controller. The communications interface connection cable incorporated with the 2070-8 shall be supplied with connector DB-9S to mate with the 2070-7 module, unless otherwise directed by Drawings and specifications.

b. A communications modem shall be supplied in accordance with FAST system requirements. The modem shall be delivered complete with the power cord and a 5-foot DB25 to DB25 RS232 cable for connection of the EX2 connector on the 2070-8 to the DTE connector on the modem, unless otherwise specified.

c. Each 2070N Controller shall come equipped with a 2070-1B single-board CPU, which holds 1 MB capacitor-backed static RAM, and is equipped with an RJ45 Ethernet Communications on face plate. This port will support standard TCP/IP protocols. The module shall also contain a DB25 EIA485 serial communications port.

d. The controller that is provided shall be configured with a short power outage tolerance of at least 400 milliseconds without causing a CPU reset, and a minimum of 4 MB of DRAM memory, 4 MB of FLASH memory, and 512 KB of SRAM.

2. The A, B, C, and D plugs shall be installed on the front of the controller with the identification letters for the Cannon plugs right-side up. The master key shall be located at the top of the plug, not the bottom.

3. The 2070N Controller supplied shall, at a minimum, meet the following criteria:

a. Proper implementation of all TEES and the above specifications.

b. Successful monitoring of the operation in a test cabinet environment.

c. Confirmation that the LCD display and the display cover are environmentally sealed to keep dust and other particles from entering between them.

d. Verification of operation with short power outages and momentary surges.

e. Verification of operation with the following provisions of software operation and compatibility.

4. All 2070N controller units shall be compatible and function properly with the latest revision of the Next Phase Intersection Management Software developed by Siemens ITS. All 2070N controller units shall be compatible and function properly with the i2tms communication package developed by Siemens ITS for the FAST Traffic Signal System, and shall be complete with all requisite hardware, cables, connectors, and related firmware for connection to and communication with the i2tms central software.

D. Alternate (non-2070N) Controller Construction Specification:

1. General Description. This specification describes an advanced traffic signal controller, meeting the latest NEMA specification, as well as providing advanced features for future enhancements. This Controller shall be supplied if specified in the Contract Documents.

2. Traffic signal controller shall meet or exceed all requirements of NEMA TS 2-2003.

a. The supplier shall provide a letter with bid from an independent testing laboratory certifying controller compliance to NEMA TS 2-2003.

b. A programming instruction manual shall be supplied on a CD with each controller purchased.

3. The controller shall meet the Standard NEMA configuration as NEMA TS 2-2 Type 2 for direct parallel connection to load switches and detectors, fully backward compatible with NEMA TS 1 Type 1 equipment.

4. In addition to NEMA requirements, the Central Processor Unit (CPU) shall provide the following:

a. Microware OS-9 operating system with runtime license.

b. Controller shall be capable of accessing OS-9 operating system via shell interface through RS-232 front panel communications port and be compatible with all NextPhase versions.

c. A Motorola 68360 microprocessor, 25 MHz version.

d. Four megabytes minimum dynamic random access memory (DRAM).

e. Eight megabytes minimum FLASH memory organized as a disk drive.

f. One megabyte minimum static random access memory (SRAM).

g. Time of Day (TOD) clock with hours, minutes, seconds, month, year, and automatic daylight savings time adjustment. TOD may be implemented in the CPU via electronic circuitry, operating system software, or a combination of both.

h. During power failures, the SRAM and TOD shall be powered by standby voltage from the power supply.

5. Controller shall not require additional hardware to run NextPhase software.

6. In addition to NEMA requirements, the power supply shall provide the following:

a. Line Frequency Reference (LFR) signal shall be by crystal oscillator, which will synchronize to the 60 Hz AC incoming power at 120 degrees and 300 degrees. A continuous square wave signal shall be provided at +5 VDC amplitude, 8.333 ms half-cycle pulse duration, and 50 ±1 percent duty cycle.

b. The LFR shall compensate for missing pulses and line noise during normal operation. The LFR shall continue through 500 millisecond power interruptions.

c. Standby voltage will be maintained by super capacitor. No batteries of any type will be used.

7. In addition to NEMA requirements, keyboard and display shall provide the following:

a. The keypad may be removable by pulling off and installed by pushing on, without the use of tools.

b. If a removable keypad is provided, an extension cord will be provided to allow use of the keyboard while it is not attached to the controller. It will be stowed in an obvious and easily reachable location.

c. The keypad/display will be a Liquid Crystal Display (LCD) with 8 lines, 40 characters each.

d. LCD contrast will be adjustable.

e. Backlighting will be provided for the LCD.

8. In addition to NEMA requirements, the controller shall provide the following communications functions:

a. Built-in native 10 Base-T Ethernet with RJ-45 connector on controller front panel.

b. Built-in configurable Internet Protocol (IP) address with factory default and unique MAC address.

c. Built in Infra-Red (IR) wireless port.

d. Built in EIA-232 port for uploading and downloading applications software, as well as to update the operating system.

9. In addition to NEMA requirements, the controller housing shall conform to the following:

a. Polycarbonate construction, except back panel, rear mounting tabs, and power.

b. Supply mounting plate shall be aluminum for electrical grounding.

c. Built-in polycarbonate carrying handle.

d. The physical size shall not exceed 16 inches wide by 10 inches deep by 8 inches tall.

e. The NEMA A, B, and C plugs mounted on the front panel shall have the plug key in the upright (12 o'clock) position.

E. The controller harnesses for connectors A, B and C shall be connected according to the following diagrams.

CONTROLLER CONNECTOR A			
Pin	Function	Pin	Function
A	Reserved	AA	Test Input B
B	+24 V DC External	BB	Walk Rest Modifier
C	Voltage Monitor	CC	Coded Status Bit A (Ring 1)
D	PH 1 Red	DD	PH 1 Phase ON
E	PH 1 Don't Walk	EE	PH 1 Ped Omit
F	PH 2 Red	FF	Ped Recycle (Ring 1)
G	PH 2 Don't Walk	GG	Max II Selection (Ring 1)
H	PH 2 Ped Clear		
J	PH 2 Walk		
K	PH 2 Veh Call Det		
L	PH 2 Ped Call Det		
M	PH 2 Hold		
N	Stop Timing (Ring 1)		
P	Inhibit Max Term (Ring 1)		
R	External Start		
S	Internal Advance		
T	Indicator Lamp Control		
U	AC- Common		
V	Chassis Ground		
W	Logic Ground		
X	Flashing Logic Out		
Y	Coded Status Bit C (Ring 1)		
Z	PH 1 Yellow		
a	PH 1 Ped Clear		
b	PH 2 Yellow		
c	PH 2 Green		
d	PH 2 Check		
e	PH 2 Phase ON		
f	PH 1 Veh Call Det		
g	PH 1 Ped Call Det		
h	PH 1 Hold		
i	Force-off (Ring 1)		
j	Ext Min Recall All PH's		
k	Manual Control Enable		
m	Call to Non Actuated I		
n	Test Input A		
p	AC+ (control)		
q	5 PPS		
r	Coded Status Bit B (Ring 1)		
s	PH 1 Green		
t	PH 1 Walk		
u	PH 1 Check		
v	PH 2 Ped Omit		
w	Omit All Red Clear (Ring 1)		
x	Red Rest Mode (Ring 1)		
y	Spare 1		
z	Call to Non Actuated II		

CONTROLLER CONNECTOR B			
Pin	Function	Pin	Function
A	PH 1 Phase Next	AA	Overlap A Green
B	*	BB	Overlap B Yellow
C	PH 2 Next	CC	Overlap B Red
D	PH 3 Green	DD	Overlap C Red
E	PH 3 Yellow	EE	Overlap D Yellow
F	PH 3 Red	FF	Overlap C Green
G	PH 4 Red	GG	Overlap B Green
H	PH 4 Ped Clear	HH	Overlap C Yellow
J	PH 4 Don't Walk		
K	PH 4 Check		
L	PH 4 Veh Call Det		
M	PH 4 Ped Call Det		
N	PH 3 Veh Call Det		
P	PH 3 Ped Call Det		
R	PH 3 Phase Omit		
S	PH 2 Phase Omit		
T	PH 5 Ped Omit		
U	PH 1 Phase Omit		
V	Ped Recycle (Ring 2)		
W	*		
X	*		
Y	PH 3 Walk		
Z	PH 3 Ped Clear		
a	PH 3 Don't Walk		
b	PH 4 Green		
c	PH 4 Yellow		
d	PH 4 Walk		
e	PH 4 Phase ON		
f	PH 4 Phase Next		
g	PH 4 Phase Omit		
h	PH 4 Hold		
i	PH 3 Hold		
j	PH 3 Ped Omit		
k	PH 6 Ped Omit		
m	PH 7 Ped Omit		
n	PH 8 Ped Omit		
p	Overlap A Yellow		
q	Overlap A Red		
r	PH 3 Check		
s	PH 3 Phase ON		
t	PH 3 Phase Next		
u	Overlap D Red		
v	*		
w	Overlap D Green		
x	PH 4 Ped Omit		
y	Spare 5		
z	Max II (Ring 2)		

*User Assigned

CONTROLLER CONNECTOR C			
Pin	Function	Pin	Function
A	Coded Status Bit A (Ring 2)	AA	PH 6 Ped Clear
B	Coded Status Bit B (Ring 2)	BB	PH 6 Check
C	PH 8 Don't Walk	CC	PH 6 Phase ON
D	PH 8 Red	DD	PH 6 Phase Next
E	PH 7 Yellow	EE	PH 7 Hold
F	PH 7 Red	FF	PH 8 Check
G	PH 6 Red	GG	PH 8 Phase ON
H	PH 5 Red	HH	PH 8 Phase Next
J	PH 5 Yellow	JJ	PH 7 Walk
K	PH 5 Ped Clear	KK	PH 7 Ped Clear
L	PH 5 Don't Walk	LL	PH 6 Walk
M	PH 5 Phase Next	MM	PH 7 Check
N	PH 5 Phase ON	NN	PH 7 Phase ON
P	PH 5 Veh Call Det	PP	PH 7 Phase Next
R	PH 5 Ped Call Det		
S	PH 6 Veh Call Det		
T	PH 6 Ped Call Det		
U	PH 7 Ped Call Det		
V	PH 7 Veh Call Det		
W	PH 8 Ped Call Det		
X	PH 8 Hold		
Y	Force-off (Ring 2)		
Z	Stop Timing (Ring 2)		
a	Inhibit Max Term (Ring 2)		
b	Spare 1		
c	Coded Status Bit C (Ring 2)		
d	PH 8 Walk		
e	PH 8 Yellow		
f	PH 7 Green		
g	PH 6 Green		
h	PH 6 Yellow		
i	PH 5 Green		
j	PH Walk		
k	PH 5 Check		
m	PH 5 Hold		
n	PH 5 Phase Omit		
p	PH 6 Hold		
q	PH 6 Phase Omit		
r	PH 7 Phase Omit		
s	PH 8 Phase Omit		
t	PH 8 Veh Call Det		
u	Red Rest Mode (Ring 2)		
v	Omit All Red (Ring 2)		
w	PH 8 Ped Clear		
x	PH 8 Green		
y	PH 7 Don't Walk		
z	PH 6 Don't Walk		

CONTROLLER CONNECTOR D *Pins are user defined, and shall be wired*			
Pin	Function	Pin	Function
A		AA	
B		BB	
C		CC	
D		DD	
E		EE	
F		FF	
G		GG	
H		HH	
I		JJ	
J		KK	
K		LL	
L		MM	
M		NN	
N		PP	
P			
R			
S			
T			
U			
V			
W			
X			
Y			
Z			
a			
b			
c			
d			
e			
f			
g			
h			
i			
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k			
l			
m			
n			
p			
q			
r			
s			
t			
u			
v			
w			
x			
y			
z			

623 T.02.04 MAGNETIC INDUCTION LOOP DETECTORS

A. General.

1. The term "loop detector" applies to a complete and operating installation consisting of a loop or loops installed in the roadway in accordance with the Drawings and specifications, a sensor unit with solid state switching output, and a power source.
2. Loop detectors shall meet the requirements of and operate in accordance with the latest edition of NEMA TS 1.
3. All loop locations shall be approved by the Engineer prior to installation.
4. Loop leads shall be properly marked in the pull box and the cabinet as to the location and which vehicular phase of the traffic signal is associated with that loop.
5. A minimum of 2 feet of loop wire and 2 feet of loop lead-in shall be provided and stored in the pull box for slack.
6. All loop wires home run to pull box shall clearly identify the direction of the cables windings for ease of installation.
7. Minimum 3 turns per foot shall be provided.
8. The completed loop detector shall be capable of detecting any vehicle currently licensed by the state of Nevada.

B. Preformed Loops.

1. Loop detector wires shall be installed as preformed loop sensors when new roadways are being constructed or the existing asphalt or concrete pavement is being replaced.
   a. The wires shall be installed in the roadway base material at least 2 inches below the concrete or below the first course of asphalt/concrete paving.
   b. Preformed loop wires constructed specifically to be embedded directly into the subbase material or to be installed as preformed loops shall be used as shown on the Drawings.
   c. The loop assemblies shall be properly located under the roadway in the proposed lane configuration and appropriately secured to prevent movement prior to and during the installation of the paving material.
2. Direct burial loop wires shall not be installed in road base material containing aggregate with sharp edges or aggregate larger than 1/2-inch diameter.
   a. However, this requirement shall not prevent the installation of preformed loops.
   b. The materials surrounding the wires shall be changed to meet this specification if necessary.
3. Preformed loop detectors shall be installed when pavement is milled 2-1/2 inches or more by cutting loop wire slots into the coarse grade of the asphalt pavement material and installing the direct-burial preformed loop wires.
   a. The overlay material may then be applied over the embedded loop wires with the finish course to complete the installation.
   b. These preformed loops supplied shall be as specified in the Contract Documents and approved by the Engineer.

4. Preformed loops may be required to be installed as replacements to regular loops as specified in the Contract Documents or as directed by the Engineer.

   a. In this case, the cut in the roadway shall be made through the existing finish grade of the asphalt or concrete.

   b. The preformed loops shall be placed in the roadway cut 2 inches below the surface of the roadway and sealed using approved loop sealant.

5. The preformed loops shall be factory assembled.

   a. Home runs and interconnections shall be prewired and shall be an integral part of the loop assembly.

   b. Each loop shall be fabricated for the specific application.

   c. All materials used in the fabrication of the preformed loops shall be flexible and shall have properties that will withstand the temperatures and pressures of paving applicators without melting, breaking, or cracking.

6. The tee shall be constructed of heavy-duty, high-temperature synthetic rubber or high-impact glass impregnated plastic.

   a. The minimum size of loop wire permitted shall be 18 AWG stranded copper with TFFN or XLPE insulation.

   b. Splices are not allowed in the loop wire.

   c. The tee shall not melt, break, or crack under the thermal and pressure conditions of the paving operations.

   d. Preformed loop lead home run wires from the tee to the pull box shall be the same as the loop wire since splicing is not permitted.

   e. Loop leads shall be twisted a minimum of 3 times per foot of length.

   f. Tees shall be checked electrically for wire breaks and continuity following assembly and construction before shipment to the project site.

7. All preformed loops and the type to be used shall be approved by the Engineer prior to installation.

C. Cable-in-Duct System.

1. Traffic signal detection loops that are to replace existing loops or are otherwise to be placed by cutting through the finished pavement surface and that are not preformed loops shall be installed using a cable-in-duct system.

2. The loop wires shall be installed in slots cut in the pavement and shall be oriented and sized in accordance with the Contract Documents or as directed by the Engineer.

3. The cable-in-duct system is a loop wire encased in flexible plastic tubing.

   a. The system shall consist of flexible plastic tubing, 1/4-inch outside diameter, surrounding a single conductor, No. 14 AWG, XHHW-2, cross-linked, polyethylene insulated loop wire.

   b. The tubing containing the loop wire shall be installed in a 3/8-inch wide saw slot in accordance with the Uniform Standard Drawings.

4. The flexible plastic tubing shall be Type III, Grade P33, Category 5, Class C, and shall meet the following physical dimensions:

a. Duct Size: 0.250 inch.

b. Outside Diameter: 0.250 (± 0.010) inch.

c. Wall Thickness: 0.032 (+0)(-0.010) inch.

d. Nominal Inside Diameter: 0.185 inch.

e. Minimal Bending Radius: 1.00 inch.

5. The loop wire shall meet IMSA 51-5.

a. The wire shall be single conductor, No. 14 AWG copper wire with 19 strands.

b. The insulation shall be 15 mils of black PVC complying with UL 62 with an overall jacket of clear nylon in accordance with ASTM D4066.

c. The wire shall be rated for 600 volts and have a nominal OD of 0.25 inch.

6. The cable-in-duct system shall meet the performance tests as specified in NEMA standards.

7. Sawed slots shall be blown clean and dried prior to the installation of the loop wire.

a. Loop wire shall be carefully placed into the saw slot using special tools to avoid damaging the wire.

b. The saw cuts shall be blown clean after wire installation and before placement of sealant.

D. Loop wire insulation shall be tested using a megohmeter prior to the placement of loop wire sealant. Insulation resistance readings shall not be less than 100 megohms at 1,000 volts.

E. Detector loop sealant to be used shall be approved by the Engineer prior to installation.

F. Loop Lead-In Conductors.

1. The loop lead-in cable shall be 1 pair No. 12 AWG, tinned copper, 19 strands each in accordance with IMSA 50-2.

2. The pair shall be twisted a minimum of 3 times per foot.

3. Insulation on the individual wires shall be high-molecular weight polyethylene complying with ASTM D1248, clear and black.

4. The wires shall be wrapped helically with aluminum/polyester tape applied with stranded copper drain wire.

5. The overall insulation jacket shall be polyethylene.

6. The cable shall be rated for 600 volts with a nominal OD of 0.376 inch.

G. Each through lane presence and advance detection loop in the system shall have a separate lead-in cable to the controller cabinet.

1. A lead-in cable shall be provided for every 2 left turn presence loops.

2. Each loop shall be 6 feet by 6 feet unless specified otherwise in the Contract Documents or directed by the Engineer.

H. Detector Operational Characteristics. All loop detector amplifiers shall meet NEMA specifications and shall conform to the following requirements:

1. All detector amplifiers shall give a constant output with an open or failed loop.

2. All detectors shall be shelf mounted or rack mounted as specified in the Contract Documents.
3. All detector amplifiers shall be equipped with a fully functional LCD that is used for both monitoring and programming.
4. Amplifier programming shall be accomplished through the LCD.
5. The LCD shall be backlit and shall display the complete status of the connected loop, which includes but is not limited to the loop inductance, the loop frequency, and the accumulated number of loop failure incidents.
6. Fully functional delay/extend functions shall be incorporated into the programming.
7. Loop amplifiers shall be equipped with a phase green override input for each detection channel.
8. All loop amplifiers shall be capable of presence or pulse modes of operation.
9. There shall be 1, 2, or 4 channels per each loop detector, as specified in the Contract Documents.
10. Loop detector amplifiers shall have loop fail memory log and loop fail diagnostics.
11. Loop detector amplifiers shall have a minimum of 4 loop frequencies and a minimum of 8 sensitivity settings including the Off position.
12. Loop detector amplifiers shall contain solid-state components only. Relays are not allowed.
13. Loop detector amplifiers shall be self-tuning and have complete environmental tracking.
14. The detector amplifier shall be capable of continuous operation in a temperature range of -35 degrees F to +165 degrees F.
15. The amplifiers shall place a permanent vehicle call to the traffic signal controller if a power interruption occurs. The unit shall retune automatically within 15 seconds after the restoration of power.
16. The amplifiers shall not require a warm-up period prior to operation.
17. The amplifier units shall incorporate built-in lightning protection meeting the latest NEMA Standard.
18. All loop detector amplifiers shall have circuitry and controls for individual selection of delay or extension timing on each channel.
19. The sensor unit power supply shall be integral to the amplifier.

I. Cabinet Wiring for Induction Loops.

1. If single channel shelf-mount detectors are specified on the Drawings, each loop detector shown on the Drawings shall be individually wired to terminal blocks in the controller cabinet.
2. Each loop detector amplifier shall have a standard cable harness at least 6 feet long wired to the terminal blocks.
3. Connection to the amplifier unit shall be made using a threaded shell type connector pinned for the circuitry as shown below:

a. For a 4-Channel Detector Amplifier: MS Connector Circuit

1) A Power, Neutral, 120 VAC Power, Neutral, 120 VAC
2) B Channel 4 Output, Relay Common Channel 4 Output, Source
3) C Power, Line, 120 VAC Power, Line, 120 VAC
4) D Channel 1 Loop Input Channel 1 Loop Input
5) E Channel 1 Loop Input Channel 1 Loop Input
6) F Channel 2 Loop Input Channel 2 Loop Input
7) G Channel 2 Loop Input Channel 2 Loop Input
8) H Chassis Ground Chassis Ground
9) J Channel 3 Loop Input Channel 3 Loop Input
10) K Channel 3 Loop Input Channel 3 Loop Input
11) L Channel 4 Loop Input Channel 4 Loop Input
12) M Channel 4 Loop Input Channel 4 Loop Input
13) N Channel 1 Output, Relay Normally Open Channel 1 Output, Drain
14) P Channel 1 Output, Relay Common Channel 1 Output, Source
15) R Channel 2 Output, Relay Common Channel 2 Output, Source
16) S Channel 2 Output, Relay Normally Open Channel 2 Output, Drain
17) T Channel 3 Output, Relay Common Channel 3 Output, Source
18) U Channel 3 Output, Relay Normally Open Channel 3 Output, Drain
19) V Channel 4 Output, Relay Normally Open Channel 4 Output, Drain

b. For a Single Channel Detector Amplifier: MS Connector Circuit

1) A 120-volt (AC grounded conductor)
2) B Relay Contact Common (Output Negative)
3) C 120-volt (AC line)
4) D Loop
5) E Loop
6) F Relay Contact (Output Positive) N.C.
7) G Relay Contact, Open for Call
8) H Chassis Ground
9) I Spare
10) J Spare

J. Slot Sealant Tests and Acceptance.

1. Insulation Test. Insulation tests for each loop to ground shall be in accordance with the latest edition of NEMA TS 1.

2. Sensitivity Test. The completed loop detector shall be capable of detecting any vehicle currently licensed by the state of Nevada.

K. Installation of Inductive Detector Loop Sealant.

1. Detector loop sealant shall be either:

   a. A 2-component epoxy or a polyurethane material that cures in the presence of moisture and conforms to the following specifications.

   b. A hot-melt, rubberized asphalt material conforming to the following specifications.

2. Sealant shall be suitable for use in both asphalt concrete and Portland cement concrete pavements.

TWO COMPONENT EPOXY COMPOSITION

	Parts by Weight
Component A:	
Epoxy Resin, Araldite 6010	100
Nonyl Phenol	20
Alkylbenzene, Alkylate 31	20
Titanium Dioxide, Titanox 2015	1.62
Colloidal Silica, Cabosil	3
Glycerine	0.5
Silicone Anti-foam, G.E. Viscasil	0.01
Component B:	
Poly Mercaptan, Dion 3800 L C	40
N-Aminoethylpiperazine	17
2,4,6 - Tri (dimethylaminomethyl) Phenol	2
Furnance Black	0.03
Nonyl Phenol	34.6
Alkylbenzene, Alkylate 31	34.6
Colloidal Silica, Cabosil	4
Glycerine	0.5
Silicone anti-foam, G.E. Viscasil	0.01
Characteristics of Adhesives:	
Component A:	
Viscosity, Poise, Brookfield	150-300
Shear Index	2.5 minimum
Component B:	
Viscosity, Poise, Brookfield	100-250
Shear Index	2.0 minimum
Characteristics of Compounded Adhesive:	
Gel Time, Minutes	13 to 16
On 1/8 inch cast sheet, cured 18 hours at 77 degrees F plus 5 hours at 158 degrees F	
Tensile Strength Minimum	700 psi
Elongation, Percent, Minimum	70

TWO COMPONENT EPOXY COMPOSITION

	Parts by Weight
Shore D Hardness, Minimum	50
Color shall match Federal Standard No. 595; color range shall be 26081 to 26173	

POLYURETHANE SEALANT

Property and Results	Measuring Standard and Conditions
Hardness (indentation) — 65-85	ASTM D2240 Rex Type A, Model 1700 77 degrees F, 50 percent relative humidity
Tensile Strength — 500 psi (minimum)	ASTM D412 Die C, pulled at 20 ipm
Elongation — 400 percent, minimum	ASTM D412 Die C, pulled at 20 ipm
Flex at -40 degrees F — no cracks	25 mil free film bend over 1/2-inch mandrel
Weathering Resistance — Slight Chalking	ASTM D822 Weatherometer 350 hours Cured 7 days at 77 degrees F 50 percent relative humidity
Salt Spray Resistance — 500 psi, minimum tensile; 400 percent minimum elongation	ASTM B117, 28 days at 100 degrees F 5 percent NaCl, Die C, pulled at 20 ipm
Dielectric Constant — Less than 25 percent change over a temperature of -22 degrees F to 122 degrees F	ASTM D150

Chemical Resistance: Chemical and Results	Test Method
De-Icing Chemical — No Effect	ASTM D471
Gasoline — Slight Swell	ASTM D471
Hydraulic Brake Fluid — No Effect	ASTM D471
Motor Oil — No Effect	ASTM D471
Calcium Chloride (5 percent) — No Effect	ASTM D471

Tests conducted on deaerated, 0.020 inch, dry film liquid immersion; 28 days at 77 degrees F

HOT-MELT, RUBBERIZED ASPHALT SEALANT

Property and Limits	Measuring Standard and Conditions
Cone Penetration — 20 - 35 (1/10 mm.) max.	ASTM D5, 77 degrees F, 150 g, 5 sec
Flow -- 5 mm. maximum	ASTM D5329, Section 6, 140 degrees F
Resilience --60% minimum	ASTM D6690, 77 degrees F
Softening Point – 200 degrees F	ASTM D36
Ductility -- 30 - 55 centimeters	ASTM D113, 77 degrees F, 5 cm/sec
Flash Point –575 degrees F	ASTM D92, COC
Viscosity -- 2,500 - 3,500 centipoises (Brookfield)	ASTM D3236 375 degrees F

623 T.02.05 EMERGENCY VEHICLE PRIORITY CONTROL SYSTEM (INTERNAL PREEMPTION)

A. General Emergency Vehicle Detection System Description.

1. The Priority Control System shall consist of a data-encoded optical emitter, optical detectors, optical detector cable, and priority control unit.

2. The system shall employ data-encoded optical communications to identify the presence of designated priority vehicles, cause the traffic signal controller to initiate a specific preprogrammed preemption procedure, and record the vehicle by classification and identification number.

   a. The matched set of components that make up the system shall cause the existing traffic controller to be manipulated upon recognition of the signal from the vehicle.

   b. The vehicle communication is provided to the controller by the optical detectors at or near the intersection which receives a pulsating light from the vehicle over a line-of-sight path.

3. The system shall require no action of the vehicle operator other than the operation of the emitter switch located in the vehicle. The vehicle operator leaves the switch in the ON position until the vehicle passes the targeted traffic signal.

4. The system shall interface with existing traffic signal controllers without compromising normal operation or existing safety provisions.

   a. The system shall operate on a first-come, first-served basis or on a selected priority.

   b. The higher priority requests will override lower priority requests.

   c. The system shall be designed to yield to other priority demands such as railroads.

B. Matched System Components.

1. To ensure desired performance, the system shall provide the synergy of the 4 principal components, matched and proven through integrated testing and extensive functional experience.

2. The matched component system shall offer compatibility with all types of traffic signal controllers and shall provide future compatibility of all priority control elements.

3. Data-Encoded Optical Emitter. Shall be a compact, lightweight, weatherproof, light-emitting device with internal, regulated power supply designed to produce high intensity optical energy in visible and infrared wavelengths as well as encoded pulses that carry vehicle class and ID number information, from a single source, precisely timed by a crystal controlled circuit.

4. Optical Detector.

   a. Shall be a lightweight, weatherproof, adjustable, bidirectional optical detector assembly.

   b. Internal circuitry shall transform optical energy from the optical emitter assembly into electrical signals for delivery (up to 1,000 feet) via optical detector cable to the priority control unit.

5. Optical Detector Cable. Shall be a durable, shielded, 3-conductor cable with a drain wire and the necessary electrical characteristics to carry power to the optical

detector from the priority control unit and to carry the optical detector signal to the priority control unit.

6. Priority Control Unit. This equipment shall provide interface between the optical detectors and the traffic signal controller unit and shall comply with the following while not compromising the existing fail-safe provisions:

   a. Provide sufficient power to all optical detectors required for the intersection.

   b. Differentiate optical detector signals from 1 or more emitters on a first-come, first-served basis.

   c. Provide output signals to the traffic signal controller to cause a preemption sequence to display the desired phase green for the approaching emergency vehicle.

   d. All input and output wires of the priority control system shall be terminated on a separate panel before being wired to the controller back panel.

   e. Assist the traffic signal controller in providing a smooth transition to non-priority operation after the passage of the emergency vehicle through the intersection.

   f. Store up to 100 of the most recent priority control calls in non-volatile memory and retain the record if power terminates.

C. System Operation. The emergency vehicle preempt system shall operate in accordance with the following:

1. Priority control system shall be activated by an optically transmitted signal capable of recognizing and discriminating an Optical Emitter flash rate of Class I 9.63855 Hz ±0.0014 Hz or Class II 14.0359 Hz ±0.0039 Hz from a single light source or upon the actuation of a test switch or remote call signal to the phase selector. The system shall cause the traffic controller to select the green phase associated with the approaching emergency vehicle and place a priority call to initiate that phase.

2. The system shall not require modification or replacement of the existing controller unit beyond adding the necessary system hardware.

3. The system shall not cause the traffic signal controller to skip vehicular change or clearance intervals.

4. The system shall be capable of accepting emergency preempt calls from all approaches to the intersection independently without modification or replacement of the existing phase selector unit.

5. The system shall maintain adequate minimum traffic signal displays when priority control is active and all traffic signal display indications and sequences shall conform to the MUTCD.

6. The system shall provide for up to 3 optical detectors to be connected to each channel.

7. The system shall allow the traffic signal controller to resume normal timing operation after the preempt clears.

8. The system shall not attempt controller manipulation nor retain priority vehicle calls during periods of Intersection Flash operation.

D. System Component Specification. System components shall conform to the following:

1. Data-encoded Optical Emitter.

a. The flash signal shall consist of a frequency base signal and a coded overlay signal that can be used to transmit information.

b. The flash sequence generated by the data-encoded emitter shall carry 3 types of information:

1) The base frequency as established in Subsection 623 T.02.05.C "System Operation," subparagraph 1.

2) The vehicle classification and identification code. The data-encoded emitter shall be capable of setting a minimum of 10 different classifications with 1,000 different identification numbers per class for each priority.

3) Intersection detection range setting.

c. The data-encoded emitter will conduct self-diagnostics designed to check for missing pulses.

d. The data-encoded emitter will be equipped with a disable input that, when activated, will cease unit operation, thereby eliminating the possibility of inadvertent signal transmission after the priority vehicle has arrived at its destination.

2. Optical Detector.

a. The optical detector shall be a lightweight, weatherproof device capable of sensing and transforming pulsed optical energy into electrical signals usable by the phase selection equipment.

b. The unit shall be high-impact polycarbonate construction with non-corrosive hardware.

c. The unit shall be designed for simple mounting at or near an intersection on mast arm, pedestal, pipe, or traffic signal.

d. The unit shall accept optical signals from all approaches to the intersection independently without modification or replacement of the existing phase selector unit.

e. The unit shall include a design feature to allow aiming of the 2 optical sensing inputs for skewed approaches or slight curves, and may be field verified.

f. The unit shall be responsive to the optical emitter at a distance of 1,800 feet.

g. The unit shall be capable of providing the necessary electrical signal to the priority control unit (phase selector) through up to 1,000 feet of optical detector cable.

3. Optical Detector Cable.

a. The cable shall deliver the necessary signal from the optical detector to the phase selector over a maximum distance of 1,000 feet.

b. The cable shall be three No. 20 AWG (minimum gauge) stranded copper conductors and 1 bare ground wire.

c. The individual conductors shall be tinned copper and shall be color coded as follows:

1) Orange for delivery of optical detector power (+).

2) Bare for optical detector neutral (-).

3) Yellow for optical detector signal.

4) Blue for a second optical detector signal.

4. Priority Control Equipment (Phase Selector). The Emergency Vehicle Priority Control or Phase Selector shall be a self-contained stand-alone unit that shall recognize input signals from separate preempt channels for all traffic signal approaches and shall contain the following major parts:

a. Card Rack:

1) The power supply shall be contained in a card rack.

2) The power supply shall be powered from AC mains in the traffic signal cabinet, and shall supply power to the Optical Detectors.

3) Plug-in card edge connectors and appropriate plugs and harnesses shall be used to connect the card rack unit to the cabinet wiring assembly.

b. Priority Control Discriminator Plug-in Module:

1) This module unit shall either be a single plug-in 4-channel device or 2 plug-in 2-channel devices, as specified in the Contract Documents or directed by the Engineer, designed to be used with optical Emitters and Detectors.

2) The unit shall be capable of recognizing and discriminating Optical Emitter flash rates as described in Subsection 623 T.02.05.C "System Operation," subparagraph 1.

3) The unit shall be capable of recognizing and distinguishing data-encoded optical signals and shall meet the following requirements:

a) Programming and retrieving the data stored shall be accomplished using an IBM PC-compatible computer. Unit shall have the capability of storing 100 of the most recent calls. Each record entry shall include information as follows:

(1) Vehicle Classification.

(2) Vehicle Identification Number.

(3) Vehicle Priority level.

(4) Vehicle Direction.

(5) Call Duration.

(6) Final green indications at the end of the preempt call.

(7) Duration of final green indications.

(8) Time date and duration of the call.

b) Unit shall be capable of 3 levels of discrimination of data-encoded optical signals as described elsewhere in this specification.

c) Interface with the cabinet shall be wired as described elsewhere in this specification.

E. Reliability. All equipment supplied as part of the optical priority remote traffic control system intended for use in the traffic signal controller cabinet shall meet the electrical and environmental specifications contained in the latest edition of the NEMA standards.

623 T.02.06 TRAFFIC SIGNAL VIDEO IMAGE DETECTION SYSTEMS

A. Video detection systems shall be as specified in the Contract Documents or equal as approved by the Engineer.

623 T.02.07 SYNCHRONIZING CLOCK

A. Unless otherwise specified in the Contract Documents, all controllers shall be supplied with a highly accurate synchronizing clock that maintains time by referencing signals that are broadcast from Global Positioning System (GPS) satellites.

B. The timing device shall be provided on an integrated circuit card format that slides easily into the rack of a 2070 traffic signal controller.

1. The timing device shall have the same footprint as the ATC/2070-7x and shall be capable of accuracy to within 10 milliseconds of the GPS data stream.

2. The timing device shall be an output only device and shall not receive commands from the controller.

a. The time shall be updated every minute on the minute so that the controller maintains an accurate time of day and is referenced every minute to the GPS control.

b. Time zone and daylight savings shall be selected by means of an 8-position dipswitch on the circuit board.

C. A signal status LED indicator shall be provided on the front panel of the timing device that shows the status of the clock signal. The LED indicator shall display the accuracy of the clock.

D. Windows based software shall be provided with the timer that can be used for training, system configuration, and device testing.

E. A small GPS antenna shall be provided that mounts on top of the control cabinet and connects to the circuit card for enhanced signal reception.

1. The connecting coaxial cable shall be 6 feet in length.

2. The antenna shall be mounted on the controller cabinet where there is a clear view of the sky to facilitate adequate linkage with satellite signals.

TRAFFIC SIGNALS AND FITTINGS

623 T.02.08 VEHICLE SIGNAL FACES

A. All vehicle signal faces shall consist of individual signal sections rigidly fastened together.

1. Each section shall have a separate and complete housing.

2. The actual number and type of sections shall be shown on the Drawings and in accordance with the *Manual on Uniform Traffic Control Devices* (MUTCD) and the Uniform Standard Drawings (USD).

3. Vehicle signal face shall be installed as indicated on the Drawings.

4. All vehicle signal faces shall be mounted onto their supports by mounting assemblies in accordance with the Uniform Standard Drawings.

B. All new vehicle signal faces installed at any one intersection shall be the product of the same manufacturer.

C. Traffic signal indications that have been installed and are not in operation shall be covered from public view in accordance with Subsection 623 G.03.03, "Scheduling of Work," to clearly show that the signals are inoperative.

D. Optical Units:

1. Optical units for vehicular traffic signals shall be LED modules and shall be interchangeable with all traffic signal head manufacturers.

2. The LEDs shall be securely fastened to a printed circuit board and shall meet FCC Title 47, Subpart B, Section 15 Regulations for electrical noise.

3. The LED module shall be watertight when properly mounted in the signal head enclosure and conform to NEMA and Institute of Transportation Engineers (ITE) moisture resistance standards. The modules shall specifically conform to the NEMA 250 moisture resistance standards for Type 4 enclosures.

4. ALL LED modules shall be operationally compatible with NEMA TS 1 and NEMA TS 2 conflict monitoring parameters.

5. All indications shall conform to the most recent edition of the ITE publication "Vehicle Traffic Control Signal Heads - Light Emitting Diode Circular Signal Supplement" (VTCSH-LED), adopted by reference into the MUTCD. The modules shall be certified by independent testing lab that they meet the VTCSH-LED specification.

6. All vehicular LED modules shall reach 90 percent of full illumination within 110 milliseconds of the application of the nominal voltage and shall cease emitting visible illumination within 110 milliseconds of the removal of the nominal operating voltage.

7. The LED module circuitry shall prevent flicker of the LED output at frequencies less than 100 Hz over the operating voltage range. There shall be no visible illumination from the LED module when the applied voltage is less than 35 VAC.

8. The LED modules for vehicle signal control shall be 12 inches in diameter. They shall be complete individual units, consisting of plastic tinted lenses (red, yellow, or green) made of ultraviolet stabilized polycarbonate, an LED circuit board inclusive of all individual LEDs and required circuit components, a minimum 39-inch 18 AWG color-coded wire leads with strain relief and female quick connect/fasten terminals for 18 AWG wire, and a 1-piece commercial grade neoprene gasket.

9. The LED modules shall be connected directly to line voltage, 117 VAC nominal, and shall operate over the voltage range of 80 VAC to 135 VAC, with a power factor exceeding 0.90.

   a. Total harmonic distortion shall be 20 percent or less.

   b. The intensity of the LED signal shall not vary by more than 10 percent over the allowable voltage range.

10. The failure of any one LED in ball modules shall not cause the loss of more than 2-1/2 percent of lens surface illumination, nor more than 1 percent of the entire module luminosity.

11. Lenses for LED modules shall incorporate facets that serve to enhance the optical efficiency of the LED traffic signal module.

   a. Facets shall be arranged on the inside of the lens.

   b. External lens facets are not allowed.

c. The LED lens shall reduce glare and sun reflection.

12. The housing of the LED vehicular signal module shall be marked "TOP" to designate the proper orientation of the module in the traffic signal housing and shall be marked with a color-coded symbol to identify the color of the LED module. In addition, all arrow indications shall designate the orientation by a label affixed to the assembly.

13. All LED vehicular indications shall produce the appearance of an incandescent traffic signal indication.

    a. The illuminated surface of each LED ball indication shall appear to the motorist as uniform and shall have a wide viewing angle that makes it suitable for installation on wide roadways.

    b. Individual LED arrays shall not be visible separately for these indications but shall light the surface of the tinted lens uniformly to make the indication appear to be illuminated by incandescent lamps.

14. Manufacturer Warranty:

    a. The manufacturer's warranty of all LED modules shall be minimum 5-year replacement of any defective or failed LED units from the time of activation.

    b. The manufacturer shall further warranty all LED modules for a minimum life of 5 years for compliance with minimum illumination output from date of acceptance.

    c. The manufacturer shall be responsible for all pickup or shipping costs for the replacement units.

E. Housing.

1. Each signal section housing shall be either die-cast or permanent mold-cast aluminum conforming to ANSI Standard C-10.1.

2. Maximum height of a signal section shall be 10 inches for each 8-inch section and 14-1/16 inches for each 12-inch section.

3. Each section shall be complete with a 1-piece, hinged door mounting for the lens and other parts of the optical system, watertight gaskets, and a simple door-locking device.

4. The optical system shall be mounted for ready access and removal.

5. The sections shall be interchangeable and so constructed that sections can be removed and added.

6. There shall be an opening in the top and bottom of each section to receive a 1-1/2-inch pipe.

7. All bolts, screws, hinge pins, door-locking devices, and other hardware shall be stainless steel.

8. All gaskets shall be of neoprene.

9. Each signal section shall be constructed so that structural failure of the housing will not occur with a wind load pressure of 25 pounds per square foot on the projected area of the complete signal face housing, including backplate and visors.

10. Any fracture within the housing assembly or a deflection of more than half the lens diameter of the signal section will be considered structural failure.

F. Electrical Components.

1. Traffic signal section wiring shall conform to ANSI Standard D-10.1.

2. Each LED module shall be wired to a terminal block mounted inside at the back of the signal housing.

3. The terminal block shall have sufficient screw-type terminals to terminate all field conductors independently with separate screws.

4. The terminals to which field conductors are attached shall be permanently identified or conductors shall be color coded to facilitate field wiring.

G. Visors. Each section shall be provided with a removable, full-circle, metal visor conforming to ANSI Standard D-10.1 and the Uniform Standard Drawings, unless otherwise shown on the Drawings.

H. Directional Louvers.

1. Where shown on the Drawings, directional louvers shall be furnished and installed in signal visors.

2. Directional louvers shall be so constructed as to have a snug fit in the signal visors.

3. The outside cylinder shall be constructed of 0.030-inch nominal thickness or thicker sheet steel or the cylinder and vanes shall be constructed of 3003 H14 aluminum alloy of equivalent thickness.

4. Dimensions of louvers and arrangements of vanes shall be as shown on the Drawings.

I. Backplates.

1. Backplates shall be furnished and installed on all vehicular signal heads.

2. Dimensions, materials, and installation details shall be as shown in the Uniform Standard Drawings No. 900 through No. 903.

3. No background light shall show between the backplate and the signal face or between sections.

4. Where a backplate consists of 2 or more sections, the section shall be fastened with rivets or with aluminum bolts peened after assembly to prevent loosening.

5. All traffic signal backplates shall be louvered and shall be painted or powder coated flat black using the same technique as on the signal housing.

J. Signal Mounting Assemblies.

1. Assemblies for the mounting of signal faces shall consist of 1-1/2-inch standard steel pipe and necessary fittings, slip-fitters, and terminal compartments painted or powder-coated using the same technique and the same color as on the signal housing.

a. All post top and side mount brackets shall have bronze or ferrous terminal compartments.

b. Each terminal compartment shall be fitted with a terminal block containing a minimum of 12 poles, each with 2 screw-type terminals.

c. Each terminal shall be designed to accommodate at least five No. 14 AWG conductors.

d. A cover shall be provided on the compartment to give ready access to the terminal block.

2. Bracket-mount terminal compartments shall be designed to bolt securely to a pole.

a. The dimensions of mounting assembly members between the axis through the center of the terminal compartment, or slip-fitter, shall not exceed 11 inches, except where required to provide proper signal face alignment or permit programming of programmed visibility signal faces or when otherwise directed by the Engineer.

b. Each mounting assembly shall be oriented to provide maximum horizontal clearance to the adjacent roadway.

c. All mounting assembly members shall be either plumb or level, symmetrically arranged, and securely assembled.

d. All conductors shall be concealed.

e. Mounting assemblies shall be watertight and free of sharp edges or protrusions that might damage conductor insulation.

3. Post-top mounted signals shall be installed using a slip-fitter.

a. The slip-fitter shall fit over a 4-1/2-inch outside diameter pipe or tapered standard end.

b. Each slip-fitter shall be provided with 3 cadmium-plated or stainless steel set screws evenly arranged around the fitting.

c. Each slip-fitter used to post-top mount signals with brackets shall be provided with an integral terminal compartment.

4. Side mount assemblies shall be attached to the signal pole in accordance with Uniform Standard Drawings No. 404.1024 and No. 404.1029.

5. All mounting assemblies shall be provided with positive locking, serrated fittings that, when mated with similar fittings on the signal faces, shall prevent faces from rotating. Fittings shall permit fastening at increments of not more than 7 degrees.

623 T.02.09 PROGRAMMED VISIBILITY VEHICLE SIGNAL FACES

A. Each programmed visibility signal face and the installation thereof shall conform to Subsections 623 T.02.08.I, "Backplates," and 623 T.02.08.J, "Signal Mounting Assemblies."

B. Each programmed visibility signal section shall provide a nominal 12-inch solid or arrow indication.

1. Color and arrow configuration shall conform to ANSI Standard D-10.1.

2. Each section shall be provided with a sun visor.

C. All signal sections shall be provided with an adjustable connection that permits incremental tilting from 0 to 10 degrees above or below the horizontal while maintaining a common vertical axis through couplers and mountings.

1. Terminal connection shall permit external adjustment about the mounting axis in 5 degree increments.

2. The signal shall be mountable with ordinary tools and capable of being serviced without tools.

3. Adjustment shall be preset at 4 degrees below the horizontal, unless otherwise specified.

D. The visibility of each programmed visibility signal face shall be capable of adjustment or programming within the face. When programmed, each signal face's indication shall be visible only in those areas or lanes to be controlled, except that during dusk and darkness a faint glow to each side will be permissible.

E. Prior to programming, each signal section with a yellow indication shall provide a minimum luminous intensity of 3,000 candela on the optical axis, and a maximum intensity of 30 candela at 15 degrees horizontal from the axis.

1. Each such signal section shall be capable of having its visibility programmed to achieve the following luminous intensities:

a. A minimum of 3,000 candela on the optical axis.

b. A maximum of 100 candela at from 1/2 degree to 2 degrees horizontal from the axis.

c. A maximum of 10 candela at from 2 degrees to 15 degrees horizontal from the axis.

2. Under the same conditions, the intensities of the red indication and the green indication shall be at least 19 and 38 percent respectively of the yellow indication.

F. Each signal face or each signal section shall include integral means for regulating its luminous intensity between limits in proportion to the individual background luminance.

1. Lamp intensity shall not be less than 97 percent of uncontrolled intensity at 1,000 foot-candles, and shall reduce to 15 ±2 percent of maximum intensity at less than 1 foot-candle.

2. The dimming device shall operate over an applied voltage range of 95 volts to 130 volts, 60 Hz and a temperature range of -40 degrees F to 165 degrees F.

G. The Contractor shall have a manufacturer's representative program the heads.

623 T.02.10 PEDESTRIAN SIGNAL FACES

A. Each pedestrian signal face shall conform to the following:

1. Messages shall be Lunar White WALKING PERSON and Portland Orange COUNTDOWN conforming to the requirements of the *Manual on Uniform Traffic Control Devices*.

2. Each pedestrian signal face shall be installed at the location and mounted in the manner shown on the Drawings.

3. All new pedestrian signal faces installed at any one intersection shall be of the same make and manufacturer.

4. Pedestrian signal indications that have been installed and are not in operation shall be covered from public view in accordance with Subsection 623 G.03.03, "Scheduling of Work," to clearly show that the signals are inoperative.

5. Pedestrian signals may be temporarily turned so that the faces are not visible to pedestrians if approved by the Engineer.

B. Optical Units.

1. Optical units for pedestrian signals shall be LED modules and shall be interchangeable with all pedestrian signal head manufacturers.
2. The LEDs shall be securely fastened to a printed circuit board and shall meet FCC Title 47, Subpart B, Section 15 Regulations for electrical noise.
3. The LED module shall be watertight when properly mounted in the signal head enclosure and conform to NEMA and ITE moisture resistance standards. The modules shall specifically conform to the NEMA 250 moisture resistance standards for Type 4 enclosures.
4. ALL LED modules shall be operationally compatible with NEMA TS 1 and NEMA TS 2 conflict monitoring parameters.
5. The LED module circuitry shall prevent flicker of the LED output at frequencies less than 100 Hz over the operating voltage range. There shall be no visible illumination from the LED module when the applied voltage is less than 35 VAC.
6. The LED modules for pedestrian signals shall be 17 inches wide and 16 inches high.
    a. LED modules shall be complete units, consisting of clear, textured and stabilized polycarbonate lenses, an LED circuit board inclusive of all individual LEDs and required circuit components, a 39-inch No. 18 AWG color-coded wire leads with strain relief and female quick connect/fasten terminals for No.18 AWG wire, and a one-piece commercial grade neoprene gasket.
    b. The LEDs shall be securely fastened to a printed circuit board and shall meet FCC Title 47, Subpart B, Section 15 Regulations for electrical noise.
7. LED modules shall have textured lenses to reduce glare.
8. The COUNTDOWN LED modules shall utilize exclusively AS or TS ALnGaP technology. The PERSON LED modules shall utilize InGaN technology.
    a. LED modules shall not exhibit degradation of more than 30 percent of their initial light intensity following accelerated life testing (operating at 185 degrees F and 85 percent humidity for 1,000 hours).
    b. LED modules shall be connected directly to line voltage, 117 VAC nominal, and shall operate over the voltage range of 80 VAC to 125 VAC, with a power factor of 0.90 or better.
    c. Total harmonic distortion shall be 20 percent or less.
    d. The intensity of the LED signal shall not vary by more than 10 percent over the allowable voltage range.
9. Each individual LED module shall have a separate power source for the WALKING PERSON and COUNTDOWN indications internal to the module.
10. The LED modules shall be energy efficient.
11. Unless otherwise specified, the LED modules shall include a countdown indication as specified in the most recent MUTCD requirements.
12. Manufacturer Warranty:
    a. The manufacturer's warranty of all LED modules shall be minimum 5-year replacement of any defective or failed LED units from the time of activation.

b. The manufacturer shall further warrantee all LED modules for a minimum life of 5 years for compliance with minimum illumination output from date of acceptance.

c. The manufacturer is responsible for all pickup or shipping costs for the replacement units.

C. Housing.

1. The housing shall be made of 3003 H14 die cast aluminum alloy with smooth finish on both sides.

a. Thickness shall be 1/8-inch minimum at the points of support.

b. The housing shall be corrosion resistant and shall provide for easy access to and replacement of all components.

c. All machine screws, studs, and washers shall be either nickel plated brass, stainless steel, or other corrosion resistant material.

d. Gaskets shall be provided as required to make the housing rain-tight and dust tight.

e. Gaskets shall conform to the provisions in ASTM D1056, Grade SBE42.

2. The housing shall be provided with top and bottom openings for 1-1/2-inch pipe.

a. Unused openings shall be closed with watertight closures painted to match the housing, as shown on the Uniform Standard Drawings.

b. The housing construction design shall not incorporate a clamshell mounting.

c. The housing shall be fully adjustable.

3. Terminal Block: A light duty terminal block shall be mounted in the housing for field wiring.

4. Finish: The outside of the housing shall be painted the same color using the same painting process as for the vehicular signals.

5. Pedestrian Signal Mounting Assemblies:

a. Assemblies for the mounting of pedestrian signals shall consist of 1-1/2-inch standard steel pipe and necessary fittings, slip-fitters, and terminal compartments painted or powder-coated using the same technique and the same color as on the signal housing.

b. All post top and side mount brackets shall have bronze or ferrous terminal compartments.

1) Each terminal compartment shall be fitted with a terminal block containing a minimum of 6 poles, each with 2 screw-type terminals.

2) Each terminal shall be designed to accommodate at least five No. 14 AWG conductors.

3) A cover shall be provided on the compartment to give ready access to the terminal block.

c. Bracket-mount terminal compartments shall be designed to bolt securely to a pole.

1) The dimensions of mounting assembly members between the axis through the center of the terminal compartment, or slip-fitter, shall not exceed 11 inches, except where required to provide proper pedestrian signal face alignment.

2) Each mounting assembly shall be oriented to provide maximum horizontal clearance to the adjacent roadway.

3) All mounting assembly members shall be either plumb or level, symmetrically arranged, and securely assembled.

4) Construction shall permit all conductors to be concealed.

5) Mounting assemblies shall be water-tight and free of sharp edges or protrusions which might damage conductor insulation.

d. Post-top mounted pedestrian signals shall be installed using a slip-fitter.

1) The slip-fitter shall fit over a 4-1/2-inch outside diameter pipe or tapered standard end.

2) Each slip-fitter shall be provided with 3 cadmium-plated or stainless steel set screws evenly arranged around the fitting.

3) Each slip-fitter used to post-top mount signals with brackets shall be provided with an integral terminal compartment.

e. All mounting assemblies shall be provided with positive locking, serrated fittings that, when mated with similar fittings on the signal faces, shall prevent faces from rotating. Fittings shall permit fastening at increments of not more than 7 degrees.

623 T.02.11 PEDESTRIAN PUSH BUTTONS

A. Pedestrian push buttons of tamper-proof construction shall be furnished and installed for all pedestrian phases. The assembly shall be weatherproof and so constructed that it will be impossible to receive any electrical shock under any weather condition.

B. The pedestrian push button switch shall be a phenolic, enclosed, precision snap-acting type switching unit. It shall be single-pole, double-throw, with screw-type terminals, rated 15 amperes at 125 VAC, and shall have the following characteristics:

1. The switching unit shall have a stainless steel plunger actuator.

2. The switch shall be provided with U-frame to permit recessed mounting.

3. The switch shall have an operating force of 0.56 to 0.81 lbf and have a minimum release force of 0.25 lbf.

4. Switch pre-travel shall be 1/64 inch maximum.

5. Switch over-travel shall be 7/32 inch minimum.

6. Switch differential travel shall be 0.0004 to 0.002 inch.

C. Push buttons shall be 2-inch minimum diameter.

D. Pedestrian push button housings attached to poles 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.

E. Pedestrian push buttons to be mounted on top of a 2-1/2-inch diameter post shall incorporate a slip-fitter coupling with recessed set screws for securing the mechanism rigidly to the post.

F. Push button and sign shall be installed on crosswalk side of the pole.

G. Arrows on push button sign shall point in same direction of corresponding crosswalk.

H. Mounting height of the pedestrian push button shall be in accordance with the latest published edition of the ADA Guidelines.

I. Pedestrian push button signs shall be designated on the Drawings.

623 T.02.12 FLASHERS

A. All flasher signal heads shall be a minimum 12-inch diameter lens.

B. Visors. Each flashing beacon shall be provided with a tunnel type visor.

C. Flashing Beacon Control Assembly.

1. Each flashing beacon control assembly shall consist of switches, circuit breakers, terminal blocks, flasher, wiring, and electrical components necessary to provide proper operation of the beacons, all housed in a single enclosure.

2. The enclosure shall be as specified in the Uniform Standard Drawings or Special Provisions.

D. Circuit Breakers and Switches.

1. A single-pole 15-ampere circuit breaker shall be installed to control each ungrounded conductor entering the enclosure.

2. A switch to permit manual operation and testing of the flasher circuit shall be provided and labeled "Auto-Test."

3. The switches shall be toggle type, single-pole, single-throw, and rated at 15 amperes, 125 VAC.

4. Switches shall be connected in parallel with the timing control circuit so that the timer is bypassed when the switch is in the Test position.

E. Flasher. A 15-ampere solid state flasher shall provide for a 2-circuit alternate operation of beacons.

F. Terminal Blocks. Terminal blocks shall be rated at 25 amperes, 600 volts, shall be molded from phenolic material, and shall be the barrier type with plated brass screw terminals and integral type marking strips.

623 T.02.13 TRAFFIC SIGNAL POLES

A. All traffic signal poles shall consist of a continuous tapered rounded or multi-sided steel pole shaft of the length specified, pole cap, anchor bolt cover, and hand hole cover(s), with the bolts, nuts, and washers necessary to complete the installation of the pole shaft.

B. The traffic signal and luminaire mast arms shall consist of continuous, tapered round steel tubes of the lengths specified, mast arm end caps and bolts, nuts, and washers necessary to complete the installation of the mast arms.

C. Pole assemblies, traffic signal mast arms, luminaire mast arms and brackets, anchor-bolt and handhole covers, and pole and mast arm caps shall be hot-dip galvanized in conformance with ASTM A123.

1. Associated hardware shall be hot dip galvanized in accordance with ASTM A153.
2. Flaws in the appearance of galvanized components shall be cause for rejection by the Engineer.
3. The Engineer shall reject galvanized materials with finishes that have a striped or uneven appearance, a build-up of zinc hydroxide, rust stains, ash inclusions, dross protrusions, and/or flux inclusions.
4. Galvanized materials that exhibit these flaws shall also be rejected.

D. Anchor-bolt covers shall be a two-piece aluminum or ferrous metal design with a finish to match the pole shaft.

1. Anchor bolt covers shall cover the base plate completely and shall be firmly secured in place at the bottom of the pole.
2. Anchor bolt covers for traffic signal poles shall rest on the top of the foundation when installed properly but shall not exceed 6 inches in height.
3. All bolts, screws, nuts, and washers necessary to assemble the cover shall be included.

E. Poles shall sustain a horizontal test load in accordance with manufacturer's specifications without failure of any component part.

F. Luminaire arms for traffic signal poles shall sustain a vertical load of 100 pounds applied within 3 inches of the luminaire end of the support with the support attached to a rigid structure.

1. The vertical deflection shall not exceed 5-1/2 percent of the bracket or mast arm length.
2. The luminaire brackets or mast arms shall sustain a transverse horizontal load of 150 pounds applied within 3 inches of the luminaire end of the support with the support attached to a rigid structure.
3. The horizontal deflection shall not exceed 10 percent of the bracket or mast arm length.
4. The pole attached devices shall not develop any looseness within the specified loading range.

G. Traffic signal mast arms shall sustain the vertical loads as represented in the Uniform Standard Drawings.

H. All welds shall be continuous.

1. One circumferential weld shall be allowed for each 10 feet of length and 1 longitudinal weld will be permitted in assembling the shaft.
2. Where the sections are butt-welded together, the welded seams of adjacent sections shall be placed together to form a continuous weld.
3. Butt joints shall be reinforced in the pole/arm by 3-inch wide sleeves of the same composition and gauge as the steel in the pole/arm.
4. The sleeves shall be centered at the joint and shall be in full contact with the metals that are being joined.

5. The weld metal shall extend to the sleeve, making the sleeve an integral part of the joint.

6. Welding shall be done by American Welding Society (AWS) certified welders.

I. All surplus weld material or protrusions shall be ground smooth.

1. Ground joints shall maintain the strength of the original metal.

2. Exposed welds, except fillet and longitudinal welds, shall be ground flush with the base metal.

J. Exposed edges of base plates shall be broken. The pole shaft shall telescope through the base plate and shall be secured by 2 continuous welds, 1 on the inside at the bottom of the plate and the other on the outside on top of the plate.

K. The pole shafts shall be of round cross section, with a minimum outer diameter at the base as shown in the Uniform Standard Drawings for the type of pole specified, and shall uniformly decrease in diameter at the rate of 0.14 inches per foot of length.

1. The pole shafts may be multi-sided with a minimum roundness ratio of 98 percent so that the poles retain the appearance of a round unit.

2. Multi-sided poles shall have a minimum of 16 sides.

3. Poles that appear multi-sided, with noticeable edges between the sides that are clearly visible, may be rejected by the Engineer.

4. Pole shafts shall be straight, with a permissive variation not to exceed 1/4 inch for each 10 feet of pole shaft.

a. A 30-foot pole would have 3/4 inch allowable deviation at the midpoint of the pole shaft.

b. A 20-foot shaft would have 1/2 inch allowable deviation.

c. A 10-foot shaft could deviate a maximum of 1/4 inch at the midpoint.

L. Type 1-A and 1-B traffic signal poles shall be constructed of 0.120-inch or thicker steel with the dimensions shown in the Uniform Standard Drawings.

M. A grounding lug shall be supplied interior to all signal and lighting pole shafts, including 1-A and 1-B pedestal poles, opposite the handhole for securing the grounding connections. This grounding lug shall be threaded to accept a standard 1/2-inch bolt and shall be welded to the inside of the pole where it is easily accessed for maintenance and repairs.

N. Traffic signal pole luminaire mast arms shall be manufactured of tapered steel and shall be 15 feet.

1. The tapered arms shall taper to provide a minimum of 7-1/2 inches of arm of a constant and uniform outside diameter of 2.4 inches perpendicular to the shaft for attaching the luminaire.

2. Alternatively, the arm may include a luminaire end consisting of 2-inch, Schedule 40 pipe, conforming to ASTM A53 or ASTM A500, Grade B, welded in place so that a minimum of 7-1/2 inches is exposed for the attachment of the luminaire.

3. The pole attachment end shall include a 3-bolt, rain-tight steel fitting as called for on Standard Drawing No. 318.

4. The fitting shall be welded in place.

5. The bolts shall be high strength conforming to ASTM A325.

O. Signal poles and arms shall be fabricated from weldable grade sheet steel having a minimum yield strength, after fabrication, of 48,000 psi.

P. All 30- and 40-foot traffic signal poles shall be furnished with 2 luminaire mast arm mounting plates with the 3-bolt simplex shown in the Uniform Standard Drawings.

Q. All surplus weld material or protrusions shall be ground smooth.

1. Ground joints shall maintain the strength of the original metal.

2. Exposed welds, except longitudinal and fillet welds, shall be ground flush with the base metal.

3. Anchor bolts, nuts, and washers for traffic signal poles shall conform to the Uniform Standard Drawings for the type of pole specified and shall be hot-dip galvanized.

4. The bolts shall be galvanized for the entire length of the bolt.

R. Handholes in the base of XX, XX-A, and XX-B traffic signal poles shall have a minimum OD of 6 inches by 9 inches.

1. Handholes shall face away from oncoming traffic and shall be located 12 inches above the base plate.

2. The handhole shall be 6 inches by 9 inches OD reinforced frame with flat or indented type cover.

3. The handhole cover shall utilize two 1/4-inch standard thread screws secured to steel plates welded inside the handhole opening to hold the cover in place.

4. The screws shall be a weather and vandal resistant 1/4-inch hexagonal socket head screw.

5. Handholes may be rectangular or oval.

S. Handholes opposite the traffic signal mast arms of XX, XX-A, and XX-B traffic signal poles shall have a minimum OD of 6 inches by 9 inches.

1. Handholes shall be 180 degrees opposite the signal mast arms and shall conform to the Uniform Standard Drawings.

2. The handhole shall be centered with the mast arm assembly.

3. The handhole cover shall utilize two 1/4-inch standard thread screws secured to steel plates welded inside the handhole opening to hold the cover in place.

4. The screws shall be a weather and vandal resistant 1/4-inch hexagonal socket head screw.

5. Handholes may be rectangular or oval.

T. Handholes for 1-A and 1-B traffic signal poles shall have a minimum OD of 4 inches by 6 inches, and the bottom shall be 8 inches above the base plate.

1. The cover plate shall be secured with two 1/4-inch bolts secured to steel plates welded inside the handhole opening with standard thread and tamper-proof hexagonal heads.

2. Handholes may be rectangular or oval.

U. Poles, arms, and associated hardware to be painted shall be galvanized in accordance with ASTM A123 and ASTM A153 prior to applying the finish coating.

1. The finish of the galvanized materials shall then be prepared according to the paint manufacturer's recommendation before the finish paint or powder coating is applied.

2. The finish coating shall consist of a minimum of 2 coats of aliphatic urethane or Triglycidyl Isocyanurate (TGIC) Polyester Powder.

3. The finish shall be colored as specified in the Contract Documents or by the Engineer at the time of order.

V. The manufacturer's identification tag shall be mounted above the handhole.

623 T.02.14 INTERCONNECT JUNCTION CABINET

A. Traffic signal interconnect junction cabinets are not permitted except as specifically approved by the Engineer in consultation with FAST.

B. The interconnect junction cabinets shall be Tesco Enclosure Class 22-000-NR, 43 inches by 20 inches by 11 inches, or approved equal.

C. The cabinet shall be equipped with 1 Reliable Electric No. R66B4-25 terminal block, or approved equal, having capacity for 25 pairs of No. 22 AWG wire.

D. The terminal block shall be mounted on a painted wood panel secured to the back of the cabinet.

E. The Contractor shall provide and install a door lock with a key and all foundation, anchor bolts, and hardware in accordance with instructions of the cabinet manufacturer.

623 T.02.15 RED LIGHT DISPLAY INDICATORS

A. Red light display indicators shall be installed at the locations shown in the Drawings or as directed by the Engineer.

623 T.02.16 INTERNALLY ILLUMINATED STREET NAME SIGNS

A. Internally illuminated street name signs shall be provided at all traffic signal locations, unless otherwise specified in the Contract Documents.

B. The signs shall be 8 feet long and 22-5/16 inches high with street names on both sides of the sign. The signs shall be weather-tight and consist of 6063 T-5 alloy aluminum housing.

C. The sign panels shall be fabricated of clear plastic sheeting having a minimum thickness of 0.1875 inches with aluminum framing.

1. The clear plastic panels shall be covered with translucent white, wide-angle, prismatic reflective sign face sheeting, and either reverse-screened with manufacturers' recommended green ink and clear coating or overlaid with green, electronic cuttable, transparent overlay film.

2. The sign sheeting shall be applied in a vertical orientation in accordance with the manufacturer's recommendations.

3. The sign face shall have a 2-1/4-inch white border.

4. Sign lettering shall be 8-inch series D upper/lower case design unless otherwise specified by the Engineer.

5. Lower case letters shall be 5 inches in height.

6. The sign face shall have the compass direction of the location marked in the upper left corner of each sign panel with a 5-inch upper case letter (N, S, E or W).

7. The street name suffix (Street, Way, Blvd., and so forth) shall be displayed in the upper right corner of the sign panel with upper case letters.

8. The street address number of the location shall be shown at the lower right corner in 5-inch upper case letters and numerals.

9. Engineer approval is required for the sign faces prior to fabrication.

D. The lighting ballast shall be Advance 120V, 60 Hz RSM175STP, Class P, Type HL, Type 1 outdoor ballast.

1. Lamps shall be 430 mA cool white.

2. Two lamps, spaced 6 inches apart, are required for each lighted sign.

3. A lighting ballast is required for each lamp.

E. The internal wires shall be carefully installed along the side of the street name sign canister and shall be secured in place with a continuous bead of clear silicon rubber.

F. The sign shall be capable of withstanding winds of 100 mph without damage.

623 T.02.17 ELECTRICAL SERVICE

A. Electrical service pedestals to be installed for traffic signals systems shall comply with Subsection 623 G.02.07, "Electrical Service Pedestals."

B. Connection to the electrical utility shall be as shown on the Drawings, as indicated in the Special Provisions, or as directed by the Engineer.

C. The Contractor shall be responsible for coordinating with the electrical utility at the proper time to ensure the electrical connection will be energized on schedule.

623 T.02.18 UNINTERRUPTIBLE POWER SUPPLY SYSTEMS (UPS)

A. When specified, an uninterruptible power supply system shall be supplied in accordance with the Contract Documents.

CONSTRUCTION

623 T.03.01 PAINTING

A. The preparation and finishing of new equipment and refinishing existing materials shall be as follows:

1. Galvanized and stainless steel devices shall not be painted unless otherwise specified in the Contract Documents or approved in writing by the Engineer.

2. Non-ferrous surfaces shall be painted only if specified in the Contract Documents or approved and directed by the Engineer. Surfaces shall be cleaned and coated with vinyl wash primer. Ferrous metal surfaces shall be cleaned and immediately coated with the primer specified in Subsection 714.03.01.B, "Pre-Treatment, Vinyl Wash Primer (State Specification 8010-61J-27)."

3. All traffic signal poles, posts, and mast arms shall be hot-dip galvanized by the manufacturer in accordance with ASTM A123. Traffic signal poles shall not be painted unless specifically called for in the Drawings and Special Provisions.

4. Directional louvers and backplates shall be painted flat black.

5. Traffic signal cabinets and controller boxes shall conform to Subsection 623 T.02.01, "Traffic Signal Controller Cabinets."

6. Factory enameled equipment and materials shall be examined for damaged paint after installation, and such damaged surfaces shall be refinished by the Contractor to the satisfaction of the Engineer.

7. Existing equipment and material to be repainted, whether remaining in place or to be relocated, shall be cleaned of all rust, scale, grease, dirt, and poorly bonded paint to the satisfaction of the Engineer.

8. All bare metal shall be prime painted immediately after cleaning, or as specified for new material. Two finish coats shall then be applied over newly primed areas.

9. Blast cleaning of galvanized metal surfaces that are in good condition will not be permitted.

10. Paint coats may be applied either by hand brushing or by approved spraying machines with the work performed in a neat and workmanlike manner.

    a. No spraying shall be done at the job site in windy or bad weather conditions unless approved by the Engineer.

    b. The Engineer may require the use of brushes or spray equipment for the application of paint depending on the application and the weather conditions.

11. The thickness of each paint coat shall be limited to that which will result in uniform drying throughout the film. Skips, holidays, thin areas, or other deficiencies in any 1 coat of paint shall be corrected to the satisfaction of the Engineer before the next coat of paint is applied.

12. The final coat shall present a smooth surface, uniform in color, and free of runs, sags, excessive brush marks, tiger-striping, or other deformities as determined by the Engineer.

13. Galvanizing repair shall consist of metalizing or hot-stick galvanizing.

    a. Surfaces regalvanized shall be prepared in accordance with ASTM A780.

    b. Application of the zinc metalizing protection shall be in accordance with ANSI/AWS C2.18-93.

    c. Zinc soldering or hot-stick galvanizing shall be performed by skilled personnel familiar with the procedure and surrounding areas shall not be damaged by the heat applied.

    d. In either case, the renovated areas shall have a zinc coating thickness of at least as thick as that specified in ASTM A123.

    e. Cold galvanizing spray or other methods of applying cold galvanizing shall not be allowed.

623 T.03.02 ELECTRICAL TESTING

A. Prior to completion of the work, the Contractor shall cause the following tests to be made on any or all new electrical circuits, as required by the Engineer and in the presence of the Maintaining Agency representative:

1. Test for continuity of each circuit.

2. A visual inspection of all grounding connections. Electrical equipment and components shall not be energized unless properly grounded as specified in the Contract Documents and directed by the Engineer.

3. A megohmeter test on each single conductor circuit between the circuit conductor and all other circuits and ground as specified in the Contract Documents and directed by the Engineer.

   a. The insulation resistance shall not be less than 500 megohms when tested at 500 volts.

   b. Individual conductors in traffic signal cable, RF cable, Opticom cable, CCTV power cable, communications cable, other multi-conductor cables, and coaxial cables shall be exempted from the megohm testing by the Engineer if a visual inspection of these cables shows no suspicious cuts, tears, or other damage to the outside insulation.

   c. Under no circumstances shall street light fixtures, video detection cameras, or other low voltage components be subjected to the high voltage of this test.

4. A flash test for traffic signal installations to verify the terminals and connections before turn-on.

5. A functional test in which it is demonstrated that all parts of the system function as specified or intended.

6. Any fault in any material or in any part of the installation revealed by these tests shall be replaced or repaired by the Contractor immediately. All repairs and material replacements shall be completed to the satisfaction of the Engineer.

623 T.03.03 GROUNDING

A. All electrically conductive materials of the electrical system shall be connected to earth and system grounds and shall conform to the following:

1. Metal pull box covers shall be grounded with No. 4 AWG 7-strand copper wire connected to the system ground and the pull box cover.

   a. The connection to the pull box cover shall be made using an exothermal welding system that is appropriate for the material of the cover.

   b. An irreversible compression type connector shall be used to connect to the system grounding conductor.

2. The Contractor shall be responsible for grounding the electrical system including pull boxes, poles, cabinets, conduits, service pedestals, and other enclosures to the satisfaction of the Engineer. No separate payment shall be made for this work unless specifically shown in the list of pay items.

3. Poles and traffic signal cabinets shall be grounded to the system and earth grounds using bare No. 4 AWG copper wire connected to the anchor bolts of the concrete foundation and to the grounding plate installed under the foundation. Grounding the system shall comply with Standard Drawing 404.213.

4. Service pedestals shall be grounded using UFER ground of 20 feet of No. 4 AWG, bare, stranded copper conductor coiled under the foundation of the pedestal.

5. The bare grounding wire of traffic signal poles shall be equipped with a copper grounding lug to be attached to the equipment ground screw.

a. The lug shall be sized to snugly fit over the grounding bolt of the equipment.

b. The grounding wire lug shall be an irreversible, compression type component and shall be installed on the bare grounding conductor 24 inches from the end of the wire to allow connection of other grounding conductors to the end of the bare wire.

c. The grounding lug shall be installed so that the bare grounding wire end, when pulled through the handhole, shall have a minimum length of 12 inches outside of the pole.

d. The No. 8 AWG green system grounding conductor from the conduit and all other grounding conductors servicing equipment on the pole shall be connected to the end of the bare grounding conductor with a removable, mechanical device such as a split bolt.

623 T.03.04 CABINET INSTALLATIONS

A. Electrical service pedestals and traffic signal controller cabinets shall not be installed in areas that are regularly irrigated with broadcast sprinklers or areas that may become flooded with sprinklers.

STREET LIGHTING SECTION

DESCRIPTION

623 L.01.01 GENERAL

A. Street lighting construction shall consist of furnishing, installing, modifying, or removing street light poles and fixtures or other electrical installations in the roadway right-of-way as shown on the Drawings and specified in the Contract Documents.

B. The locations of street light poles, electrical services, and other associated equipment shown on the Drawings are approximate. The Engineer will confirm exact locations of these items in the field.

C. All materials furnished and installed shall be manufactured, handled, and used in a manner to ensure completed work with undamaged equipment and materials in accordance with the Drawings, specifications, and Special Provisions. Engineer approval of all materials shall be required prior to installation.

D. All systems shall be complete and in satisfactory operating condition at the time of acceptance including successful completion of all testing required by these specifications.

E. All work performed on any street lighting component or system shall be under the direct on-site supervision of an Electrician certified as a Journeyman or greater. An electrician with Journeyman level status certification or IMSA Roadway Lighting certification shall supervise the installation of electrical raceways that are part of a street lighting system.

F. The Contractor shall be responsible for locating and protecting all underground and aerial utilities and infrastructure improvements.

1. The exclusion of utilities and other structures on the Drawings or in the Special Provisions does not limit the Contractor's responsibility for these construction elements.

G. If specified in the Contract Documents, GPS coordinates shall be supplied.

623 L.02.01 STREET LIGHT POLES AND ARMS

A. All lighting poles shall consist of a continuous tapered round steel pole shaft of the length specified, pole cap, anchor bolt cover, and hand hole cover(s), with the bolts, nuts, and washers necessary to complete the installation of the pole shaft.

B. The luminaire arm shall have a minimum length of 8 feet.

1. The arm shall be formed from 2-inch, Schedule 40 pipe, with standard 2.4-inch outside diameter (OD) conforming to ASTM A53 or ASTM A500, Grade B.
2. The overall length and vertical rise of the arm shall be in a ratio of 1:4, vertical to horizontal.
3. The overall shape of the curvature of the arm shall be similar to the arms shown on Standard Drawing 316.
4. A minimum straight portion of 7-1/2 inches shall be provided to attach the luminaire.
5. The pole shaft end of the arm shall have a single bolt, rain-tight, steel fitting with a cupped rim, simplex hooking mechanism.
6. The fitting on the arm shall be shaped to lock over the street light pole simplex fitting by gravity and shall be secured by a single 1/2-inch bolt with standard thread.

C. Luminaire mast arms 10 feet and longer shall be manufactured of tapered steel tubing.

1. The arms shall taper to provide a minimum of 7-1/2 inches of arm of a constant and uniform outside diameter of 2.4 inches perpendicular to the shaft for attaching the luminaire.
2. Or, alternatively, the arm may include a luminaire mounting end consisting of 2-inch, Schedule 40 pipe, conforming to ASTM A53, welded in place so that a minimum of 7-1/2 inches are exposed for the attachment of the luminaire.
3. The pole attachment end shall include a 3-bolt, rain-tight, steel simplex fitting as called for on Standard Drawing No. 318.
4. The fitting shall be welded in place.
5. The bolts shall be high strength conforming to ASTM A325.

D. Pole assemblies, luminaire mast arms and brackets, anchor-bolt and handhole covers, and pole and mast arm caps shall be hot-dip galvanized in conformance with ASTM A123.

1. Associated hardware shall be hot-dip galvanized in accordance with ASTM A153.
2. Flaws in the appearance of galvanized components shall be cause for rejection.
3. The Engineer will reject galvanized materials with finishes that have a striped or uneven appearance, a buildup of zinc hydroxide, rust stains, ash inclusions, dross protrusions, and/or flux inclusions.
4. Galvanized materials that exhibit a spidery, blotchy, or spotted appearance, that have a general surface roughness, or that exhibit lumpiness or runs in the finish shall also be rejected.

E. Anchor-bolt covers shall be a 2-piece aluminum or ferrous metal design with a finish to match the pole shaft, shall cover the base plate completely, and shall be firmly secured in place at the bottom of the pole.

1. Anchor-bolt covers for street light poles shall rest on the top of the foundation when installed properly but shall not exceed 6 inches in height.

2. All bolts, screws, nuts, and washers necessary to assemble the cover shall be included.

F. Luminaire arms for street light poles shall sustain a vertical load of 100 pounds applied within 3 inches of the luminaire end of the support with the support attached to a rigid structure.

1. The vertical deflection shall not exceed 5-1/2 percent of the bracket or mast arm length.

2. The luminaire brackets or mast arms shall sustain a transverse horizontal load of 150 pounds applied within 3 inches of the luminaire end of the support with the support attached to a rigid structure.

3. The horizontal deflection shall not exceed 10 percent of the bracket or mast arm length.

4. The pole attached devices shall not develop any looseness within the specified loading range.

G. The pole shafts shall be of round cross section, with a minimum outer diameter at the base as shown in the Uniform Standard Drawings for the type of pole specified, and shall uniformly decrease in diameter at the rate of 0.14 inch per foot of length.

H. Pole shafts shall be straight, with a permissive variation not to exceed 1/4 inch for each 10 feet of pole shaft.

1. A 30-foot pole would have 3/4 inch allowable deviation at the midpoint of the pole shaft.

2. A 20-foot shaft would have 1/2 inch allowable deviation.

3. A 10-foot shaft could deviate a maximum of 1/4 inch at the midpoint.

I. Poles shall sustain a horizontal test load of 500 pounds applied 18 inches from the top of the shaft in any direction without failure of any component part, and with a deflection of not more than 7-1/2 percent of the pole shaft length as measured from point of load application to the base plate.

J. All welds shall be continuous.

1. One circumferential weld shall be allowed for each 10 feet of length and 1 longitudinal weld will be permitted in assembling the shaft.

2. Where the sections are butt-welded together, the welded seams of adjacent sections shall be placed together to form a continuous weld.

3. Butt joints shall be reinforced in the pole/arm by 3-inch wide sleeves of the same composition and gauge as the steel in the pole/arm.

4. The sleeves shall be centered at the joint and shall be in full contact with the metals that are being joined. The weld metal shall extend to the sleeve, making the sleeve an integral part of the joint.

5. Welding shall be done by AWS certified welders.

K. All surplus weld material or protrusions shall be ground smooth.

1. Ground joints shall maintain the strength of the original metal.

2. Exposed welds, except fillet welds, shall be ground flush with the base metal.

L. Street light pole safety bases shall conform to Uniform Standard Drawings or as specified in the Contract Documents and approved by the Engineer.

M. Sheet steel used in the manufacturing process of street light poles shall have a minimum yield of 48,000 psi, or which after forming or cold rolling shall develop a minimum of 48,000 psi.

1. Poles shall have a minimum thickness of 0.119 inch for 11 gauge poles and 0.179 inch for No. 7 gauge poles.

2. The shaft shall be formed from not more than 1 piece of sheet steel for each 10 feet of pole length.

N. The pole base plate shall be 1 inch thick for No. 11 gauge standards and 1-1/8 inch thick for No. 7 gauge pole shafts.

1. Both base plates shall be 11-1/2 inches square and shall conform to ASTM A27, Grade 65-35 cast steel; ASTM A36 steel plate; or ASTM A283, Grade D steel plate.

2. The base plates shall be slotted to accommodate four 1-1/8-inch anchor bolts equally spaced at the corners for a 10-1/2-inch to 11-1/2-inch bolt circle diameter.

3. The slots shall be 2-1/8 inches long OD.

4. Exposed edges of base plates shall be finished smooth with the corners neatly rounded to a radius of approximately 1/8 inch.

5. The pole shaft shall telescope through the base plate and shall be secured by 2 continuous welds, 1 on the inside at the bottom of the plate and the other on the outside on top of the plate.

O. If specified in the Contract Documents, the handhole shall be 6 inches by 9 inches OD reinforced frame with slip-resistant indented type cover located 12 inches above the base plate.

1. Otherwise, a 4-inch by 6-inch reinforced frame with slip-resistant type cover shall be supplied.

2. The handhole cover shall utilize two 1/4-inch standard thread screws to secure the cover in place.

3. The screws shall be a weather and vandal resistant 1/4-inch hexagonal socket head screw.

P. A grounding lug shall be supplied interior to the pole shaft opposite the handhole for securing the grounding connections. This grounding lug shall be threaded to accept a standard 1/2-inch bolt and shall be welded to the inside of the pole where it is easily accessed for maintenance and repairs.

Q. The manufacturer's identification tag shall be placed above the handhole.

623 L.02.02 ANCHOR BOLTS

A. Anchor bolts for standard lighting poles shall conform to the following:

1. Anchor bolts shall conform to ASTM F1554, Grade 55, or ATSM A307 and shall have a minimum yield strength of 36,000 psi.

2. Anchor bolts shall be provided with 2 nuts and two 2-inch washers.

3. The anchor bolts and all nuts and washers shall be galvanized by the hot-dip process conforming to ASTM A123 and ASTM A153.

4. Anchor bolts shall be galvanized for the entire length of the bolt.

5. After galvanizing, the bolt threads shall accept the standard galvanized nuts for the full length of the thread without requiring tools, causing removal of protective coating, or requiring rethreading of the bolt or nut.

6. Anchor bolts for No. 7 gauge street light poles shall be 1-1/8 inches by 40 inches by 4 inches.

7. Anchor bolts for No. 11 gauge street light poles shall be 1 inch by 36 inches by 4 inches.

8. The upper 8 inches of the anchor bolts shall be threaded.

623 L.02.03 STREET LIGHTING LUMINAIRES

A. The standard luminaire shall be of the high pressure sodium type, horizontal burning, cobra head style, and in wattages specified in the Contract Documents.

1. The luminaire shall consist of a precision die cast aluminum housing, globe ring, lens, ballast, socket assembly, igniter, reflector, and hinged door.

2. The hinged door shall be lowered by releasing a latch mechanism and allowing the door to swing free on its hinge.

3. The latch assembly shall be easily operated while wearing lineman's gloves.

4. The hinged door latch shall have an audible locking mechanism and shall provide easy access to the refractor, reflector, ballast, igniter, and lamp.

5. The luminaire shall be provided with a terminal connection block installed in the upper housing.

B. The luminaire fixture shall be bonded to earth ground with a grounding conductor.

C. The luminaire housing and optical assemblies for 250-watt and 750-watt fixtures shall be the same size as is normally standard usage by the manufacturer for 400-watt fixtures.

1. The slip fitter shall be capable of adapting to 1-1/4-inch through 2-inch pipe bracket without rearrangement of parts and be adjustable +5 degrees from horizontal.

2. The optical assembly shall consist of an aluminum reflector, prismatic acrylic refractor for 100-watt luminaires, and borosilicate prismatic glass refractor for 150-watt through 750-watt luminaires or, when specified, shall be of polycarbonate resin vandal resistant material.

a. The refractors shall have accurately molded light controlling prisms and shall be resistant to impact and thermal shock.

b. The refractor shall provide maximum transmission and minimize unwanted spill light.

c. The socket size shall be mogul.

d. The socket shall be heavy duty, 20-ampere shrouded porcelain and shall be vertically and horizontally adjustable to obtain variations in light distribution patterns.

e. The socket shall have a non-cantilevered, spring loaded contact.

f. Standard street light fixtures shall be supplied with medium semi-cutoff photometrics and IES type III distribution, unless otherwise specified in the Contract Documents or directed by the Engineer.

D. The starting aid (igniter) for all luminaires shall be the plug-in type, removable without the use of tools.

E. The ballast shall be located in the top portion of the light fixture and shall be prewired to the lamp socket and terminal board.

1. Ballasts mounted on the hinged door are not allowed.

2. The ballast shall be of a "multi-tap" configuration, capable of starting and operating the lamp of the type and wattage indicated in Drawings and specified herein from a nominal 120-volt, 240-volt, 60 Hz power source, as shown in the Drawings within the limits specified by the lamp manufacturer.

3. The ballast, including starting aid, shall protect itself against normal lamp failure modes.

4. The ballast shall be capable of operating the lamp in an open or short circuit-condition for 6 months without significant loss of ballast life.

F. The ballast shall be a magnetic regulator type.

1. The coils and insulation shall be impregnated and baked using a high temperature varnish.

2. This treatment shall make the ballast impervious to normal moisture and environmental conditions and shall provide mechanical strength to thoroughly bond the coils to withstand vibration and shock.

G. The ballast shall reliably start and operate the lamp in ambient temperatures down to -30 degrees F for the rated life of the lamp.

1. Ballast primary current during starting shall not exceed normal operating current.

2. The lamp current crest factor shall not exceed 1.8 for ±10 percent line voltage variation at any lamp voltage.

3. The power factor of the lamp-ballast system shall not drop below 0.95 for ±10 percent line voltage variations at any lamp voltage.

4. The ballast design shall be such that the normal manufacturing tolerance for capacitors of ±6 percent will not cause more than a ±5 percent variation in regulation throughout rated lamp life for nominal line voltage.

H. Cut off luminaires shall be furnished for intersection lighting unless otherwise specified in the Contract Documents or directed by the Engineer.

1. This luminaire shall meet all of the applicable specifications contained herein and provide true 90-degree light cutoff and shielding with an Alzak aluminum reflector, a heat and impact resistant flat (or sag) glass lens, a 2-position adjustable socket holder, and a mogul size porcelain screw shell socket with lamp grips.

2. Maximum candela at 80 degrees shall be 9 and maximum candela at 90 degrees shall be 0.

3. The light distribution shall be IES Type III.

4. Intersection lighting installed in conjunction with traffic signals or at future traffic signal locations shall be 120-volt, HPS with IES SC3 optics.

I. Luminaires shall be leveled and adjusted in accordance with instructions of the manufacturer or as directed by the Engineer.

1. A leveling mechanism shall be provided for leveling the luminaire in both major directions.

2. A bubble leveling device shall be provided on the exterior of the luminaire to aid in this process.

J. Capacitors shall be suitably protected from corrosion and isolated from higher temperatures created by the ballast.

K. A slip-fitter shall be provided with a leveling clamp providing ±5 degrees vertical leveling.

L. All parts and fittings shall have a corrosion resistant finish.

1. The housing shall be free of any casting or forming burrs before the finish is applied.

2. Luminaires shall be painted with 2 finish coats of high gloss gray enamel or polyurethane powder coating.

M. The complete unit shall have uniform lines throughout and shall aesthetically combine in a cobra head design. The luminaire shall maintain the horizontal line of the housing when properly mounted on the bracket arm.

N. A permanent data sheet shall be provided on the inside of the housing containing pertinent information, such as a connection diagram, operating voltages, size of lamp required, part number of required igniter, and ballast requirements.

O. Heat and moisture resistant silicon rubber or fiber gaskets shall be provided around the reflector to produce a completely sealed optical assembly. A heat resistant silicon gasket shall also be provided between the reflector and the socket.

P. Unless otherwise specified in the Contract Documents or directed by the Engineer, all street lighting luminaires shall be furnished complete with high-pressure sodium high intensity discharge lamps with the following characteristics:

Type/Watts	Description	ANSI Code	Lamp	Initial Lumens	Rated Life
HPS 750	LU750	S51WA-400	Clear	110,000	16,000 hours
HPS 400	LU400	S51WA-400	Clear	50,000	24,000 hours
HPS 250	LU250	S50VA-250	Clear	28,000	24,000 hours
HPS 200	LU200	S66MN-200	Clear	22,000	24,000 hours
HPS 150	LU150/55	S55SC-150	Clear	16,000	24,000 hours
HPS 100	LU100	S54SB-100	Clear	9,500	24,000 hours

Q. The Contractor shall guarantee that all lamps that fail within 1 year under normal operating conditions shall be replaced at no additional cost to the Contracting Agency.

R. All luminaires and component parts shall be new with labels in accordance with ANSI standards. Reconditioned, reconstructed, or remanufactured luminaires and component parts are not acceptable.

S. Engineer approval of all street light fixtures shall be required prior to installation.

623 L.02.04 FUSEHOLDERS AND FUSES

A. This subsection applies to multiple street lighting circuits only.

B. Fuseholders and fuses shall be installed in the bases of all street lighting poles and shall be accessible through the handholes.

1. The fuseholders shall be single pole for 120 volts or double-pole for 240 volts.

2. The fuseholders shall be waterproof without the use of tape, with integral or separate conductor insulating boots.

C. The single pole fuse holders used for 120-volt circuits shall be composed of 2 parts that consist of sections for the line side and the load side. The fuseholder body and terminals shall be vapor and waterproof when the line and load sections are mated together according to the manufacturer's recommendations.

D. The double-pole fuseholder shall contain 2 fuseholder chambers that consist of a line side section and a load side section that are secured together with a screw when properly closed. Both load side connections shall be simultaneously disconnected when the fuseholder is opened.

E. Electrical arcs that may occur when connecting the matching pieces while the circuit is operational shall be confined within the body when a properly sized fuse is seated firmly in the terminals.

F. Fuse holders shall be rated for 600 volts and shall accept Midget 250-volt L4J12F fuse or approved equal. Glass, paper, or indicating type fuses are not acceptable.

623 L.02.05 STREET LIGHTING SYSTEMS

A. Unless otherwise specified on the Drawings, all the street lighting systems shall be 240-volt, single phase, 2-wire circuits connected in parallel (multiple).

B. Unless otherwise specified in the Contract Documents or approved by the Engineer, the 2-wire system shall consist of two No. 4 AWG stranded copper conductors with black and red THW-2 or XHHW-2 insulation to carry the load, and 1 green 8 AWG THW-2 or XHHW-2 equipment bonding conductor. Engineer approval of conductors to be installed shall be required prior to installation.

C. The service wire for the 240-volt/100-amp pole mounted service panel shall be three No. 1/0 AWG, stranded copper, THW-2 or XHHW-2 conductors from the service panel to the electrical utility transformer.

D. Electrical services installed for lighting on collector or arterial streets shall be standard electrical service pedestals and shall comply with Subsection 623 G.02.07, "Electrical Service Pedestals."

E. Unless otherwise specified in the Contract Documents, the cable from the base of the lighting pole to the luminaire shall be 3 conductors (one of them ground), No. 10 AWG solid copper with insulation, rated at 600 volts. The individual conductors shall be insulated with TW grade, and the outer jacket shall be PVC jacket type UF grade.

MISCELLANEOUS ELECTRICAL EQUIPMENT

623 L.02.06 STREET LIGHT CONTROLS

A. Contactor shall be a heavy-duty, commercial, mechanical armature type.

1. The mechanical type shall consist of an operating coil, a laminated core, a laminated armature, contacts, and terminals.

2. Contacts shall be silver alloy.

B. For series lighting systems the photoelectric control shall be capable of switching series lighting systems through a high voltage controller.

C. Types of photoelectric controls shall be as follows:

1. Type I. Type I photoelectric control shall consist of a photoelectric unit and a contactor in a single weatherproof housing.

2. Type II.

a. Type II photoelectric control shall consist of a photoelectric unit installed at the top of the first lighting standard from the service point, and shall control the lighting contactor in the pad mounted service cabinet.

b. A bypass switch shall be included to permit manual operation of the lighting system contactor.

c. Unless otherwise specified in the Contract Documents, the photoelectric units shall be for 120-volt operation on 2-wire or 3-wire single phase multiple lighting systems.

3. Equipment Details.

a. The photoelectric unit shall consist of a light sensitive element connected to a control relay.

b. The light sensitive element shall have a spectral response such that it is especially sensitive to north sky illumination and shall have an ON level adjustable between minimum limits of 0.6 footcandles and 1.1 footcandles.

c. The unit shall be so designed that a failure of any electrical or electronic component will energize the lighting circuit.

d. The photoelectric unit shall be mounted at the top of the standard designated on the Drawings and shall be oriented as directed by the Engineer.

4. Contactor.

a. The contactor shall be constructed in accordance with NEMA standards for lighting contactors and shall have contacts rated to switch the specified lighting load.

b. Contactor shall be the mechanical armature type.

c. The mechanical type shall consist of an operating coil, a laminated core, a laminated armature, contacts, and terminals.

d. Contacts shall be silver alloy.

5. Housing.

a. The contactor may be either integral with the photoelectric unit or may be located externally from it.

b. When located externally, the contactor shall be housed in a suitable NEMA Type 3 rain-tight enclosure with hasp for a padlock.

c. The rain-tight enclosure shall be mounted on the same standard as the photoelectric unit at a height of approximately 28 feet above the base.

d. All contactors' housings shall be approved by the Engineer prior to installation.

6. Wiring. Conductors between the photoelectric unit and an external contactor shall be a minimum No. 12 AWG, and shall be installed inside the lighting standard.

623 L.02.07 PAINT

A. Unless otherwise specified herein all metal parts, fittings, signal heads, posts, pedestals, standards, cabinets, controller boxes, and so forth shall be prepared and painted according to these specifications.

B. Types of paints to be used shall be as specified in Section 714, "Paint and Pavement Markings."

CONSTRUCTION

623 L.03.01 PAINTING AND FINISH REPAIR

A. The preparation and refinishing of existing equipment to be reused on projects shall be as specified below.

B. Galvanized, ferrous, and nonferrous surfaces to be painted shall be cleaned and immediately coated with vinyl wash primer, conforming to Subsection 714.03.01.B, "Pre-Treatment, Vinyl Wash Primer (State Specification 8010-6J-27)."

C. Primer coats applied by the manufacturer shall be checked by the Engineer and shall be repainted by the Contractor if necessary. Primer coats that are considered to be in good condition by the Engineer shall not require reapplication by the Contractor.

D. All removed and reused equipment and equipment that has been repaired in-place shall require appropriate refinishing by the Contractor.

E. Factory enameled equipment and materials shall be examined for damaged paint after installation, and such damaged surfaces shall be repainted to the satisfaction of the Engineer.

F. Existing equipment and material to be repainted, whether remaining in place or to be relocated, shall be cleaned of all rust, scale, grease, dirt, and poorly bonded paint by any method satisfactory to the Engineer.

1. Immediately after cleaning, all material shall be primed as appropriate and 2 finish coats of paint shall be applied after the primer coat has dried.

2. Blast cleaning of galvanized metal surfaces in good condition, as determined by the Engineer, will not be permitted.

G. Paint coats may be applied either by hand brushing or by approved spraying machines in the hands of skilled operators.

1. No spraying shall be done at the job site in windy or bad weather conditions and unless approved by the Engineer.

2. The work shall be done in a neat and workmanlike manner.

3. The Engineer may require the use of brushes or spray equipment for the application of paint depending on the materials and the weather conditions.

H. The thickness of each paint coat shall be limited to that which will result in uniform drying throughout the film. Skips, holidays, thin areas, or other deficiencies in any 1 coat of paint shall be corrected to the satisfaction of the Engineer before the succeeding coat is applied.

I. The final coat shall present a smooth surface, uniform in color, and free of runs, sags, or excessive brush marks.

J. Galvanizing repair of street light poles and appurtenances shall consist of metalizing or hot-stick galvanizing.

1. Surfaces regalvanized shall be prepared in accordance with ASTM A780.

2. Application of the zinc metalizing protection shall be in accordance with ANSI/ AWS C2.18-93.

3. Zinc soldering or hot-stick galvanizing shall be performed by skilled personnel familiar with the procedure, and surrounding areas shall not be damaged by the heat applied.

4. In either case, the renovated areas shall have a zinc coating thickness of at least as thick as that specified in ASTM A123.

5. Cold galvanizing spray or other methods of applying cold galvanizing shall not be allowed.

623 L.03.02 BONDING AND GROUNDING

A. Metallic cable sheaths, steel conduit, metal poles, pedestals, pull boxes, and other metal enclosures shall be metallically joined together and made mechanically and electrically secure to form a continuous electrical conducting path, and shall be effectively grounded as required by the *National Electrical Code*.

B. All conduits shall contain a No. 8 AWG, stranded copper grounding conductor with THW-2 or XHHW-2 green insulation to be used as a systems ground.

C. Bonding of street light poles and foundations shall be accomplished with a bare No. 4 AWG stranded copper wire attached to each anchor bolt and to the grounding bolt installed on the lower lip of the lighting pole handhole or inside the base of the pole as shown on the Uniform Standard Drawings.

1. The grounding end of the bare wire shall be connected to a grounding plate installed under a felt protective insulator under the foundation.

2. An extra length of 20 feet of No. 4 AWG grounding wire shall be coiled under the foundation for added contact with the earth.

3. The No. 8 AWG green systems grounding conductor from the conduit and the No. 10 AWG luminaire ground shall be connected to the No. 4 AWG bare foundation grounding wire.

D. Additionally, all electrically conductive materials of the electrical system shall be connected to earth and system grounds and shall conform to the following:

1. Pull box covers shall be grounded with No. 4 AWG 7-strand copper bare wire connected to the system ground and the pull box cover.

a. The connection to the pull box cover shall be made using an exothermal welding system that is appropriate for the material of the cover.

b. An irreversible compression type connector shall be used to connect to the system grounding conductor.

2. The Contractor shall be responsible for grounding the electrical system in accordance with the Contract Documents including pull boxes, poles, cabinets, conduits, service pedestals, and other enclosures to the satisfaction of the Engineer.

3. Grounding of conduit and neutral at the service point shall comply with the applicable sections of Article 250 of the *National Electrical Code*.

4. Pole foundation grounding wire shall be equipped with a copper grounding lug to be attached to the equipment ground screw.

a. The lug shall be sized to fit over the 1/2-inch grounding bolt of the pole.

b. The grounding wire lug shall be an irreversible, compression type component and shall be installed on the bare grounding conductor approximately 24 inches from the end of the wire to allow connection of other grounding conductors.

c. The grounding lug shall be installed so that the bare grounding wire end, when pulled through the handhole, shall have a minimum length of 12 inches outside of the pole.

d. The No. 8 AWG green system grounding conductor from the conduit and all other grounding conductors servicing equipment on the pole shall be connected to the end of the bare grounding conductor with a removable, mechanical device such as a split bolt.

623 L.03.03 ELECTRICAL TESTING

A. Prior to completion of the work, the Contractor shall cause the following tests to be made on all lighting and electrical circuits, as directed by the Engineer and in the presence of the Maintaining Agency representative:

1. Test for continuity of each circuit.

2. A visual inspection of all grounding connections. Electrical equipment and components shall not be energized unless properly grounded to the satisfaction of Engineer.

3. A megohmeter test on each single conductor circuit between the circuit conductor and all other circuits and ground in the conduits.

a. The insulation resistance shall not be less than 500 megohms when tested at 1,000 volts for 1 minute.

b. Individual conductors in UF cable and other multi-conductor cables shall be exempted from the megohmeter testing by the Engineer if a visual inspection of the cables show no suspicious cuts, tears, or other damage to the outside insulation.

c. Under no circumstances shall street light fixtures or other low voltage components be subjected to the high voltage of this test.

4. Any fault in any material or in a part of the installation revealed by these tests shall be replaced or repaired by the Contractor in a manner approved by the Engineer, and the same test shall be repeated until corrected.

METHOD OF MEASUREMENT

623.04.01 MEASUREMENT

A. The unit of measurement for "Traffic Signal Systems," "Street Lighting Systems," "Traffic Signal and Street Lighting Systems," and appurtenances for a complete operating system will be lump sum or unit price as specified in the Contract Documents.

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

BASIS OF PAYMENT

623.05.01 PAYMENT

A. The lump sum price or unit prices paid for traffic signal systems, street lighting systems, sign illumination systems, service pedestals, modifying existing systems, or any combination thereof shall be full compensation for doing all the work complete and in place as indicated in the Contract Documents and as directed by the Engineer, including excavation and backfill; concrete foundations; restoring sidewalk, pavement, and appurtenances damaged or destroyed during construction; salvaging existing materials; and making all required tests.

B. Full compensation for all additional materials and labor, not shown on the Drawings 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.

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

PAY ITEM	PAY UNIT
Traffic Signal Systems (may include sign lighting)	Lump Sum or Unit Price
Street Lighting Systems (may include sign lighting)	Lump Sum or Unit Price

SECTION 624

ACCOMMODATIONS FOR PUBLIC TRAFFIC

DESCRIPTION

624.01.01 GENERAL

A. This work shall consist of providing for traffic by constructing, maintaining, and removing detours or special detours, permitting traffic to pass through construction, and using flaggers 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

A. 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

A. 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.

B. Grading for special detours shall consist 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. This work shall conform to Subsection 107.21, "Dust Control."

C. 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 the detours shall be placed and constructed in accordance with the requirements for the particular materials used.

D. Water shall be applied to detours in amounts necessary to attain the compaction of graded sections and of surfacing materials.

E. Maintenance on special detours shall consist of performing any work necessary to maintain the detour satisfactorily, as ordered by the Engineer.

F. Eradication of special detours shall consist of blade grader and scraper work supplemented by other equipment if needed. Eradication shall 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 FLAGGERS

A. If, in the opinion of the Engineer, controlled traffic is necessary for protection of the work or for safety of public traffic, flaggers shall be employed by the Contractor.

B. Flaggers shall have completed an approved instructional course in flagging procedures.

C. A prospective flagger shall possess a valid flagger card attesting satisfactory completion of said instructional course conducted by the Nevada Department of Transportation or some other approved course given by another governmental agency.

624.03.03 PILOT CARS

A. If, in the opinion of the Engineer, it is necessary to afford additional protection to the work, workers, or public traffic, a pilot car and driver shall be used as the Engineer 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.

B. 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 drawings appended to the Special Provisions, or shown on the plans.

624.03.04 MAINTAIN BASE

A. 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

A. 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

A. Measurement for the various items involved in accommodating traffic shall be paid for as specified below:

1. 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."

2. When the proposal contains the item Flaggers, measurement for payment shall be the number of hours flaggers are used for the protection of the work or the safety of public traffic, as directed by the Engineer. If no separate item for flaggers is contained in the proposal, the cost of required flaggers 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.

3. When the proposal contains the item of Pilot Cars, 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.

4. 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."

5. When equipment is used for constructing special detours or maintaining the base and such equipment is rented as indicated in the proposal, the equipment shall be measured for payment by the number of hours actually used.

BASIS OF PAYMENT

624.05.01 PAYMENT

A. Payment for Special Detours and Maintain Base, measured as specified in Subsection 624.04.01, "Measurement," will be paid for by "Force Account."

B. Eradication of special detours shall be paid for as "Force Account" and shall be included in the bid item for Special Detours.

C. 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 shall be full compensation for the vehicle, an experienced driver, all operating costs, and depreciation.

D. When the item pilot car does not appear in the proposal, and it is necessary to protect the traveling public, in the Engineer's opinion, pilot cars shall be furnished by the Contractor and payment for pilot cars will be made in accordance with Subsection 104.03, "Extra Work," except, however, when the Contractor constructs and maintains a detour at Contractor's expense as provided in Subsection 104.04, "Maintenance of Traffic," subparagraph E.3.

E. The accepted quantities of flaggers, when contained as a separate item in the proposal and measured as specified in Subsection 624.04.01, "Measurement," will be paid for at the contract bid price per hour per flagger, which shall be full compensation for the flaggers, flagging, signs, and equipment.

F. 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.

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

H. Payment will be made under:

PAY ITEM	PAY UNIT
Special Detours	Force Account
Pilot Car	Hour
Flaggers	Hour
Maintain Base	Force Account
Rent Equipment (type)	Hour

SECTION 625

CONSTRUCTION SIGNS

DESCRIPTION

625.01.01 GENERAL

A. This work shall consist of furnishing, erecting, maintaining, relocating, and removing work zone traffic control devices, including signs, channelizing devices, and lighting devices at locations set forth in the contract documents, or as directed by the Engineer, for the protection of the work, workers, and guidance and safety of the motoring and pedestrian public.

B. All work zone traffic control devices shall remain the property of the Contractor upon completion of the contract and shall be removed from the project by the Contractor.

C. All work zone traffic control devices shall conform to the latest edition of the *Manual on Uniform Traffic Control Devices for Streets and Highways* (MUTCD), published by the U.S. Department of Transportation, Federal Highway Administration, as well as the current edition of the Traffic Control Plans for Highway Work Zones for the Clark County Area, unless otherwise indicated on the plans or by the Special Provisions.

D. Regulatory signs shall be mounted so that the bottom of the sign will be a minimum of 5 feet above the ground surface or the pavement.

MATERIALS

625.02.01 GENERAL

A. It is expressly intended that a broad selection of material be granted the Contractor since work zone traffic control devices are in temporary use and new products become commercially available regularly.

1. Sign panels may be constructed of steel, aluminum, wood, or other approved material and be of a sound, durable nature.

2. The materials shall be of such quality to do the job for which they are intended and are subject to approval by the Engineer.

3. Signs and channelizing devices that have become dull, have flaking or peeling paint, are dirty or discolored, or are otherwise marred shall be repaired or replaced with acceptable units.

B. Reflective sheeting for all signs and channelizing devices shall conform to Subsection 716.03.01, "Reflective Sheeting."

625.02.02 SIGN DIMENSIONS

A. Sign dimensions shown in the MUTCD are minimum standard.

1. Increases above this minimum are permissible and desirable where investigation has shown a larger sign is needed for adequate emphasis.

2. 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

A. Before any detour, temporary route, or work zone is opened to traffic or imposed upon existing traffic, all necessary signs shall be in place.

B. Signs required by road conditions or restrictions shall be removed immediately when those conditions cease to exist or the restrictions are withdrawn.

C. Guide signs directing traffic to and on temporary routes or detours shall be removed when no longer applicable.

D. Signs and barricades shall be maintained in operable condition.

1. Care shall be exercised to keep the sign faces free of dust and splashed mud.

2. Any signs and barricades that become scarred, damaged, or destroyed shall be repaired immediately or replaced, at no additional cost to Contracting Agency and as directed by the Engineer.

E. The responsibility for the protection of the work, workmen, and public traffic will rest with the Contractor and the Contractor shall be liable for damages and injury suffered by reason of the Contractor's operations or any circumstances, conditions, actions, or negligence in connection therewith.

625.03.02 SIGN PLACEMENT

A. Signs shall be placed in conformance with the MUTCD.

B. All temporary stop signs shall be mounted on a post that is embedded in the ground a minimum of 18 inches or to a depth sufficient to prevent overturning by wind loadings and easy removal by vandals as approved by the Engineer with the following possible exceptions:

1. A flagger is used to supplement temporary stop signs. The temporary stop signs shall be post-mounted and embedded in the ground when no flagger is present.

2. Temporary stop signs may be used with a moving construction operation with frequent lane shifts only when construction is in progress and the flagger is present. When no construction is in progress and no flagger is present, the temporary stop signs shall be post-mounted and embedded in the ground.

625.03.03 SIGN SUPPORTS

A. Signs, posts, pole mountings, and sign foundations shall be constructed to hold signs rigidly in a proper and permanent position, and prevent the signs from swaying in the wind, or from being turned or otherwise displaced.

B. A portable or removable type of mounting may be used for signs required intermittently or that are frequently moved. Such a mounting shall be heavy enough not to turn over in the wind, and the base shall not be appreciably wider than the sign.

C. A portable or removable type of mounting for temporary stop signs may only be used in a moving operation during the time when construction personnel are present.

1. Such a mounting shall be heavy enough not to turn over in the wind.

2. Temporary stop signs shall be post-mounted and embedded in the ground after working hours when no flagger is present.

625.03.04 CHANNELIZING DEVICES

A. Projects closed to traffic shall be protected by appropriate channelizing devices, as approved by the Engineer, in conjunction with appropriate work zone warning signs.

B. If weighting of channelizing devices is necessary, sand bags may be used as long as a low center of gravity is maintained as approved by the Engineer.

METHOD OF MEASUREMENT

625.04.01 MEASUREMENT

A. No direct measurement shall be made for work zone signs and channelizing devices unless otherwise specified.

BASIS OF PAYMENT

625.05.01 PAYMENT

A. No direct payment shall be made for work zone signs and channelizing devices unless otherwise specified.

SECTION 626

FINAL CLEANUP

DESCRIPTION

626.01.01 GENERAL

A. 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 Contractor's operations, whether or not part of the improvement.

B. This shall be required on all areas used or occupied by the Contractor within or outside the right-of-way limits.

MATERIALS

626.02.01 BLANK

CONSTRUCTION

626.03.01 FINAL CLEANUP

A. Rubbish, excess material, temporary structures, and discarded equipment shall be collected and disposed of as directed by the Engineer.

1. Burning is prohibited.
2. Pits or trenches for equipment setups or camp sites shall be filled and the ground restored, insofar as feasible, to its original conditions, within or outside of the right-of-way limits.
3. Temporary haul roads within the right-of-way limits shall be scarified and bladed to blend with surroundings.
4. Pits from which materials have been obtained shall be dressed and shaped to conform with the surrounding ground.
5. Waste shall be removed from the tops of banks and placed in the bottom of pit.
6. Unless otherwise specified or directed by the Engineer, banks of pits shall be cut to not steeper than 2:1 slopes to blend with the natural contours.
7. Bottoms of pits shall be reasonably smooth.
8. All other disturbances shall be removed or corrected as directed by the Engineer with particular attention to the abatement of any dust hazard.

B. Working areas and backslopes pertaining to the improvement shall be hand raked and loose objects including rocks and clods in excess of 2 inches in any dimension shall be removed from the site.

C. Pavement, curb and gutter, sidewalks, and driveways shall be swept or flushed and presented to the Contracting Agency in condition for maintenance without further work.

METHOD OF MEASUREMENT

626.04.01 MEASUREMENT

A. The unit of measure for "Final Cleanup" shall be lump sum.

BASIS OF PAYMENT

626.05.01 PAYMENT

A. The lump sum price paid for "Final Cleanup" shall be lump sum price bid for this item.

B. All payments shall be made in accordance with Subsection 109.02, "Scope of Payment."

C. Payment will be made under:

PAY ITEM	PAY UNIT
Final Cleanup	Lump Sum

SECTION 627

PERMANENT SIGNS

DESCRIPTION

627.01.01 GENERAL

A. This work shall consist of furnishing, erecting, relocating, and installing signs, sign supports, and other materials required for highway signs in accordance with the current edition of the *Manual on Uniform Traffic Control Devices* (MUTCD) and these specifications, as shown on the plans, and as directed by the Engineer.

B. This item does not include street name signs or construction signs used for traffic control during construction.

C. The work shall generally consist of:

1. Overhead signs, including concrete foundations, steel sign posts and frames, and aluminum sign panels with reflective sheeting.
2. Ground mounted signs consisting of concrete foundations, steel sign posts, aluminum sign panels with reflective sheeting, and appurtenances.

D. This work does not include sign illumination systems.

627.01.02 SHOP DRAWINGS

A. When overhead sign structures are to be furnished, the Contractor shall submit to the Engineer 5 sets of shop drawings for each overhead sign structure for approval.

B. Fabrication of the overhead sign structures shall not commence until the shop drawings have been approved by the Contracting Agency.

C. Shop drawings for other than overhead signs will not be required; however, all signs shall conform to the plans and the MUTCD.

1. For signs which are shown on the Sign Summary Sheets and are not included in the MUTCD, special sign design sheets shall be furnished by the Contracting Agency to the bidders of the project.
2. The special design sheets shall include such information as letter heights, spacing between letters and words, borders, sign radii, and so forth.
3. These signs shall conform to the special design sheets as well as the drawings noted in the plans.

MATERIALS

627.02.01 GENERAL

A. Materials shall conform to Section 716, "Sign Materials."

627.02.02 REFLECTORIZATION

A. All signs shall utilize Class 6 retroreflective sheeting for sign background, letters, numerals, symbols, borders, and accessories.

B. All letters, numerals, symbols, borders, and accessories shall be directly applied to the sign background.

627.02.03 LETTERS, NUMERALS, SYMBOLS, AND ACCESSORIES FOR GUIDE SIGNS

A. All names of places and highways on guide signs shall be composed of lower case letters with initial capital letters.

1. The initial capital letters shall be 1-1/3 times the loop height of the lower case letters.

2. Other legends on guide signs shall be in capital letters.

B. The initial capital letters and numerals used shall be Series E, modified by widening the stroke-width to approximately 1/5 the letter or numeral height.

C. Tables of recommended letter spacing can be obtained from the FHWA.

D. Arrows that are used for large directional guides shall be in direct proportion to the arrows shown in the MUTCD.

CONSTRUCTION

627.03.01 PANEL FASTENINGS

A. The panel sections shall be provided with suitable fastenings, as shown on the plans, to permit easy attachment to the supporting frames.

1. The fastenings shall be so designed as to carry the full design load with a factor of safety of not less than 1.5.

2. Panel sections shall be provided with closure strips at the joints.

B. Panel fastenings for use on sign panels covered with Class 4 or Class 6 reflective sheeting shall utilize nylon washers for contact between the reflective sheeting and the metal washer.

627.03.02 CLOSURE STRIPS

A. Closure strip shall be anchored by aluminum rivets as shown on the plans.

B. Rivets shall be the same color as the sign face.

C. Closure strips are required only on aluminum sign panels.

627.03.03 INSTALLATION

A. Sign locations indicated on the plans are approximate only. Final determination of sign locations will be made in the field by the Engineer.

B. 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.

C. All signs shall be erected as specified before, during, or immediately after the completion of bituminous plantmix surface operations.

D. 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.

E. Each sign face shall be thoroughly cleaned according to the reflective material manufacturer's recommendations.

1. All undesirable material that is visible on the face of the sign shall be removed.

2. The use of abrasives or other cleaning material that will scratch or otherwise deface the sign shall not be permitted.

F. Sign islands shall be constructed as roadway embankment in conformity with Section 203, "Excavation and Embankment."

1. Structure excavation and backfill shall conform to Section 206, "Structure Excavation," and Section 207, "Structure Backfill."

2. Anchor bolts shall be set true to line and grade.

3. Posts shall be plumb.

G. 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.

H. Care shall be exercised at all times in the handling, storing, transporting, and erecting of the signs. Signs that are damaged shall be repaired or replaced at no additional cost to the Contracting Agency.

I. Pipe sign posts may be field cut and drilled to adjust for local conditions when approved by the Engineer.

1. Flame cutting will not be permitted.

2. All field cuts and abraded areas on steel posts shall be thoroughly cleaned and given 2 coats of paint having a high-zinc dust content conforming to Federal Specification MIL-P-21035.

J. Extending the lengths of sign posts to adjust for local conditions by splicing or welding will not be permitted.

627.03.04 TESTS

A. The Contractorshall verify that all required tests have been made by qualified testing laboratories as approved by the Contracting Agency.

B. The Contractor shall furnish the Contracting Agency with a written certification that all required tests have been satisfactorily completed and that materials and fabrication thereof comply with all the requirements.

627.03.05 RELOCATION

A. This work shall consist of temporary or permanent relocation of existing permanent sign panels, posts, and footings as shown on the plans and as directed by the Engineer.

B. Existing sign panels and posts that are removed for relocation shall be stockpiled on the jobsite at locations determined by the Engineer and shall remain the property of the Contracting Agency.

C. The Contractor shall remove and dispose of all concrete from sign posts prior to stockpiling as directed by the Engineer.

D. Temporary relocation of permanent sign panels for public bus or transit stops shall be as indicated on the plans or as directed by the Engineer. Temporary locations for public bus or transit stops shall conform to Subsection 107.07, “Traffic and Access.”

E. The Contractor shall exercise care when removing and stockpiling signs for relocation. Signs that are damaged shall be repaired or replaced at no additional cost to the Contracting Agency.

METHOD OF MEASUREMENT

627.04.01 MEASUREMENT

A. 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.

B. The quantity of “Permanent Signs, Relocate” to be measured for payment shall be the number of each sign relocated, temporary or permanent.

C. 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.

D. Measurement for payment of sign supports for permanent signs listed as "Permanent Overhead Sign Support Structures" shall be measured on a Lump Sum basis.

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

BASIS OF PAYMENT

627.05.01 PAYMENT

A. 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.

B. Sign panels shall be paid for at the contract unit price bid per square foot for "Permanent Sign Panels (Overhead)" 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 sign panels (for signs listed as overhead signs) complete in place as shown on the plans and herein specified.

C. Sign supports shall be paid for at the contract Lump Sum price bid for "Permanent Overhead Sign Support Structures" 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 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.

D. The contract unit price bid per each for "Permanent Signs, Relocate" shall be full compensation for removal of sign panels and posts, removal and disposal of sign footing, stockpiling of existing sign panels and posts, installing existing sign panel at temporary location, furnishing and installing posts and new footings, and installing existing sign panels thereon and for furnishing all labor, materials, tools, supplies, equipment, and

incidentals necessary to complete the work as shown on the plans, as specified, and as directed by the Engineer.

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

F. 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
Permanent Signs, Relocate	Each

SECTION 628

TRAFFIC STRIPING, PAVEMENT MARKINGS, AND CURB MARKINGS

DESCRIPTION

628.01.01 GENERAL

A. The Contractor shall furnish and install all traffic striping, marking, and all other directional information on the surfaces of highways, streets, detour roads, medians, and curbing as shown on the plans and required by the contract documents.

B. As defined in Section 714, "Paint and Pavement Markings," Type 2 pavement marking materials shall be used for transverse markings such as crosswalks and stop bars as well as for symbols and legends.

C. Type 1 markings are defined as longitudinal markings such as lane lines and edge lines.

MATERIAL

628.02.01 MATERIALS FOR TRAFFIC STRIPING, PAVEMENT MARKING AND CURB MARKING

A. Materials for traffic striping and marking shall conform to Section 714, "Paint and Pavement Markings."

B. All paint, epoxy, and polyurea paint traffic stripes (except black stripes) shall be beaded on the final finish coat in accordance with Subsection 714.03.12, "Reflective Material."

C. The retroreflective preformed pavement markings shall conform to the applicable requirements of Subsection 714.03.06, "Pavement Markings."

1. The retroreflective preformed pavement markings shall consist of plastic or thermoplastic material with pigments selected to conform to standard highway colors.

2. Retroreflective beads shall be incorporated into the film to provide immediate and continuing retroreflection.

3. Preformed words and symbols shall conform to the applicable shapes and sizes as outlined in the current edition of the *Manual on Uniform Traffic Control Devices for Streets and Highways* (MUTCD).

D. The Contractor shall furnish all equipment, materials, labor, and supervision necessary for installing traffic lanes, directional arrows, guide lines, curbs, parking lines, crosswalks, and other designated markings in accordance with the contract plans, or for approved temporary detours essential for safe control of traffic through and around the construction site.

E. The Contractor shall warranty the applied markings for a minimum of 1 year from the date of installation.

1. If the manufacturer provides a longer warranty, the longer warranty shall apply.

2. If, for any reason, the markings fail to perform as specified, the Contractor, under this warranty, shall completely remove the old markings and apply new markings at no additional cost to the Contracting Agency.

CONSTRUCTION

628.03.01 WEATHER CONDITIONS

A. Pavement marking materials shall be applied only when the pavement surface is dry and clean, when the surface temperature is above 40 degrees F and rising, and when the weather is not windy, foggy, or humid.

B. Epoxy paint, polyurea paint, and preformed marking material, plastic or thermoplastic, shall only be applied if surface temperature is a minimum of 40 degrees F and rising at the time of marking installation.

C. If the manufacturer of the marking material requires a minimum surface temperature different than detailed above, the higher temperature shall be used.

628.03.02 EQUIPMENT

A. All equipment required to perform the work shall be approved in advance by the Engineer, and shall include, but not be limited to, such apparatus as brushes, brooms, compressors, air blowers to properly clean the pavement surface, a mechanical marking machine, a suitable device for heating the paint to the specified temperatures, a bead dispensing device, auxiliary hand spray painting equipment, paint rollers, or other equipment as may be necessary to satisfactorily complete the work.

B. For traffic paint applications, the striping machine shall be an approved spray-type marking machine suitable for applying traffic paint in accordance with Section 714, "Paint and Pavement Markings," or as recommended by the paint manufacturer. The striping machine shall:

1. Have sufficient paint capacity for each color with adequate air pressure to perform the work satisfactorily without excessive stopping.
2. Produce a uniform film thickness and cross section at the required coverage.
3. Produce markings with clean-cut edges without running or spattering.
4. Be capable of being guided within the straightness tolerances set forth in these specifications.
5. Have suitable adjustments for painting the line with width specified and when required.
6. Be equipped with an automatic cycling device to produce intermittent (skip) lines.
7. Be equipped to produce a variable skip pattern, including simultaneous painting of a broken line on 1 side and a solid line on the other side of the multiple strips. An acceptable tolerance in the skip pattern is plus or minus 6 inches.
8. Be capable of 3-gun application consisting of 1 black and 2 yellow spray guns operating simultaneously or individually.
9. Be capable of operating 2 white guns simultaneously.
10. Have a wheel base of sufficient length to produce a straight line to meet the straightness tolerance specified in Subsection 628.03.05, "Layout, Alignment, and Spotting."
11. Be capable of producing curved lines without abrupt breaks, in accordance with approved layouts.

C. For epoxy paint and polyurea paint applications, the striping equipment shall be a system capable of applying both yellow and white epoxy or polyurea paint to manufacturer's recommended proportions, producing striping of uniform dimension which comply with parameters for pavement markings set forth in Section 714, "Paint and Pavement Markings."

1. Equipment shall be capable of placing 2 lines of traffic striping simultaneously with either line in a solid or intermittent pattern and applying retroreflective beads and or reflective elements at the rate recommended by the manufacturer.

2. The equipment shall also have a metering device able to register the accumulated footage of markings installed per day for each spray gun.

3. A technical expert in equipment operations and epoxy or polyurea applications shall be present at all times during the installation of epoxy or polyurea paint markings.

D. Equipment shall also be designed so that pressure gauges for each proportioning pump are constantly visible to the operator at all times during equipment operation so that any fluctuation and pressure difference can be monitored immediately. In addition, the striping equipment shall have a minimum of one 24-inch long minimum static mixer unit for the proper mixing of the 2 components of the epoxy paint material.

E. Provision shall be made for a dispenser capable of applying glass beads at the required rate.

F. Word markings, letters, numerals, and symbols shall be applied using suitable spray equipment together with stencils and templates.

G. Equipment for the application of preformed thermoplastic or plastic pavement marking material shall be as recommended by the manufacturer and as approved by the Engineer. Thermoplastic markings require the use of a propane torch as recommended by the manufacturer to fuse markings to asphalt and Portland cement concrete pavements by means of heat.

H. The Contractor shall provide a wet sandblasting machine with sufficient sand, water, and air capacity to completely remove all existing or temporary traffic striping or unneeded traffic markings.

1. This machine shall meet all requirements of the air pollution control district having jurisdiction.

2. All sand used in wet sandblasting shall be removed from the pavement without delay as the sandblasting operation progresses.

3. Removal of striping by high velocity water jet may be permitted when approved by the Engineer.

628.03.03 GEOMETRY, STRIPES, AND TRAFFIC LANES

A. Permanent and temporary striping and marking shall be in accordance with the MUTCD and Volume I of the Standard Drawings.

B. If the Contractor elects to alter the existing traffic stripes and markings, or to divert the flow of traffic on construction projects for Contractor's own convenience, and there are no specific pavement markings or lane delineations shown on the plans or in the Special Provisions, the Contractor shall, with the approval of the Engineer, provide the necessary temporary striping in accordance with the MUTCD at no additional cost to the Contracting Agency.

C. When not otherwise shown on the plans, detour transitional traffic line striping shall have a minimum taper of 20:1 for temporary striping and 30:1 for permanent striping.

D. Temporary traffic lanes shall be at least 10 feet wide and no lane shall encroach within 5 feet of an open excavation or within 2 feet of a longitudinal curb.

628.03.04 PREPARATION OF EXISTING SURFACES

A. Existing markings and striping, either permanent or temporary, that are to be abandoned or obliterated shall be removed by wet sandblasting or other approved methods.

1. Dry sandblasting may be used in selected areas only with the permission of the Engineer and with approval of the air pollution control authority having jurisdiction over the area in which the work will be performed.

2. Alternate methods of marking removal require prior approval of the Engineer.

3. Obliteration of traffic striping with black paint or light emulsion oil shall be done only with the prior approval of the Engineer.

B. Before applying pavement markings, the existing pavement surface shall be cleaned by washing, sweeping, blowing, vacuuming, or other methods recommended by the marking manufacturer, as necessary to remove moisture, dirt, grease, oils, acids, laitance, curing compound of Portland cement concrete, or other foreign matter that would reduce the bond between the pavement marking material and the pavement.

C. After cleaning, the surface shall be dried before applying pavement markings.

628.03.05 LAYOUT, ALIGNMENT, AND SPOTTING

A. When necessary, the Engineer will furnish the needed control points for required pavement striping and markings.

B. The Contractor shall establish pilot lining between these points by stringline or other method to provide striping that will vary less than 1/2 inch in 50 feet from the specified alignment.

C. The Contractor shall stripe or otherwise delineate the traffic lanes in accordance with the Standard Drawings and the MUTCD in the new roadway, portion of roadway, or detour before opening it to traffic if so required by the Contract Documents.

D. The Contractor shall provide an experienced technician to supervise the location, alignment, layout, dimensions, and application of the markings.

628.03.06 APPLICATION OF PAINT, EPOXY PAINT, AND POLYUREA PAINT

A. Traffic striping and marking shall be applied at locations and to the dimensions and spacing indicated on the approved plans in accordance with this specification and Section 714, "Paint and Pavement Markings," or as provided in the Special Provisions.

B. Where temporary traffic striping or marking is required, it shall not be applied until the layouts, alignments, sequencing, and condition of the existing surface have been approved.

C. Pavement marking material shall be mixed in accordance with the manufacturer's instructions. The material shall be mixed thoroughly and applied to the surface at the proper temperature, at its original consistency, and without the addition of paint thinner or other materials.

D. If traffic paint is applied in 2 coats, comply with the following:

1. Retroreflective beads will be required only in the second coat.
2. The first coat shall be thoroughly dry before the second coat is applied.
3. On open-graded surfaces, the second coat shall follow no sooner than 10 calendar days after initial application.

E. Application of retroreflective beads and or reflective elements shall be applied using the double drop method and in accordance with manufacturer's recommendations.

1. Application rate of beads shall be as required by the manufacturer to meet retroreflectivity requirements specified in Subsection 714.03.06, "Pavement Markings."
2. In addition, retroreflective beads shall be applied to traffic markings in accordance with Subsection 714.03.12, "Reflective Material."

F. Ten days shall elapse between the application of a bituminous seal coat and the permanent traffic marking material.

1. The traffic paint, epoxy paint, or polyurea paint shall not bleed, curl, or discolor when applied to bituminous surfaces.
2. If bleeding or discoloring occurs, the unsatisfactory areas shall be corrected as directed by the Engineer.

G. Straight stripes deviating more than 1/2 inch in 50 feet shall be obliterated by sandblasting or other approved method and the markings corrected.

1. The width of markings shall be as designed, within a tolerance of 4 percent.
2. When existing striping and markings are to be repainted, they shall be repainted to completely cover the old markings within 1/4 inch.
3. Stripe repainting shall be retraced within a longitudinal tolerance of 6 inches plus or minus at the end of each stripe.
4. Abrupt breaks in striping alignment will not be allowed.
5. The striping shall be a continuous operation except where crossovers are required to complete painted medians.
6. Restriping operations involving epoxy paint and polyurea paint shall be performed in accordance with manufacturer's recommendations.

H. The application of pavement markings and striping using traffic paint, epoxy paint, or polyurea paint shall be performed by competent equipment operators and painters using proper equipment, tools, stencils, templates, and shields in a workmanlike manner.

I. Difficulties experienced in cool weather may be minimized by heating the pavement marking material in accordance with manufacturer's recommendations to provide for a uniform flow of material.

J. Temporary striping and marking shall be renewed when the stripes and markings have lost 50 percent of their original visual effectiveness.

K. The Contractor shall furnish a notarized certificate signed by either an authorized employee of the manufacturer or testing laboratory stating that the pavement marking material conforms to the specified requirements and is in accordance with Subsection 714.02.01, "Certificates."

628.03.07 PROTECTION OF WORK, WORKMEN, AND THE PUBLIC

A. The Contractor shall use proper and sufficient directional signs, warning devices, barricades, pedestals, lights, traffic cones, flagmen, or such other devices as necessary to protect the work, workmen, and the public.

B. Markings and striping shall be protected from injury and damage of any kind until the material is ready for traffic.

C. Adjacent surfaces shall be protected from disfiguration by spatter, splashes, spillage, and dripping of paint, adhesives, primer, or other material.

D. In areas of high traffic volume, the Contractor shall schedule work to install traffic lines and markings in off-peak traffic hours.

628.03.08 DEFECTIVE WORKMANSHIP OR MATERIAL

A. Any work or materials not conforming to the plans and specifications shall be unacceptable and shall be redone, removed, replaced, or made satisfactory to the Engineer at no additional cost to the Contracting Agency.

628.03.09 INSTALLATION OF RETROREFLECTIVE PREFORMED PAVEMENT MARKINGS

A. Traffic striping and marking shall be applied at locations and to the dimensions and spacing indicated on the approved plans in accordance with this specification and Section 714, "Paint and Pavement Markings," or as provided in the Special Provisions.

B. The retroreflective preformed pavement marking materials shall not be applied within 2 weeks after laying and rolling asphalt concrete wearing courses unless otherwise specified in the Special Provisions.

   1. The preformed markings shall conform to the pavement contours by the action of traffic.

   2. After application, the markings shall be immediately ready for traffic.

C. The preformed retroreflective pavement markings shall be applied in accordance with the manufacturer's recommendations, a copy of which the Contractor shall supply the Contracting Agency prior to installing the pavement marking material.

D. Joints in the initial installation of new pavement markings will be allowed only on lane lines and change of direction.

E. The longitudinal bars in crosswalks, if used, shall be 1 piece.

F. Pavement marking failures shall be removed and replaced a minimum of 6 inches each side of the failure and the patch shall be a minimum of 24 inches in length.

MEASUREMENT

628.04.01 MEASUREMENT

A. The quantity of traffic striping and marking shall be measured by 1 or more of the following methods: linear footage, the area in square feet, or 1 lump sum item complete in place, as shown on the plans or indicated in the Special Provisions.

B. The quantity of Type 2 pavement marking materials for symbols and legends measured for payment shall be per each, complete and in place.

C. The quantity of Type 2 pavement marking materials for crosswalks and stop bars measured for payment shall be the number of square feet, complete and in place.

D. The quantity of Type 1 pavement marking materials for longitudinal lines measured for payment shall be per linear foot, complete and in place.

BASIS OF PAYMENT

628.05.01 BASIS OF PAYMENT

A. The lump sum or unit prices in the Proposal shall include full compensation for furnishing all labor, materials, tools, and equipment and for doing all work involved in, or appurtenant to, the installation of all traffic striping or markings**,** including removal of existing conflicting markings and preparation of surface for new markings, as shown on the plans or indicated in the Special Provisions.

B. All costs for temporary pavement painting for the convenience of the Contractor, including costs for removal of existing lines and markings, shall be at no additional cost to the Contracting Agency.

C. Payment shall be made under:

PAY ITEM	PAY UNIT
Type 2 "ONLY" Marking	Each
Type 2 (Arrow) Marking	Each
Type 2 Marking for Crosswalks and Stop Bars	Square Foot
Type 1 White 4-inch Marking	Linear Foot
Type 1 Yellow 4-inch Marking	Linear Foot

SECTION 629

WATER DISTRIBUTION FACILITIES

DESCRIPTION

629.01.01 GENERAL

A. The work to be done consists of furnishing and installing all necessary materials and equipment to complete distribution facilities, herein referred to as water mains, and/or to modify existing water facilities as shown on the plans and in accordance with the specifications.

B. Unless otherwise indicated on the plans and/or specified in the Special Provisions, the construction of water mains shall include excavation and backfill, the construction of concrete structures, anchors, thrust blocks, supports and encasements; the furnishing and placing of material and/or protective encasements; the furnishing, installing, testing, and disinfecting of water pipelines, fittings, valves, blow-offs, air valves, services, fire hydrants, and all appurtenances; and the removal and/or restoration of existing improvements; all work in accordance with the plans and specifications.

629.01.02 STANDARDS

A. All work shall conform to these specifications and the latest edition of the “Uniform Design and Construction Standards For Potable Water Distribution Systems” (UDACS) prepared by the Las Vegas Valley Water District (LVVWD). Where conflicts may arise, the UDACS shall govern.

629.01.03 SHOP DRAWINGS

A. Wherever called for in these specifications or on the drawings, or where required by the Engineer, the Contractor shall furnish to the Engineer for review 3 prints of each shop drawing.

1. The term "shop drawing" as used herein shall be understood to include lists, graphs, operating instructions, and so forth.
2. Unless otherwise required, shop drawings shall be submitted at a time sufficiently early to allow review by the Engineer, and to accommodate the rate of construction progress required under the contract.
3. Within 10 calendar days after receipt of the prints, the Engineer will return 1 print of each drawing to the Contractor with the Engineer's comments noted thereon.

B. Fabrication of an item shall not be commenced before the Engineer has reviewed the pertinent shop drawings and returned copies to the Contractor without rejection.

1. Revisions indicated on shop drawings shall be considered as changes necessary to meet the requirements of the contract drawings and specifications and shall not be taken as the basis of claims for extra work.
2. The Contractor shall have no claim for damages or extension of time due to any delay resulting from making required revisions to shop drawings.
3. The review of shop drawings by the Engineer shall apply to general design only and shall in no way relieve the Contractor of responsibility for errors or omissions

contained therein nor shall such review operate to waive or modify any provision or requirement contained in these contract specifications or on the contract drawings.

629.01.04 CONSTRUCTION LINES AND GRADES

A. Unless otherwise specified in the Special Provisions, all lines and grades required for proper execution of the work as shown in the Contract Documents shall be furnished by the Contractor.

B. The Contractor shall be responsible for the preservation of all bench marks and survey marks and shall be responsible for the cost of replacement.

C. If a pipeline profile is shown on the drawings, cut sheets shall be prepared and made available to the Engineer upon request, at least 24 hours prior to excavation.

629.01.05 OPERATION OF VALVES

A. Valves on public water mains shall be operated only by authorized personnel of the LVVWD, the governing agency, or under the direct supervision thereof.

629.01.06 JOINT USE TRENCHES

A. Joint use trenches may be as shown in the Standard Drawings.

B. Water mains shall be a minimum of 10 feet horizontally from sewers.

MATERIALS

629.02.01 GENERAL

A. The Contractor shall furnish all materials, including appurtenances, necessary to complete all work as shown and in accordance with the specifications. Fabricated materials shall be new and of current manufacture.

629.02.02 CONCRETE

A. All concrete shall be Portland cement concrete conforming to Section 501, “Portland Cement Concrete,”

629.02.03 REINFORCING STEEL

A. Reinforcing steel shall be deformed steel bars or cold-drawn steel wire, or fabricated forms of those materials, as required by the applicable drawings and specifications. Materials shall conform in quality to Section 713, "Reinforcement."

CONSTRUCTION

629.03.01 GENERAL

A. The Contractor shall perform all work required for construction of water mains and appurtenances as shown.

629.03.02 EXCAVATION

A. Excavation shall be as specified in Section 208, "Trench Excavation and Backfill."

629.03.03 PIPE BEDDING

A. Pipe bedding shall be as specified in Section 208, "Trench Excavation and Backfill."

629.03.04 TRENCH BACKFILL

A. Trench backfill shall be as specified in Section 208, "Trench Excavation and Backfill."

629.03.05 SOILS TEST

A. Soils tests shall be as specified in Subsection 208.03.20, "Testing."

629.03.06 CUTTING AND RESTORING STREET SURFACING

A. Cutting and restoring street surfacing shall be as specified in Subsection 208.03.21, "Cutting and Restoring Street Surfacing."

629.03.07 BACKFILL AROUND STRUCTURES

A. Backfill around structures shall be as specified in Section 207, "Structure Backfill."

629.03.08 CONCRETE

A. This work shall consist of furnishing and placing Portland cement concrete as specified in Section 502, "Concrete Structures."

629.03.09 CONNECTIONS TO EXISTING FACILITIES

A. The Contractor shall make connections to existing pipelines as shown.

1. Dry connections to existing facilities shall be made at times that will cause the least inconvenience to the water consumers, and shall be planned so that the duration of any shutdown will be kept to a minimum.

2. No additional compensation shall be paid for overtime which may be necessary in the making of connections to existing facilities.

B. The Contractor shall notify the Engineer at least 3 days in advance of the date on which the Contractor proposes to begin to make connections to the existing facilities.

C. After the new main is completed, the new main shall be tested and sterilized before the valve between the new main and the old main is opened.

D. Time and duration of shutdown shall be as specified by the Contracting Agency.

629.03.10 INSTALLATION OF VALVES

A. Unless otherwise noted, all buried gate valves shall be installed with the stems in a vertical position and all buried butterfly valves shall be installed with the shafts in a horizontal position.

1. Valve boxes shall be centered over the operating nuts and shall be set plumb.

629.03.11 HYDROSTATIC TESTING

A. The Contractor shall test the pipeline in conformance with the current UDACS and as specified by the Contracting Agency.

629.03.12 DISINFECTION

A. Disinfection shall be accomplished by chlorination in accordance with UDACS either at the same time or after the pipe has been tested, but the disinfection shall be completed before the pipe has been connected to the existing system.

629.03.13 FIRE HYDRANT INSTALLATIONS

A. Fire hydrants, assemblies, and the installation thereof, consisting of the hydrant, lateral, and valve at the main, shall consist of materials approved by the applicable Fire Department and shall be installed and painted in accordance with Fire Department specifications or requirements.

B. The hydrants shall have 2-1/2-inch NST nozzles higbee cut, one 4-inch NST pumper nozzle, breakaway coupling at ground level, 4-inch valve opening, and 6-inch "Ring-Tite" inlet connection.

C. All hydrants shall be of the compression type, 150 psi working pressure, and 300 psi test.

D. Hydrants shall be able to deliver 250 gallons per minute from each 2-1/2-inch outlet with a pressure loss of not more than 1-3/4 pounds for two-way, 2-1/2 pounds for three-way.

E. There shall be an O-ring between the hydrant barrel and bonnet.

F. Hydrants shall be bury type with 1-1/8-inch pentagon operating nut, with counterclockwise opening, and painted in accordance with Fire Department specifications or requirements.

629.03.14 INSTALLATION OF PIPE CASING

A. The Contractor shall furnish and install all pipe casing as specified herein and as shown on the drawings.

B. The casing shall be laid true to grade and line with no bends or changes in grade or the full length of the casing.

C. The pipe shall be supported at each end of each joint with 4-inch by 4-inch by 3-inch skids minimum.

1. The annular space between the pipe and the casing shall be backfilled with sand.
2. After installation of the pipe, and the casing shall be sealed at both ends with mortared brick or cement block.

METHOD OF MEASUREMENT

629.04.01 MEASUREMENT

A. The method of measurement shall be as specified by the Contracting Agency.

BASIS OF PAYMENT

629.05.01 PAYMENT

A. Payment shall be as specified by the Contracting Agency.

SECTION 630

SANITARY SEWERS

DESCRIPTION

630.01.01 WORK INVOLVED

A. Unless otherwise indicated on the plans and/or specified in the Special Provisions, the construction of sanitary sewers shall include excavation and backfill, tunneling, jacking, the preparation of pipe subgrade, the construction of manholes or other structures, pipe cradle and encasement, the furnishing, placing, and testing of sewer pipe, the abandonment, removal, and/or restoration of existing improvements, the construction of appurtenances and connections, and all incidentals to sewerage construction in accordance with the plans and specifications.

630.01.02 CONFORMANCE WITH LINE AND GRADE

A. Sanitary sewers and laterals shall be constructed to the sizes, lines, and grades as shown on the plans and/or specified in the Special Provisions.

630.01.03 EXISTING UNDERGROUND UTILITIES

A. The sewer laterals and other underground utilities shown on the plans have been located with as much care as possible with the aid of the utility companies and office records.

B. However, the Contracting Agency assumes no responsibility as to their exact location.

630.01.04 SEWER REPLACEMENT PROJECTS

A. **Maintenance of Flow:**

1. The sewer system shall be kept in continuous operation during construction.
2. Sewage flow shall be confined to closed conduits to avoid public nuisance and health hazard.

B. **Bypassing Flow:**

1. If the Contractor so elects, the Contractor may construct temporary pump or gravity sewer bypasses.
2. Bypasses shall be of sufficient capacity to handle peak flows without storage.
   a. When temporary pumping is required, duplicate peak flow capacity pump units shall be provided by the Contractor to continuously handle sewage flow without interruption in the event of failure of either pump unit.
   b. When temporary sewage suction sump or pit is constructed by the Contractor, such sump or pit shall be fully enclosed and properly vented as directed by the Engineer.

630.01.05 PROHIBITION OF DIVERSION

A. Temporary diversion of sewage to storm drains or stream channels will not be permitted.

630.01.06 COMPENSATION FOR MAINTENANCE OF FLOW

A. Because the method of temporary maintenance of flow during construction is at the option of the Contractor, within the limits specified above, full compensation for maintenance of flow shall be included in the prices bid in the contract proposal.

630.01.07 MECHANICAL COMPRESSION JOINT-VITRIFIED CLAY PIPE

A. Unless otherwise indicated on the plans or in the Special Provisions, sanitary sewers constructed of vitrified clay pipe shall have mechanical compression type joints.

B. Pipe and joint shall conform to Subsection 630.02.03, "Vitrified Clay Pipe Sewers and Fittings," and Subsection 630.02.04, "Jointing Vitrified Clay Pipe."

630.01.08 CONCRETE PIPE

A. Unless otherwise indicated on the plans or specified in the Special Provisions, concrete pipe for sewers shall be in accordance with Subsection 630.02.06.B, "Quality of Pipe," paragraph B of these specifications.

630.01.09 JOINTS FOR REINFORCED CONCRETE PIPE

A. Unless otherwise indicated on the plans or in the Special Provisions, joints for reinforced concrete pipe shall be in accordance with Subsection 630.02.06.F, "Joining Reinforced Concrete Pipe," paragraph F.

630.01.10 PVC SEWER PIPE

A. Unless otherwise indicated on the plans or specified in the Special Provisions, the requirements for PVC sewer pipe shall be in accordance with Subsection 630.02.07, "PVC Sewer Pipe."

MATERIALS

630.02.01 GENERAL

A. The following specifications set forth the requirements for materials used in the installation of sanitary sewer systems.

630.02.02 MANHOLES

A. Unless otherwise shown on the drawings or specified in the Special Provisions, materials to be used for concrete manholes shall be in compliance with ASTM C478.

B. Manholes shall be constructed of precast reinforced concrete risers and tops complying with ASTM C478 and in accordance with the design and construction details shown on the drawings.

C. The manhole rings and covers shall be in accordance with the Standard Drawings.

D. All manhole bases shall be Type V concrete and placed in accordance with the Standard Drawings.

630.02.03 VITRIFIED CLAY PIPE SEWERS AND FITTINGS

A. **General:**

1. The Contractor shall furnish and install extra strength vitrified clay pipe, fittings, and appurtenances of the dimensions and to the lines and grades as shown on the plans and herein specified.

2. The pipe to be installed at the various locations is identified by nominal diameter of pipe in inches followed by the acronym: VCP.

B. **Quality of Pipe:**

1. All vitrified clay pipe and fittings shall be of 1 class designated extra strength, of the best quality, vitrified, homogeneous in structure, thoroughly burned throughout the entire thickness, sound, impervious to moisture, and free from cracks, checks, blisters, broken extremities, or other imperfections.
2. Pipe shall give a metallic ring when struck with a hammer.
3. Pipe shall be bell and spigot pipe unless otherwise specified.
4. Pipe ends shall be square with the longitudinal axis.
5. Sockets shall be true, circular, and concentric with the barrel of the pipe.
6. The thickness of the shell, the depth of the socket, and the dimensions of the annular space shall be within the limits of permissible variation to dimension standards of the applicable provisions of ASTM C700 for the size of pipe indicated on the plans.

C. **Certification:** A certificate from the manufacturer shall be furnished with each shipment of pipe attesting that the pipe meets the requirements of these specifications, including test reports for the hydrostatic pressure test and the loading test hereinafter specified.

D. **Physical Tests for Pipe and Fittings:**

1. Under the supervision of and when directed by the Contracting Agency, the physical tests specified below shall be performed.
2. The cost of such supervision will be borne by the Contracting Agency and all other costs shall be borne by the Contractor.

E. **Acceptance or Rejection on Results of Test:**

1. If all the specimens tested meet the requirements of the test, all the pipe in the lot, shipment, or delivery corresponding to the sizes so tested shall be considered as complying with the test.
2. If, however, 10 percent or more of the specimens tested fail to meet the requirements of the test, or if more than 1 specimen fails to meet the requirements of the test when the number to be tested is less than 10, then a second selection of specimens may be made for that test.
3. The number of pipes to be tested in the second selection of pipe shall be 5 for each specimen of the first selection that failed to meet the standards.
4. If 90 percent or more of the pipe tested, including those first tested, meet the requirements of the test, the pipe in the lot, shipment, or delivery corresponding to the sizes so tested shall be considered as complying with that test; otherwise, all pipe of these sizes shall be rejected.

F. **Identification Marks:** All pipe and fittings shall be clearly marked with the name of the manufacturer or with a trademark of a size and type approved by and filed with the Engineer.

G. **Tests:**

1. The testing laboratory shall select at random for testing as herein specified up to 2 percent of the number of pipe in each size of pipe furnished, except that in no case shall less than 5 specimens be tested.

2. The specimens selected for testing purposes shall be sound pipe having dimensions consistent with these specifications. The lot or lots from which the test samples are taken shall be sufficient to fill the entire order for that size of pipe used in the work under the contract and, if they pass the tests, shall be so designated and marked.

3. All pipe shall be subject to inspection at the factory, trench, or other point of delivery by the Engineer. The purpose of the inspection shall be to cull and reject any pipe that, independent of the physical tests herein specified, fails to conform to these specifications, or that may have been damaged during transportation or in subsequent handling.

H. **Hydrostatic Tests:** In lieu of the standard ASTM absorption test, the following hydrostatic pressure test shall be substituted.

1. The hydrostatic pressure test shall precede the loading test by not less than 1 hour nor more than 3 hours and shall be applied to all the specimens received for testing in each size of pipe.

2. When subjected to an internal hydrostatic pressure of 10 pounds per square inch for the time specified below, the accumulated moisture on the exterior surface of the pipe shall not run down the sides in such quantity that it will exceed 10 milliliters per linear foot.

Thickness of Barrel	Testing Time
Up to and including 1 inch	7 minutes
Over 1 inch and including 1-1/2 inches	9 minutes
Over 1-1/2 inches and including 2 inches	12 minutes
Over 2 inches and including 2-1/2 inches	15 minutes
Over 2-1/2 inches and including 3 inches	18 minutes
Over 3 inches	21 minutes

I. **Loading Tests:**

1. The loading test shall be the 3-edge bearing, shall conform to the applicable provisions of ASTM C301, and shall be applied to all specimens selected for testing, except that loading to test ultimate strength will not be required.

2. Pipe shall withstand the following loads:

Nominal Pipe Size In Inches	Minimum Test Loads Pounds Per Linear Foot
4 and 6	2,000
8	2,200
10	2,400
12	2,600
15	2,900
18	3,300
21	3,850
24	4,400
27	4,700
30	5,000
33	5,500
36	6,000

Nominal Pipe Size In Inches	Minimum Test Loads Pounds Per Linear Foot
39	6,600
42	7,000

3. The net inside length of the pipe from the bottom of the socket to the spigot end of the pipe shall be used as the divisor to calculate the load per linear foot.

J. **Inspection Independent of Tests:** The following imperfections in a pipe or special fitting will be considered injurious and cause for rejection without consideration of the test results hereinabove specified:

1. There shall be no fractures or cracks passing through the barrel or socket, except that a single crack at the spigot end of the pipe not exceeding 75 percent of the depth of the socket, or a single fracture in the socket not exceeding 3 inches around the circumference nor 2 inches lengthwise may be permitted.
2. Lumps, blisters, pits or flakes on the interior surface of a pipe or fitting.
3. When the bore or socket of the pipe varies from a true circle more than 3 percent of its nominal diameter.
4. When a pipe or fitting, designated to be straight, deviates from a straight line more than 1/16 inch per linear foot. The deviation shall be measured from a straight edge at a point midway between the ends of the pipe.
5. A piece broken from either the socket or spigot end.
6. Tramp clays, gorge, or other foreign matter fused permanently to the exterior or interior surface of the pipe or fitting.
7. Pipes that, when placed in a vertical position, do not give a metallic ring when struck with a hammer.

630.02.04 JOINTING VITRIFIED CLAY PIPE

A. Vitrified clay pipe and fittings shall be furnished with mechanical compression joints or compression couplings or approved equal.

B. Materials for compression joints and couplings shall conform to ASTM C425.

C. An approved lubricant shall be used in the assembling of the pipe and no further sealing element will be required.

630.02.05 STOPPERS

A. Stoppers for sewage line shall be as approved by the pipe manufacturer.

630.02.06 REINFORCED CONCRETE PIPE

A. The Contractor shall furnish and install reinforced concrete pipe, fittings, and appurtenances of the dimensions and to the lines and grades as shown on the plans and herein specified. The pipe to be installed at the various locations is identified by nominal diameter of pipe in inches followed by the acronym: RCP.

B. **Quality of Pipe:**

1. All reinforced concrete pipe and fittings shall be made by the centrifugal process conforming to ASTM C76.

2. The pipe sections shall be manufactured with flared bell and spigot-type joints and incorporate O-ring rubber gaskets as their positive and flexible seal against internal or external hydrostatic pressures.

3. Pipe walls shall be designed and reinforced for 1350 D-load (Class III) according to ASTM C76.

4. Unless shown or specified otherwise, all RCP that is to carry sewage shall have not less than 2 inches of concrete between the inside of the pipe and the reinforcing, and not less than 1 inch clear between exterior of pipe and its reinforcing.

C. **Identification Marks:** The following information shall be clearly marked on each pipe section:

1. Permissible D-load strength

2. Name or trademark of manufacturer

3. Date of manufacture

4. Letter "T" 6 inches or more from end of pipe to indicate the top of pipe for correct installation when elliptical reinforcement is used.

5. Markings shall be indicated on the pipe sections or painted thereon with waterproof paint.

D. **Tests:** Concrete pipe may be tested by the Engineer by one or more of the tests specified below. The manufacturer shall furnish without charge all necessary equipment and samples for making the tests. All tests shall be made in accordance with ASTM C76.

1. **Absorption Test:** The absorption test may be made to determine the amount of moisture absorbed by the concrete.

2. **Three-Edge Bearing Strength Test:** The 3-edge bearing test may be made to determine the strength of the pipe and the "D" load that the pipe will withstand.

3. **Core or Cylinder Test:** Cores may be cut from the concrete of the pipe or test cylinders case of the concrete as placed for the purpose of determining the strength of the concrete in the pipe.

4. **Visual Test and Inspections:**

a. Visual inspection may be made by the Engineer before and/or after the delivery of the pipe for the purpose of determining the placement of the reinforcement, size, shape, fractures, spalls, honeycomb, or other imperfections or damage.

b. The Contractor shall notify the Engineer not less than 24 hours in advance of beginning manufacture of the pipe.

c. The Engineer shall have access to all operations of the manufacture and may inspect and test any or all equipment, materials, and operations used in the manufacturing, handling, and curing of the pipe.

E. **Cement:** Portland cement shall conform to ASTM C150, Type V (high sulfate resistant).

F. **Joining Reinforced Concrete Pipe:** Joints shall be made watertight and root-tight in an approved manner in accordance with ASTM C443.

1. **Joint Design:**

a. Pipe units shall be manufactured with flared bell and spigot-type joints.

1) The spigot end shall be provided with a gasket groove and the joint shall be sealed by a round rubber gasket in compression between the bell and spigot surfaces.

2) The length of each gasket shall be volumetrically determined so that it will substantially fill the joint recess.

3) The gasket shall be the sole element depended upon to make the joint watertight.

b. The joints shall be self-centering and, upon proper closure of the joint, the rubber gasket shall be uniformly confined with the spigot groove and enclosed. In this condition, the gasket shall not support the weight of the pipe and shall function solely as the water seal element under all normal conditions of service, including expansion, contraction, and settlement.

c. The joint shall be designed to withstand, without cracking or fracturing, the forces caused by the compression of the gasket and the required hydrostatic pressure.

2. **Rubber for Gaskets:**

a. The rubber-type compound used for manufacture of the solid continuous ring gaskets of circular cross section shall be neoprene.

b. The compound shall contain no factice, reclaimed rubber, or any deleterious substance. All gaskets shall be extruded or molded and cured in such a manner that any cross section will be dense, homogeneous, and free from porosity, blisters, pitting, and other imperfections.

3. The neoprene shall meet the following physical requirements when tested in accordance with the applicable sections of Federal Test Method Standard No. 601 and appropriate ASTM test methods as indicated.

Neoprene (by volume) min. %	50
Tensile strength, psi, min. ASTM D412	1800 (12.41 MPa)
Elongation at rupture, percentage, min. ASTM D412	425
Shore durometer, Type A (Center of range preferred)	
ASTM D2240 (the test shall be performed on the flat cross section of 1/2-inch length of gasket)	40±5
Compression set, percentage of original deflection, max. Method B (1/2-inch long section of gasket, constant deflection; 22 hours at 158 degrees F) ASTM D395	20
Accelerated aging in air (70 hours at 212 degrees F) ASTM D573 Tensile strength, percentage of original strength, min.	85
Hardness change, percentage, max.	+15
Water absorption, percent vol. change, max. 70 hours at 212 degrees F	10
Ozone 6 ppm, 25 percent elongation, 2 hours at 100 degrees F max.	No Cracking
Specific Gravity	1.30 to 1.45

4. After the joint is assembled, and if so directed by the Engineer, a thin metal feeler gauge shall be inserted by the Contractor between the bell and the spigot and the position of the rubber gasket checked around the complete circumference of the pipe. If the gasket is not in the proper position, the pipe shall be withdrawn, the

gasket checked to see that it is not cut or damaged, the pipe relaid, and the gasket position again checked, all at no additional cost to the Contracting Agency.

630.02.07 PVC SEWER PIPE

A. This subsection specifies general requirements for unplasticized polyvinyl chloride (PVC) plastic gravity sewer pipe with integral wall bell and spigot joints for the conveyance of domestic sewage.

B. **Materials:** Pipe and fittings shall meet extra strength minimum of SDR-35 of ASTM D3034.

C. **Pipe:**

1. All pipe shall be suitable for use as a gravity sewer conduit.
2. Provisions shall be made for contraction and expansion at each joint with a rubber ring.
3. The bell shall consist of an integral wall section with a solid cross section rubber ring, factory assembled and securely locked in place to prevent displacement.
4. The rubber ring shall meet ASTM D1869.
5. Sizes and dimensions shall be as shown in this specification.
6. Standard lengths shall be 20 feet and 12.5 feet ±1 inch.
7. At manufacturer's option, random lengths of not more than 15 percent of total footage may be shipped in lieu of standard lengths.

D. **Fittings:** All fittings and accessories shall be as manufactured and furnished by the pipe supplier or approved equal and have bell and/or spigot configurations identical to that of the pipe.

E. **Physical and Chemical Requirements:** Pipe shall be designed to pass all tests at 73 degrees F (±3 degrees F).

F. **Pipe Stiffness:** Minimum "pipe stiffness" at 5 percent deflection shall be 46 for all sizes when tested in accordance with ASTM D2412.

G. **Joint Tightness:**

1. Assemble 2 sections of pipe in accordance with the manufacturer's recommendation.
2. Subject the joint to an internal hydrostatic pressure of 25 psi for 1 hour.
3. Consider any leakage a failure of the test requirements.

H. **Flattening:** There shall be no evidence of splitting, cracking, or breaking when the pipe is tested as follows:

1. Flatten 6-inch long specimen of pipe between parallel plates in a suitable press until the distance between the plates is 40 percent of the outside diameter of the pipe.
2. The rate of loading shall be uniform and such that the compression is completed within 2 to 5 minutes.

I. **Drop Impact Test:**

1. Pipe (6-inch long section) shall be subjected to impact from a free falling tup (20-pound Tup A) in accordance with ASTM D2444.

2. No shattering or splitting (denting is not a failure) shall be evident when the following impact energy is applied.

Nominal Size	4-inch	6-inch	8-inch	10-inch	12-inch
Feet-Pounds	140	210	210	220	220

J. **Acetone Immersion Test:** After 2 hours of immersion in a sealed container of anhydrous (99.5 percent pure) acetone, a 1-inch long sample ring shall show no sign of flaking on exterior or interior surfaces when tested in accordance with ASTM D2152.

K. Manhole couplings manufactured by the pipe manufacturer shall be used at all manholes.

L. A gauge plug furnished by the pipe manufacturer shall be pulled through the pipe from manhole to manhole to check the pipe for overdeflection. This check will be performed after the pipe is backfilled.

SIZES, DIMENSIONS, AND TOLERANCES

Nominal Size (inch)	Outside Diameter		Minimum Wall Thickness	Weight/Pounds 20-foot Length
	Average	Tolerance		
4	4.215	±0.007	0.125	20.4
6	6.275	±0.009	0.18	43.9
8	8.4	±0.010	0.24	78.8
10	10.5	±0.013	0.3	123.4
12	12.5	±0.016	0.36	176.4

M. **Marking:**

1. Pipe in compliance with this standard shall be clearly marked as follows at intervals of 5 feet or less:
   a. Manufacturer's name or trademark.
   b. Nominal pipe size.
   c. The legend "Type PSM SDR-35 PVC Sewer Pipe."
   d. ASTM D3034.
2. Fittings in compliance with this standard shall be clearly marked as follows:
   a. Manufacturer's name or trademark.
   b. Nominal size.
   c. Material designation "PVC."
   d. PSM.
   e. ASTM D3034.

CONSTRUCTION

630.03.01 EXCAVATION AND BACKFILL

A. Excavation and backfill shall be in accordance with the Standard Drawings for excavation and backfill of sanitary sewers.

630.03.02 TRENCHES

A. Trenches shall be in accordance with Section 208, "Trench Excavation and Backfill."

630.03.03 PIPE BEDDING AND LAYING

A. **Pipe Bedding:**

1. Pipe bedding shall be in accordance with Subsection 208.03.12, "Pipe Bedding," and the Standard Drawings.
2. Place pipe that is to be bedded in a concrete cradle or encased in concrete in proper position on temporary supports consisting of concrete blocks or bricks. When necessary, rigidly anchor or weight the pipe to prevent flotation when the concrete is placed.
3. Place concrete for cradles, arches, and encasement uniformly on each side of the pipe and deposit at approximately its final position.
   a. Do not move concrete more than 5 feet from its point of deposit.
   b. Concrete placed beneath the pipe shall be sufficiently workable so that the entire space beneath the pipe can be filled without excessive vibration.

B. **Pipe Laying:**

1. Protect the pipe during handling against impact, shocks, and free fall. Do not permit hooks to come in contact with premolded joint surfaces.
2. Handle pipe with premolded joint rings or attached couplings so that no weight, including the weight of the pipe itself, will bear on or be supported by the jointing material.
3. Take care to avoid dragging the spigot ring on the ground or allowing it to be damaged by contact with gravel, crushed stone, or other hard objects.
4. After delivery alongside the trench, carefully examine each piece of pipe for soundness and specification compliance. Acceptable pipe may be marked with paint or other permanent marking material so that the marks are plainly visible after installation in the trench and before the pipe is covered.
5. Clean joint contact surfaces immediately prior to jointing.
6. Use lubricants, primers, or adhesives recommended by the pipe or joint manufacturer.
7. Unless otherwise required, lay all pipe straight between changes in alignment and at uniform grade between changes in grade.
   a. Excavate bell holes for each pipe joint.
   b. When jointed in the trench, the pipe shall form a true and smooth line.
8. Divert surface water from the trench area to the greatest extent practicable without causing damage to the adjacent property. There shall be no freestanding water on the base upon which the pipe is laid.
9. Unless otherwise permitted by the Engineer, start pipe laying at the lowest point and install the pipe so that the spigot ends point in the direction of flow.
10. At times when the pipe laying is not in progress, the open end of the pipe shall be closed with a tight-fitting cap or plug to prevent the entrance of foreign matter into the pipe.
    a. These provisions shall apply during the noon hour as well as overnight.

b. In no event shall water that has infiltrated into the trenches be allowed to enter into existing sewage flows.

c. The pipeline under construction may be used to remove water that has infiltrated into the trenches provided it is removed before entering the existing flows.

630.03.04 DEWATERING

A. All water shall be removed so the top of base is dry for pipe laying.

B. In no case shall water from the dewatering process be allowed into existing sewer lines.

630.03.05 JACKING

A. **Equipment:** The jacking equipment used for this work shall be of serviceable quality and installed and operated in accordance with standard practice for this type of work and the approval of the Engineer.

B. **Casing:**

1. The jacked casing shall be large enough and so located that the sewer main can be jacked through and adjusted true to line and grade.

2. The annular space between the sewer pipe and the casing shall be sand filled, and any voids outside the casing shall be completely filled by pressure grouting.

C. **Flotation:** Sewer pipe shall be prevented from floating.

630.03.06 TUNNELING

A. **Size:** The tunnel shall be large enough so that the sewer main can be jacked through true to line and grade.

B. **Grouting:**

1. The annular space between the sewer main and the tunnel wall shall be completely filled by pressure grouting.

2. The sewer pipe shall be prevented from floating during the grouting operation.

630.03.07 SEWER LATERALS

A. **General:**

1. The term "sewer lateral" is defined as a branch sewer laid from main sewer to a point on the property line from which private sewer service can be obtained by proper extensions.

2. Sewer laterals shall be constructed of the same type of sewer pipe and the same type of joint as is used in the trunk line sewer in accordance with the plans and all applicable provisions of these specifications.

B. **Location Mark:** Where the curb is existing or is to be constructed as a part of the same job under which sewer laterals are installed, the location of the sewer lateral shall be plainly marked by stamping or chiseling the letter "S" in the face of the curb with a letter not less than 1 inch high and 3/16 inch deep.

C. **Wye Connection:**

1. A wye shall be installed in the main for each sewer lateral and lateral connection specified to be constructed.

2. Not more than 1 lateral shall be connected in 1 length of sewer main pipe.

D. **Lateral Connections:** Existing sewer laterals cut by construction of new sewers shall be connected to the new sewer main with pipe and fittings of the same diameter and material as that of the existing lateral.

E. **Lateral Extension Connections:** Existing sewer laterals that must be extended to reach new sewer mains shall be disconnected at the existing sewer main, and shall be extended and connected to the new sewer main using pipe and fittings of the same diameter and material as that of the existing lateral.

F. **Laterals Not Shown:**

1. Laterals uncovered by the construction that are not shown on the plans shall be connected to the new sewer line.

2. Such lateral connection work will be paid for at appropriate unit bid prices.

630.03.08 HOUSE CONNECTIONS

A. **Definition:** House connections are those sewer laterals constructed on private property from the property line to a point of connection with the existing building (house) sewer

B. **Plumbing Code:** All house connections shall conform to the provisions of the applicable Plumbing Code.

C. **Conduct of Operations:**

1. The Contractor shall conduct operations to result in a minimum of interference to the existing improvements.

2. The Contractor shall restore the area to its original condition after constructing house connections.

3. Landscaping shall be carefully restored either by planting new plants of the same variety and size as those removed or by stockpiling and replacing the existing plants in a strong growing condition.

630.03.09 APPURTENANCES

A. **Stubs and Plugs:**

1. Stubs in all sewer manholes shall consist of a short length of vitrified clay extra strength pipe with mechanical compression joints, unless otherwise specified or shown.

2. All stubs shall be plugged.

B. **Material:**

1. Plugs for vitrified clay mechanical compression joint pipe, up to and including 12 inches in diameter, shall be furnished where required by the plans.

2. Plugs shall consist of vitrified clay disks with approved plastic joint component or shall consist of a resilient material plug of controlled design and dimensions for mating with the pipe to which it is to be applied.

3. A force-fit of joint shall be made between the plug and the pipe.

630.03.10 ABANDONMENT OF EXISTING SEWERS

A. **Manholes to be Abandoned:** Manholes shall be abandoned as follows:

1. Concrete base shall be cracked or broken to provide drainage.
2. The manhole shall be removed from site. The remaining hole shall be backfilled and pavement shall be replaced as specified in Subsection 630.03.01, "Excavation and Backfill."
3. The manhole material shall be returned to the Contracting Agency unless otherwise specified.

B. **Sewer Mains to be Abandoned:** Sewer mains shall be abandoned as follows:

1. Excavate and remove pipe.
2. Excavate and crush pipe in place.
3. Grout pipe with sand or grout and plug ends.
4. Method as approved by Engineer.

C. **Plugs for Sewer Mains to be Abandoned:** Plugs in sewer mains to be abandoned shall be Portland cement concrete a minimum of 12 inches thick in 15-inch mains and larger and a minimum of 6 inches thick in sewer mains smaller than 15 inches.

630.03.11 VITRIFIED CLAY PIPE FITTINGS

A. Vitrified clay pipe fittings shall include branches of every type and stoppers. Fittings shall be furnished and installed at the locations, to the grades, and of type and size shown on the plans and in conformance with these specifications.

B. **Branches:**

1. Branches of type shown on the plans shall be furnished with connections of the sizes specified and shall be securely and completely fastened to the barrel of the pipe in the process of manufacture.
2. Tee branches shall have their axis perpendicular to the longitudinal axis of the pipe. Wye branches shall have their axis approximately 45 degrees (unless otherwise specified on the plans) to the longitudinal axis of the pipe, measured from the socket end. All branches shall terminate in sockets and the barrel of the branch shall be of sufficient length to permit making a proper joint when the connecting pipe is inserted in the branch socket.
3. The quality of vitrified clay pipe fittings and the joints for fittings shall conform to the applicable provisions of these specifications.

C. **Installation of Branches:**

1. Vitrified clay pipe wyes, tees, and other types of branches shall be furnished and installed along with vitrified clay pipe sewer.
2. Wyes of size specified on the plans shall be installed for all sewer house connections and for future sewer house connections as shown on the plans, or specified in the detailed specifications.
3. Tees shall be installed for chimneys shown on the plans.

4. The longitudinal barrel of branch fittings to be placed in line and grade with the vitrified clay pipe sewer mains shall be of the same diameter, quality, and type as the sewer.

5. Installation and bedding for branches shall conform to the applicable provisions set forth for vitrified clay sewer pipe.

6. Unless otherwise specified, the branch of wye fittings shall be inclined upward at an angle not greater than 45 degrees from a horizontal line.

7. If so shown on the plans, tees with standard tee foundations shall be substituted for wye branches.

8. No wye or tee for sewer house connection branch shall be placed closer than 5 feet, in the downstream side, to the centerline of any structure.

630.03.12 VITRIFIED CLAY PIPE AT MANHOLES OR STRUCTURES

A. A 2-foot vitrified clay pipe joint of the same inside diameter as the adjoining pipe shall be placed at the inlet and outlet to each manhole or structure as shown on the drawings.

B. The pipe may be laid through the manhole to provide a smooth invert. In this event, the pipe will be broken out and the base grouted to create a smooth shelf.

630.03.13 BLANK

630.03.14 TEST FOR LEAKAGE AND INFILTRATION

A. **General:** It is the intent of the plans and specifications that the completed sewer pipes of all types, along with manholes and other appurtenances, shall be watertight.

1. Each section of sewer between 2 successive manholes shall be tested for leakage. Where excessive groundwater is encountered or dewatering procedures are required, an infiltration test shall also be made as set forth herein.

2. If either the leakage or infiltration rate as shown by the tests specified herein is greater than the amount specified, the pipe joints shall be repaired or, if necessary, the pipe shall be removed and relaid by the Contractor at no additional cost to the Contracting Agency. The sewer will not be considered acceptable until the leakage and infiltration rates, as determined by test, are less than the allowable.

B. **Leakage Test:**

1. **General:**

a. The Contractor shall water test for leakage all sections of pipe between structures.

b. Where groundwater is encountered, then both the infiltration test and leakage test shall be made.

c. Where the difference in elevation between the invert of the upper structure and the invert of the lower structure is more than 10 feet, then the air test shall be made.

2. **Water Test:**

a. Each section of sanitary sewer, between 2 successive structures, shall be tested by closing the lower end of the sewer to be tested and the inlet sewer of the upper structure with plugs or stoppers and filling the pipe and structure

with water to a point 4 feet above the invert of the open sewer in the upper structure.

b. The total leakage shall be the decrease in volume of water in the upper structure.

1) The leakage shall not exceed 200 gallons per day per inch of nominal diameter of pipe per mile of sewer pipe being tested.

2) The length of house connections shall not be used in computing the length of sewer main being tested.

c. If leakage, as shown by the test, is greater than allowed, the pipe shall be overhauled and, if necessary, replaced and relaid until the joints and pipe hold satisfactorily under this test.

d. All tests shall be completed before the street or trench is resurfaced unless otherwise directed by the Engineer.

e. The Contractor shall furnish all labor and materials for making the tests required at no additional cost to the Contracting Agency.

3. **Air Test Procedure:**

a. Each section of sewer between 2 successive manholes shall be tested by plugging all pipe outlets with suitable test plugs.

b. Air shall be slowly added until the internal pressure is raised to 4.0 psig.

c. The compressor used to add air to the pipe shall have a blow-off valve set at 5 psig to ensure that at no time the internal pressure in the pipe exceeds 5 psig.

d. The internal pressure of 4 psig shall be maintained for at least 2 minutes to allow temperature to stabilize, after which the air supply shall be disconnected and the pressure allowed to decrease to 3.5 psig.

e. The time in seconds that is required for the internal air pressure to drop from 3.5 psig to 2.5 psig shall be measured and the results compared with the values as specified in ASTM C828.

f. For convenience, specification times required for the pressure drop from 3.5 psig. to 2.5 psig. are tabulated on the following chart:

SPECIFICATION TIME (MIN:SEC) REQUIRED FOR PRESSURE DROP FROM 3.5 TO 2.5 PSIG WHEN TESTING ONE PIPE DIAMETER ONLY (PIPE DIAMETER, INCHES)

	4	**6**	**8**	**10**	**12**	**15**	**18**	**21**	**24**	**27**	**30**	**33**	**36**	**39**	**42**
25	0:04	0:10	0:18	0:22	0:27	0:32	0:36	0:45	0:54	1:03	1:12	1:21	1:30	1:39	1:50
50	0:09	0:21	0:36	0:45	0:54	1:03	1:12	1:30	1:48	2:06	2:24	2:42	3:00	3:18	3:39
75	0:14	0:32	0:54	1:08	1:21	1:34	1:48	2:15	2:42	3:09	3:36	4:03	4:30	4:57	5:29
100	0:18	0:42	1:12	1:30	1:48	2:06	2:24	3:00	3:36	4:12	4:48	5:24	6:00	6:36	7:18
125	0:22	0:52	1:30	1:52	2:15	2:38	3:00	3:45	4:30	5:15	6:00	6:45	7:30	8:15	9:08
150	0:27	1:03	1:48	2:15	2:42	3:09	3:36	4:30	5:24	6:18	7:12	8:06	9:00	9:54	10:57
175	0:32	1:14	2:06	2:38	3:09	3:40	4:12	5:15	6:18	7:21	8:24	9:27	10:30	11:33	12:47
200	0:36	1:24	2:24	3:00	3:36	4:12	4:48	6:00	7:12	8:24	9:36	10:48	12:00	13:12	14:36

SPECIFICATION TIME (MIN:SEC) REQUIRED FOR PRESSURE DROP FROM 3.5 TO 2.5 PSIG WHEN TESTING ONE PIPE DIAMETER ONLY (PIPE DIAMETER, INCHES)

	4	6	8	10	12	15	18	21	24	27	30	33	36	39	42
225	0:40	1:34	2:42	3:22	4:03	4:44	5:24	6:45	8:06	9:27	10:48	12:09	13:30	14:51	16:26
250	0:45	1:45	3:00	3:45	4:30	5:15	6:00	7:30	9:00	10:30	12:00	13:30	15:00	16:30	18:16
275	0:50	1:56	3:18	4:08	4:57	5:46	6:36	8:15	9:54	11:33	13:12	14:51	16:30	18:09	20:06
300	0:54	2:06	3:36	4:30	5:24	6:18	7:12	9:00	10:38	12:36	14:24	16:12	18:00	19:48	21:54
350	1:03	2:27	4:12	5:15	6:18	7:21	8:24	10:30	12:36	14:42	16:48	18:54	21:00	23:06	25:33
400	1:12	2:48	4:48	6:00	7:12	8:24	9:36	12:00	14:24	16:38	19:12	21:36	24:00	26:24	29:12
450	1:21	3:09	5:24	6:45	8:06	9:27	10:48	13:30	16:12	18:54	21:36	24:18	27:00	29:42	32:51
500	1:30	3:30	6:00	7:30	9:00	10:30	12:00	15:00	18:00	21:00	24:00	27:00	30:00	33:00	36:30

g. If the length to be tested is not calculated above, the following formula can be used to calculate the time required for the specified pressure drop.

TABLE 1 MINIMUM TEST TIME FOR VARIOUS PIPE SIZES

Nominal Pipe Size, in.	T(time), min/100 ft.	Nominal Pipe Size, in.	T(time), min/100 ft.
3	0.2	21	3.0
4	0.3	24	3.6
6	0.7	27	4.2
8	1.2	30	4.8
10	1.5	33	5.4
12	1.8	36	6.0
15	2.1	39	6.6
18	2.4	42	7.3

$$T = \frac{\text{Time in Table 1}}{100} \times L$$

WHERE

T = Time for pressure to drop from 3.5 psig to 2.5 psig in minutes

L = Length of line between manholes

h. If the pressure drop from 3.5 psig to 2.5 psig occurs in less time than the above tabulated or calculated values, the pipe shall be overhauled and, if necessary, replaced and relaid until the joints and pipe hold satisfactorily under this test.

i. If the section of line to be tested includes more than one pipe size, calculate the test for each size and add the test times to arrive at the total test time for the section.

j. At the end of air testing, all manholes shall be water tested to ensure they are water tight in accordance with Subsection 630.03.14.A, "General."

4. **Test for Infiltration:**

a. If, in the construction of a section of the sewer between structures, excessive groundwater is encountered, the test for leakage shall also be required as described in the subsection on leakage test.

b. For infiltration tests, the end of the sewer at the upper structure shall be closed sufficiently to prevent the entrance of groundwater, and pumping of groundwater shall be discontinued for at least 3 days, after which the section shall be tested for infiltration.

c. The infiltration shall not exceed 0.028 gallons per minute, per inch of diameter, per 1,000 feet of mainline sewer being tested, and does not include the length of house laterals entering that section.

d. Where any infiltration in excess of this amount is discovered before completion and acceptance of the sewer, the sewer shall be immediately uncovered at no additional cost to the Contracting Agency and the amount of infiltration reduced to a quantity within the specified amount of infiltration before the sewer is accepted.

e. Should, however, the infiltration be less than the specified amount, the Contractor shall stop individual leaks that may be observed when ordered to do so by the Engineer.

f. The Contractor shall furnish and install calibrated flumes, or "V" notch weirs, for measuring infiltration and making the tests required at no additional cost to the Contracting Agency.

g. All tests shall be completed before street or trench is resurfaced, unless otherwise directed by the Engineer.

630.03.15 TESTS FOR ALIGNMENT AND GRADE, AND DAMAGED OR DEFECTIVE PIPE IN PLACE

A. After the pipe has been installed, tested for leakage, backfilled to existing grade, and manholes raised, the sewer shall be "balled" from manhole to manhole with a sewer scrubbing ball of type and size, approved by the Engineer, with the assistance of the Contractor's forces.

B. All "balling" and "mirroring" shall be done in the presence of the Engineer and shall constitute tests for alignment, grade, damaged or defective pipe in place, and any other type of faulty installation.

C. Should "balling" or "mirroring" indicate any faulty installation of the pipe, repairs or replacements shall be made at no additional cost to the Contracting Agency and as directed by the Engineer.

D. Full compensation for making these tests shall be included in the contract unit prices and no additional allowance will be made therefor.

E. Where sewers are of sufficient size to permit hand cleaning, "balling" may be omitted.

METHOD OF MEASUREMENT

630.04.01 MEASUREMENT

A. The method of measurement shall be as specified by the Contracting Agency.

BASIS OF PAYMENT

630.05.01 PAYMENT

A. Payment shall be as specified by the Contracting Agency.

SECTION 631

STREET NAME SIGNS

DESCRIPTION

631.01.01 GENERAL

A. The street name signs, mounting post, location, fabrication, and installation shall conform to these specifications and any specifications referred to as part of this specification.

631.01.02 STREET NAME SIGN FACES

A. The legend shall include the name of the street with proper suffix, ordinal, and block number as assigned by the responsible agency for that jurisdiction, all in accordance with the Standard Drawings.

MATERIALS

631.02.01 GENERAL

A. The finished face shall be applied to an aluminum sign blank conforming to the Standard Drawings.

631.02.02 SIGN LEGEND

A. The legend shall be made by 1 of the following 3 methods:

1. By reverse screening with green (blue for the City of North Las Vegas) transparent ink on a white wide-angle prismatic retroreflective sheeting that conforms to the material specified in Subsection 716.03.01, "Reflective Sheeting," Class 6. When this method is used, the block number on the sign face may be 2-inch numerals, die-cut from white conforming to the material specified in Subsection 716.03.01 "Reflective Sheeting," Class 6, white, using pressure-sensitive adhesive.

2. By applying white die-cut letters to green (blue for the City of North Las Vegas) wide-angle prismatic retroreflective sheeting that conforms to the material specified in Subsection 716.03.01 "Reflective Sheeting," Class 6.

   a. When this method is used, the letters and numerals shall be die-cut from white sheeting conforming to the material specified in Subsection 716.03.01, "Reflective Sheeting," Class 6, white, and shall be applied using pressure-sensitive adhesive.

   b. The sign fabricator shall supply the Contracting Agency with a written guarantee of workmanship, stating that any lettering that peels or loosens from the sign face within 5 years will be repaired, or the sign replaced, free of charge.

3. By applying green (blue for the City of North Las Vegas) electronic cuttable transparent overlay film to white wide-angle prismatic retroreflective sheeting that conforms to the material specified in Subsection 716.03.01, "Reflective Sheeting," Class 6.

CONSTRUCTION

631.03.01 STREET NAME SIGN INSTALLATION

A. The fabricated signs shall be installed using the hardware and piping as shown on the Standard Drawings and as specified in Subsection 716.03.06, “Sign Hardware, Post," and Related Materials.”

B. The signs shall be installed on the corners of the intersection as indicated on an approved plan. Further, the signs shall be located on the P.C. line as indicated in the Standard Drawings.

631.03.02 EXCEPTIONS

A. No exceptions to the above specifications shall be allowed without prior written consent from the Contracting agency.

METHOD OF MEASUREMENT

631.04.01 MEASUREMENT

A. The quantity of street signs measured for payment will be the number of complete signs in place.

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

BASIS OF PAYMENT

631.05.01 PAYMENT

A. Payment for street name signs shall be for each complete sign in place.

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

C. Payment will be made under:

PAY ITEM	PAY UNIT
Street Name Sign	Each

SECTION 632

HEADLIGHT GLARE SCREEN

DESCRIPTION

632.01.01 GENERAL

A. 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.

B. 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

A. The aluminum and steel materials for the headlight glare screen shall conform to the provisions specified below.

B. **Expanded Mesh:**

1. The expanded steel mesh panels shall be fabricated from 22 gauge galvanized sheet commercial quality steel (dry for continuous strip painting) conforming to ASTM A525 with a 1.25-ounce commercial galvanized coat with minimum spangle.
2. The expanded aluminum mesh panels shall be fabricated of aluminum alloy 3105-H25.
3. The expanded mesh panels shall have the following nominal dimensions:
   a. Diamond Size:
      1) 1.33 inches short dimension (center to center of bridges).
      2) 4.00 inches long dimension (center to center of bridges).
   b. Strand Size:
      1) Aluminum: 0.050 inch thick.
      2) Steel: 0.034 inch thick.
      3) Aluminum or Steel: 0.250 inch in width.
   c. Panel Size for Type A:
      1) 2'-0" long dimension of diamonds.
      2) 6'-8" or 12'-8" short dimension of diamonds.
   d. Panel Size for Type B:
      1) 2'-0" long dimension of diamonds
      2) 5'-5" or 10'-5" short dimension of diamonds.
4. The weight of expanded aluminum mesh shall not be less than 0.21 pound per square foot.
5. Steel mesh panels before fabrication shall be treated in power washing equipment with a chemical conversion coating conforming with Federal Specification MIL-C-5541

and furnished with 2 coats of protective paint on both sides, applied before fabrication.

6. Aluminum mesh panels before fabrication shall be treated in power washing equipment with a chemical conversion coating conforming with Federal Specification MIL-C-5541 and finished with 1 coat of high temperature baking enamel on both sides, applied before fabrication.

C. **Finish of Mesh Panels:**

1. The finish for the steel mesh panels shall be 1 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 1 continuous pass through the roller coating equipment.

2. 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 finish shall be applied in 1 continuous pass through the roller coating equipment.

3. The color of the enamel finish shall be Interstate Green unless otherwise specified. The baking enamel shall be uniform throughout and shall be smooth and free from flow lines, streaks, blisters, and other surface imperfections.

4. The composition of the baked dry film shall conform to the following requirements:

a. **Thickness:** The dry film thickness shall not be less than 0.8 mil as determined by ASTM D1400.

b. **Gloss:** The gloss of the enamel shall be standard medium gloss (60 degrees specular gloss 70 minimum when tested in accordance with Federal Test Method Standard No. 141, Method 6101).

c. **Color Uniformity:** The color uniformity of the enamel after baking shall be constant within commercial limits when checked visually in the MacBeth Daylight Booth.

d. **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.

D. 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 20 degrees from the straight-ahead direction of the headlight beams.

E. Shearing shall be accomplished in a uniform and workmanlike manner with a minimum of burrs, edge spalling of enamel, sharp edges, and shear marks.

F. **Posts, Caps and Hardware:**

1. Posts on metal beam barrier rail shall be fabricated of structural steel conforming to ASTM A36 shall be hot-dip galvanized after fabrication in accordance with ASTM A123. Hardware shall be commercial quality and shall be galvanized.

2. Posts on concrete barrier rail shall be standard weight black pipe conforming to ASTM A53 or ASTM A120 and shall be threaded to receive standard threaded pipe caps.

a. Posts and caps shall be hot-dip galvanized after fabrication.

b. Hardware shall be commercial quality and shall be galvanized.

G. **Tension Wires:** The top and bottom tension wires shall be 7-gauge and shall be galvanized coil spring steel wire of commercial quality.

H. **Wire Ties:**

1. The bottom tension wire shall be tied to each post with 9-gauge (0.1483-inch minimum diameter) steel wire ties or hog rings.
2. The expanded mesh panels shall be tied to the top and bottom tension wires and to each post with 11-gauge (0.120-inch minimum diameter) steel wire ties and hog rings.
3. Steel wire ties and hog rings shall be commercial quality and shall be galvanized.
4. 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.
5. The aluminum wire ties shall be aluminum alloy 1100-H18 conforming to ASTM B211. Aluminum hog rings shall be fabricated from either aluminum alloy 6061-T94 or 5052-H38.

I. **Removable Expanded Mesh Panel:**

1. Removable expanded mesh panels shall be installed as shown on the plans.
2. 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.
3. The sign shall conform to the provisions for target plates as provided in Section 619, "Object Markers and Guide Posts," and the plans.
   a. The enamel finish coat shall comply with Federal Specification TT-E-489 as required in Section 721, "Object Markers and Guide Posts."
   b. The color of the finished sign shall be white.
   c. The letters on the sign shall be black.
   d. The message on the panel shall read: "Emergency Panel."
4. NOTE: At no additional cost to the Contracting Agency, 2 certificates covering each order of material shall be furnished by the manufacturer, certifying that the product complies with the specifications.
   a. One certificate shall be delivered to the Engineer in charge of the job site at the time of, or prior to, delivery of the order.
   b. The other certificate shall be delivered to the Contracting Agency prior to acceptance of the material.

CONSTRUCTION

632.03.01 GENERAL

A. Headlight glare screen shall be erected on steel posts, tied to a top and bottom tension wire, and mounted on the metal beam or concrete barrier rail at the location and in accordance with the details shown on the plans.

B. The exact location of the removable expanded mesh Emergency Panel will be determined by the Engineer.

METHOD OF MEASUREMENT

632.04.01 MEASUREMENT

A. 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.

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

BASIS OF PAYMENT

632.05.01 PAYMENT

A. The quantity of headlight glare screen measured as provided above shall be paid for at the contract unit price bid per linear foot, which 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.

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

C. 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

A. This work shall consist of furnishing and placing pavement markers at the locations shown on the plans or where directed by the Engineer.

B. The markers shall have the shape, dimensions, and tolerances shown on the plans.

C. Pavement markers will be of the type and color shown on the plans.

MATERIALS

633.02.01 NON-REFLECTIVE PAVEMENT MARKERS

A. 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.

1. The markers shall be produced from any suitable combination of intimately mixed clays, shales, talcs, flints, feldspars, or other inorganic material that will meet the properties herein required.
2. The markers shall be thoroughly and evenly matured and free from defects that affect appearance or serviceability.

B. The top surface of the non-reflective marker shall be convex and the radius of curvature shall be between 3-1/2 inches and 6 inches, except that the radius of the 1/2 inch nearest the edge may be less.

1. Any change in curvature shall be gradual.
2. The top and sides shall be smooth and free of mold marks, pits, indentation, air bubbles, or other objectionable marks or discolorations.
3. The bottom of the ceramic markers shall be free from gloss or glaze and shall have all areas of integrally formed protrusion projecting from the surface that will increase the effective bonding surface area of adhesive.
4. The faces of the protrusions shall not deviate more than 0.05 inch from a flat surface.
5. The areas of protrusion shall have faces parallel to the bottom of the marker and shall project approximately 0.04 inch from the bottom.
6. The area of protrusions shall constitute a minimum of 30 percent of the area of the bottom of the marker and shall increase the bonding surface area by a minimum of 24 percent.
7. To facilitate forming a mold release, the sides of the protruded area may be tapered.
8. This taper shall not exceed 15 degrees from the perpendicular to the marker bottom.

C. The non-reflective ceramic type markers shall conform to the following tests:

1. Adhesive bond strength to bottom surface of the marker using epoxy adhesives specified in Subsection 633.02.03, "Pavement Marker Adhesive": 700 psi minimum.

2. Glaze Thickness: 0.005 inch minimum.
3. Moh Hardness: 6 minimum.
4. Directional reflectance (white markers only):
   a. Glazed surface: 75 minimum.
   b. Body of marker: 70 minimum.
5. Yellowness Index (white markers only):
   a. Glazed surface: 7 maximum.
   b. Body of marker: 16 maximum.
6. Color (yellow markers only):
   a. Purity: 76 percent to 96 percent.
   b. Dominant wave length: 579 mu to 585 mu.
   c. Total luminous reflectance (Y value x 100): 41 minimum.
7. Autoclave: Glaze shall not spall, crack or peel.
8. Strength: 1,500 pounds minimum.
9. Water absorption: 2.0 percent maximum.

633.02.02 REFLECTIVE PAVEMENT MARKERS

A. Reflective pavement markers shall be of the prismatic reflector type consisting of methyl methacrylate or suitable compounded acrylonitrile butadiene styrene (ABS) filled with a mixture of an inert thermosetting compound and filler material.
   1. The exterior surface of the shell shall be smooth and contain 1 or 2 methyl methacrylate, impact modified methacrylate, or polycarbonate prismatic reflector face(s) of the color specified.
   2. Reflective pavement markers shall be impact-resistant and abrasion-resistant.

B. 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 that may reduce its bond to the adhesive.
   1. The angle between the face of the marker and the base shall be no greater than 45 degrees.
   2. Marker dimensions are as set forth in the Standard Drawings.

C. In accordance with ASTM D4280, the adhesive bond strength to the bottom surface of the marker shall not be less than 500 psi when tested with epoxy adhesive.
   1. Markers with length and width both equal to 4 inches shall undergo flexural strength testing and shall withstand a minimum 2,000 pounds without breakage or significant deformation.
   2. Markers with length less than 4 inches shall undergo compressive strength testing and shall support a minimum load of 6,000 pounds without breakage or significant deformation.

D. The color of the reflector when illuminated by an automobile headlight shall be an approved clear, yellow, or red.

1. Off-color reflection shall constitute grounds for rejection.
2. The reflective markers shall have initial minimum retroreflectance values specified as the product of Table 1 and Table 2 when measured in accordance with ASTM E809.
3. The photometric quantity to be measured is the coefficient of retroreflected luminous intensity (R_I), expressed as candelas per footcandle and millicandelas per lux (mcd/lx).
4. One candela per lux equals 10.76 candelas per footcandle.

Table 1 - Minimum RI Values

Entrance angle b_2 = (b_1 = 0º)	0º	±20º
Observation angle:	0.2º	0.2º
Minimum R_I (cd/ftcd)	3.0	1.2
Minimum R_I (mcd/lx)	279	112

Table 2 - Color Multiplying Factors

Color	White	Yellow/Amber	Red	Blue	Green
Multiplying Factor	1	0.6	0.25	0.1	0.33

E. All reflective pavement markers shall meet the minimum retroreflectance values specified as the product of Tables 1 and 2 shown above for the following tests:

1. Abrasion Resistance:
   a. Entire lens surface of the marker shall be subjected to 100 rubs with a 1-inch diameter flat pad of No. 3 coarse steel wool conforming to Federal Specification FF-W-1825A.
   b. A load of 50 ±0.5 pounds shall be applied to steel wool pad during testing.
2. Temperature Resistance: Markers shall be conditioned for 12 hours at 145 degrees F ±5 degrees F.
3. Testing:
   a. Pavement markers shall be sampled and tested prior to use in accordance with Test Method Number 669 of the California Department of Transportation.
   b. Marker lots that have been previously sampled and tested by the Contracting Agency and approved as conforming with these specifications may be used without further testing, if permitted by the Engineer.

633.02.03 PAVEMENT MARKER ADHESIVE

A. The pavement marker adhesive shall be either a hot-melt bituminous adhesive or an epoxy adhesive that provides effective bonding of pavement markers to both asphalt and concrete pavement surfaces.

B. The adhesive shall not permit excessive marker movement at hot summer temperatures and shall remain flexible at winter temperatures.

C. The bituminous adhesive shall be an asphaltic material with a homogeneously mixed mineral filler that shall comply with ASTM D4280.

D. Epoxy adhesives shall comply with Subsection 728.03.10, "Epoxy Adhesives for Pavement Markers."

E. The Contractor shall furnish the Engineer with certificates of compliance executed by the manufacturers of the markers and adhesive attesting that they conform to these specifications.

CONSTRUCTION

633.03.01 INSTALLATION

A. 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 that would adversely affect the bond of the adhesive.

B. Cleaning shall be done by blast cleaning on all pavement surfaces; only air blast cleaning will be permitted on asphalt concrete surfaces.

C. 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 placed.

1. Excess adhesive around the edge of the marker, excess adhesive on the pavement, and adhesive on the exposed surfaces of the markers shall be immediately removed.
2. Soft rags moistened with mineral spirits conforming to Federal Specification TT-T291 or kerosene may be used, if necessary, to remove adhesive from exposed faces of pavement markers.
3. No other solvent shall be used.
4. The markers shall be protected against impact until the adhesive has hardened to the degree designated by the Engineer.

D. The adhesive shall not be used when either the pavement or the air temperature is less than 50 degrees F.

E. No markers shall be installed if the relative humidity of the air is greater than 80 percent or if the pavement is not surface dry.

F. The adhesive shall be prepared and applied according to the manufacturer’s requirements and specifications.

G. The Engineer shall determine when the adhesive has set sufficiently to bear traffic.

H. All markers shall be applied in accordance with the manufacturer’s recommendations.

1. Reflective markers shall be placed so that the reflective face of the marker is perpendicular to a line parallel to the roadway centerline.
2. No pavement markers shall be placed over longitudinal or transverse joints of the pavement surface.

METHOD OF MEASUREMENT

633.04.01 MEASUREMENT

A. 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.

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

BASIS OF PAYMENT

633.05.01 PAYMENT

A. 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 cleaning and preparing the pavement surface, 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.

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

C. Payment will be made under:

PAY ITEM	PAY UNIT
Non-Reflective Pavement Markers	Each
Reflective Pavement Markers	Each

SECTION 634

TEMPORARY PAVEMENT STRIPING TAPE

DESCRIPTION

634.01.01 GENERAL

A. This work shall consist of furnishing, locating, placing, maintaining, and removing temporary pavement striping tape and temporary pavement striping tape (pilot line).

B. The underlined asterisk (__*__) as used in this section denotes the skip interval distance between striping tape segments as indicated in the Contract Documents.

MATERIALS

634.02.01 TEMPORARY PAVEMENT STRIPING TAPE

A. Temporary striping tape shall be yellow or white or any combination thereof as directed by the Engineer and shall conform to the requirements specified below.

B. The striping material shall be reflectorized adhesive marking tape that will be readily visible when viewed with automobile headlights at night, shall be composed of a conformable backing coated with a pressure sensitive adhesive, and shall be designed for marking of pavements.

C. The tape shall be 4 inches wide and not less than 20 mils or more than 30 mils thick with a minimum tensile strength of 40 pounds per inch of width.

D. The color shall closely match the color normally used by the Contracting Agency in pavement striping.

E. The upper or visible surface shall have a minimum apparent reflectance of 75 percent as determined in accordance with ASTM E97.

F. Beads shall be strongly adhered to the 4-inch tape at the rate of at least 1.76 pounds but not more than 1.95 pounds per 100 linear feet.

G. The striping material backing shall permit complete removal without requiring sandblasting, solvent, or grinding methods.

H. Temporary pavement striping tape (pilot line) shall be 4-inch by 4-inch square and shall be placed on traffic lane lines at __*__-foot intervals. Lane lines at __*__-foot intervals shall be located by the Contractor as approved by the Engineer.

CONSTRUCTION

634.03.01 INSTALLATION

A. The Contractor shall furnish, apply, maintain, and remove all temporary pavement striping tape.

1. Temporary pavement striping tape may be used on construction crossovers, detours, and temporary connections.

2. Temporary pavement striping tape (pilot line) may be placed on 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.

B. The surface to which the tape is applied shall be dry and free of oil, grease, dust, or dirt.

C. 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.

D. 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.

METHOD OF MEASUREMENT

634.04.01 MEASUREMENT

A. Temporary pavement striping tape shall be measured for payment on a linear foot of tape basis.

B. Temporary pavement striping tape (pilot line, __*__-foot) shall be measured for payment on a station basis, and each 100 feet shall constitute the unit of one station. Measurement shall be made on the initial application at the locations approved by the Engineer.

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

BASIS OF PAYMENT

634.05.01 PAYMENT

A. 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, __*__-foot) 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.

B. Replacement of tape, as set forth above, shall not be measured or paid for directly but shall be considered as 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, __*__-foot).

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

D. Payment will be made under:

PAY ITEM	PAY UNIT
Temporary Pavement Striping Tape	Linear Foot
Temporary Pavement Striping Tape (pilot line, __*__-foot)	Station

SECTION 637

POLLUTION CONTROL

DESCRIPTION

637.01.01 GENERAL

A. This work shall consist of temporary pollution control measures that may be shown on the plans, specified in the Special Provisions, or ordered by the Engineer during the life of the contract.

1. The work shall meet the applicable requirements of the Clark County Department of Air Quality and Environmental Management (DAQEM).

2. The 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, adjacent property, and streams or other bodies of water.

B. The Contractor shall, 7 days prior to the preconstruction conference, submit for acceptance the Contractor's proposed plans and schedules, in duplicate, for accomplishing the prevention of erosion and pollution that may occur due to the Contractor's operations. No work shall be started until the schedules and methods of operations have been accepted by the Engineer.

C. The 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 that are to be paved under the terms of the 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

A. 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.

B. Resin emulsion shall be composed of from 57 percent to 63 percent of semi-liquid petroleum resin and the remainder water to which a suitable emulsifying agent has been added.

1. The binder shall be mixed with additional water at the job site and at the appropriate rate of 4 parts of water to 1 part of binder.

2. The exact rate of mixture shall be determined by the Engineer.

3. The resin emulsion shall be readily miscible with water and when diluted with any hard water in proportions of 1 part emulsion to 10 parts water shall show no signs of breakdown or separation of the petroleum resin base.

4. Resin emulsion that has been stored in closed containers at temperatures above freezing for a period of up to 3 months shall show no signs of separation.

5. Any resin emulsion that has been stored for more than 3 months shall not be used until tested and approved.

CONSTRUCTION

637.03.01 GENERAL

A. 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.

B. 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, to adjacent property, and to 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.

C. It is expected that compliance with the requirements will necessitate performance of certain items of work at a different time or in a different manner than originally planned, causing revisions in scheduling of work that may interfere with normal construction practices.

D. Unless otherwise approved by the Engineer, the total area of erodible earth material exposed by the Contractor's operation shall not exceed 750,000 square feet before either temporary pollution control or temporary or permanent erosion control measures are accomplished.

E. 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 scheduled so that pollution control features will be installed concurrently with or immediately following grading operations.

F. Compliance with this section shall not relieve the Contractor from Contractor's responsibility to comply with the other provisions of the contract, except that the Contractor will be required to replace, at no additional cost to the Contracting Agency, any of the temporary pollution control work that is damaged by action of the elements.

G. 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.

H. The Contractor shall coordinate temporary pollution control work, as required by the Engineer, with erosion control work specified elsewhere in the contract to ensure that effective and continuous pollution control is maintained during the construction of the project.

I. The Contractor shall conduct operations to minimize the effects of erosion and air pollution due to the Contractor's 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.

J. Mixing of the dust palliative material shall be accomplished by simultaneously placing the binder and water in the spreading equipment or by other mixing methods that will produce equivalent results.

1. The resulting mixture shall be applied with pressure type water distributor trucks equipped with a spray system, or pressure type asphalt distributors conforming to Subsection 405.03.01, "Equipment."

2. The mixture shall be applied at a total rate of approximately 1/2 gallon per square yard in 2 applications of 1/4 gallon per square yard.

3. The exact rate of application will be determined by the Engineer.

METHOD OF MEASUREMENT

637.04.01 MEASUREMENT

A. 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, "Extra and Force Account Work."

B. The required quantity of dust palliative will be measured by the ton prior to addition of water at the job site. If volumetric measurement is permitted by the Engineer, the dust palliative shall be measured as set forth in Subsection 109.01, "Measurement of Quantities," for asphaltic emulsion.

C. The cost of furnishing materials and equipment and conditioning crushing, mixing, and processing plants and other equipment to comply with the DAQEM requirements, 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

A. Payment for Temporary Pollution Control measured as provided above will be paid for by Force Account.

B. Dust palliative, measured as provided above, shall be paid for at the contract unit price bid per ton for Dust Palliative, which shall be full compensation for furnishing the material, adding and mixing additional water at the job site, 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.

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

D. 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

A. 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.

1. Membrane waterproofing consists of a coating of primer and a firmly bonded membrane composed of 2 layers of saturated glass fabric and 3 moppings of waterproofing asphalt.

2. Dampproofing consists of a coating of primer and 2 moppings of waterproofing asphalt.

MATERIALS

646.02.01 GENERAL

A. Waterproofing asphalt shall conform to ASTM D449, Type A for below ground and Type B for above ground, except that the ductility of Type B shall be 5 minimum. The provisions in ASTM D449 relating to felt, asbestos felt, and cotton fabrics shall not apply.

B. Primer for use with asphalt in waterproofing below and above ground level shall conform to ASTM D41.

C. Fabric shall conform to ASTM D1668 for bituminous glass fabric treated with asphalt.

CONSTRUCTION

646.03.01 GENERAL

A. All concrete surfaces to be waterproofed shall be smooth and free from holes and projections that might puncture the membrane. The surface to be waterproofed or dampproofed shall be dry and shall be thoroughly cleaned of dust and loose materials.

B. No primer or asphalt shall be applied in wet weather, nor when the temperature is below 65 degrees F, without authorization in writing from the Engineer.

C. The primer shall be applied to the surface and allowed to dry before the first coat of asphalt is applied.

D. The waterproofing asphalt shall be applied at a temperature of not less than 300 degrees F nor more than 350 degrees F.

646.03.02 MEMBRANE WATERPROOFING

A. Membrane waterproofing shall not be applied to any surface until the Contractor is prepared to follow application with the placing of backfill within a sufficiently short time that the waterproofing will not be damaged as a result of exposure to weathering. Any waterproofing membrane that loses its bond with the concrete shall be removed and replaced with new membrane waterproofing by the Contractor at no additional cost to the Contracting Agency.

B. Beginning at the low point of the surface to be waterproofed, the waterproofing asphalt shall be thoroughly mopped onto the surface.

1. A strip of fabric of half the width of the roll shall be rolled onto the hot asphalt immediately and carefully pressed into place to eliminate air bubbles and obtain close conformity with the surface.
2. The strip and an adjacent section of the surface, of a width equal to slightly more than 1/2 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.
3. 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 2 inches.
4. This process shall be continued until the entire surface is covered, each strip of fabric lapping at least 2 inches over the last strip but 1.
5. The entire surface shall then be mopped with hot asphalt.
6. Special care shall be taken to ensure that each lap is thoroughly sealed down.

C. 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

A. The waterproofing asphalt shall be thoroughly mopped on the surface to be dampproofed.

B. When the first mopping of asphalt has set sufficiently, the entire surface shall be mopped with the second coating of hot asphalt.

C. Special care shall be taken to ensure that there are no skips in the coatings and that all surfaces are thoroughly covered.

METHOD OF MEASUREMENT

646.04.01 MEASUREMENT

A. The quantities of membrane waterproofing or dampproofing placed as shown on the plans or directed by the Engineer will be measured by the square yards of area covered by the membrane waterproofing or dampproofing.

BASIS OF PAYMENT

646.05.01 PAYMENT

A. 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 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.

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

C. Payment will be made under:

PAY ITEM	PAY UNIT
Membrane Waterproofing	Square Yard
Dampproofing	Square Yard

SECTION 660

METAL BIN-TYPE RETAINING WALLS

DESCRIPTION

660.01.01 GENERAL

A. 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 conformity to the lines, grades, basic designs, and dimensions shown on the plans or established by the Engineer.

B. The bin-type wall comprises prefabricated members with fittings and appurtenances for complete assembly in the field.

C. The basic design of the wall refers to the length of wall spacers affecting depth of the wall.

MATERIALS

660.02.01 GENERAL

A. The galvanized sheets used in fabricating the several members shall conform to AASHTO M 36.

B. Bolts, nuts, and miscellaneous hardware shall be galvanized.

C. The various members shall be fabricated from specified metal of the respective gauges shown on the plans, but not lighter than 16 gauge. In the absence of given gauges or dimensions for any member, fitting, or appurtenance, the gauge of metal or dimensions thereof shall be as required to fully develop the strength of the members for which gauges and dimensions are given and that are used in structural combination.

D. All members, fittings, and appurtenances shall be designed as integral units or parts of the whole assembly.

CONSTRUCTION

660.03.01 FABRICATION

A. Metal bin-type retaining walls shall consist of a plurality of pair 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 tie members (spacers).

B. The necessary bolts and appurtenances shall be furnished for complete assembly of the units into a continuous closed face wall of connected bins.

C. All members shall be so fabricated that members of the same nominal size shall be fully interchangeable.

D. The members shall be fabricated and punched so that no drilling, punching, or drifting to correct defects in manufacture will be required during field assembly.

E. Members with improperly punched holes will be rejected and shall be replaced with properly punched members.

660.03.02 EARTHWORK

A. 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.

1. Below this point, trenches 18 inches in width shall be excavated for the 4 sides of the bin.

2. The bearing of the base of the bin shall be firm and shall be approved by the Engineer before erection of the wall.

B. Structure excavation and backfill for the interior of the bin and behind the wall shall conform to Section 206, "Structure Excavation" and Section 207, "Structure Backfill."

C. Backfilling behind the wall shall progress with the filling of the bins and shall not be carried ahead of the binfill.

1. Existing slopes that are shaped to cause a wedge action in the backfill shall be step-cut or benched before backfilling.

2. The limiting dimensions of structure backfill behind the wall shall be the same as those prescribed in Subsection 207.03.01, "General," for walls and abutments, or as otherwise shown on the plans.

660.03.03 ASSEMBLY

A. 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.

B. The wall height and depth may be varied.

C. 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 of the step-back.

D. The units shall be erected as shown on the plans.

E. Members shall be handled carefully. Damaged members shall be removed and new members substituted at no additional cost to the Contracting Agency.

METHOD OF MEASUREMENT

660.04.01 MEASUREMENT

A. 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.

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

BASIS OF PAYMENT

660.05.01 PAYMENT

A. The accepted quantities of metal bin-type retaining walls measured as provided in Subsection 660.04.01, "Measurement," shall be paid for at the contract unit price bid per square foot for the type specified.

B. Structure excavation and structure backfill will be paid for in accordance with Section 206, "Structure Excavation," and Section 207, "Structure Backfill."

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

D. Payment will be made under:

PAY ITEM	PAY UNIT
Metal Bin-Type Retaining Wall (type)	Square Foot

SECTION 680

FIBER OPTIC CABLE

DESCRIPTION

680.01.01 GENERAL

A. The work under this section shall consist of furnishing, installing, and testing all underground and outdoor fiber optic cables.

B. All equipment and cable selection, mounting, and installation, as well as the cable management plan must be approved by the Freeway & Arterial System of Transportation (FAST) Director or designee, prior to installation.

MATERIALS/EQUIPMENT

680.02.01 FIBER OPTIC CABLE

A. All fiber optic cable shall be Single Mode Fiber Optic (SMFO) cable that is of loose tube construction, filled with a water-blocking material, and constructed by a certified International Organization for Standardization (ISO) 9001 or 9002 manufacturer.

B. Fiber optic cable shall be dielectric and comply with the requirements of Rural Utilities Service Standards 1755.900 except as modified by these specifications.

C. Fiber optic cable shall comply with the following requirements:

1. Number of fibers: Minimum 72 strands, 6 tubes of 12 fibers each.
2. Cladding diameter: 125± 1.0 μm.
3. Core-to-cladding offset: ≤ 0.8 μm.
4. Cladding non-circularity: ≤ 1.0%.
5. Maximum attenuation: ≤ 0.40 dB/km at 1310 nm; ≤ 0.30 dB/km at 1550 nm.
6. Microbend attenuation (1 turn, 32 mm diameter): ≤ 0.05 dB at 1550 nm.
7. Microbend attenuation (100 turns, 75 mm diameter): ≤ 0.05 dB at 1310 nm.
8. Mode-field diameter (matched cladding): 9.3 ± 0.5 μm at 1310 nm; 10.5 ± 1.0 μm at 1550 nm.
9. Maximum chromatic dispersion: ≤ 3.2 ps/(nm x km) from 1285 nm to 1330 nm and < 18 ps/(nm x km) at 1550 nm.
10. Fiber polarization mode dispersion: 0.5 ps/(km) 1/2.
11. Fiber coating: Dual layered, UV cured acrylate.
12. Coating diameter: 245 μm ± 10 μm.
13. Min storage temperature range-40° F to 158° F.
14. Min operating temperature range: -4° F to 158° F.
15. Rated life: Certify a 20-year life expectancy when installed to manufacturer's specifications.

D. Buffer Tubes:

1. Each buffer tube shall be filled with a non-nutritive to fungus, electrically non-conductive, water-blocking material that is free from dirt and foreign matter.
2. The water-blocking material shall allow free movement of the fibers, without loss of performance, during installation and normal operation including expansion and contraction of the buffer tubes.
3. The water-blocking material shall be readily removable with conventional nontoxic solvents.
4. Buffer tubes shall be stranded around a central member using the reverse oscillation or "S-Z" stranding process.
5. The use of filler rods in the fiber optic cable when required to lend symmetry to the cable section is mandatory.

E. Central Strength Member: The fiber optic cable shall have a central strength member designed to prevent buckling of the cable.

F. Cable Core: The fiber optic cable shall utilize a dry water-blocking material to block the migration of moisture inside the cables.

G. Tensile Strength Members:

1. The fiber optic cable shall have tensile strength members designed to minimize cable elongation due to installation forces and temperature variation.
2. Underground fiber optic cable shall withstand a 2700N (600 lbf) tensile load where the change in attenuation does not exceed 0.2 dB during loading and 0.1 dB after loading.
3. The cable shall be rated for an installed tensile service load of 890N (200 lbf) or more.

H. Cable Jacket:

1. The fiber optic cable jacket shall be constructed of a high or medium density polyethylene (HDPE/MDPE) jacket that has been applied directly over the tensile strength members and water-blocking material.
2. The jacket shall have at least 1 ripcord designed for easy sheath removal.
3. This cable will be rated for use in both underground and overhead installations.

I. Conductive Line Locating Material:

1. A 6-pair polyethylene (PE) 39, 22 AWG (American Wire Gauge) interconnect cable shall be directly adjacent to the cable in every conduit containing fiber optic cables to aid in locating of the conduit once it is in place.
2. This is not required if an existing interconnect cable is in place.
3. Any other method of providing a conductive tracer wire must be approved by the FAST Director or designee prior to installation.

J. Environmental: The cable shall be capable of withstanding the following conditions without damage or decrease in function:

1. Total immersion in water with natural mineral and salt contents.
2. Salt spray or salt-water immersion for extended periods.
3. Wasp and hornet spray.

CONSTRUCTION

680.03.01 INSTALLATION – GENERAL

A. The cable shall not be installed in any pull box until the pull box has been approved for pulling by the Contracting Agency.

B. Cabinets shall be installed prior to cable installation.

C. Installation of fiber optic cable shall be performed by individuals who are experienced and certified by a nationally recognized fiber optic installation certification organization.

1. Certifications shall be approved by the FAST Director or designee prior to construction.

2. Installation of fiber optic cable shall be continuous and without splices unless approved by the FAST Director or designee.

3. The Contractor shall perform all final length measurements and order cable accordingly.

D. The Contractor shall handle fiber optic cable carefully taking care not to pull cable along the ground, over or around obstructions, or through unnecessary curves or bends.

1. The Contractor shall not exceed fiber optic cable bend radius at any time.

2. Manufacturer approved pulling grips, cable guides, feeders, shoes, blowing devices, pulleys, and bushings shall be used to prevent damage to the cable during installation.

E. Prior to installing any fiber optic cable, the Contractor shall furnish recommended procedures, maximum pulling tension, a list of the cable manufacturer's approved pulling lubricants, and the lubricant manufacturer's procedures for use. The Contractor shall adhere to the cable and lubricant manufacturer's installation procedures.

F. The Contractor shall ensure that the tensile load on the cable does not exceed the allowed maximum manufacturer’s specification by using a pulling load/tension system, approved by the cable manufacturer, that alerts the installer when the pulling or blowing tension approaches the limit and/or that displays the actual tension on the cable.

1. Contractor may supplement this procedure with a breakaway tension limiter set below the recommended tensile limit of the cable being pulled or blown.

2. A device known as a mechanical cable tugger may be used with appropriate tension limiter, and at no time shall any type of vehicle be used for pulling the fiber optic cable.

G. When removing cable from the reel prior to installation, place it in a figure-8 configuration to prevent kinking or twisting. Take care to relieve pressure on the cable at crossovers by placing cardboard shims (or equivalent method) or by creating additional figure-8s.

H. If cables are installed in conduit with existing cables or wires that shall remain, the Contractor shall not damage the existing cables or wires.

1. The Contractor shall disconnect, remove, reinstall, and reconnect the existing cables and wires if necessary to facilitate the installation of the new cable at no additional cost to the Contracting Agency.

2. The Contractor shall be responsible for any damage to the existing cables or wires caused by this operation.

3. New and existing conductors shall be terminated and the labeling shall be reconciled as part of this process.

4. Two weeks prior to disconnecting any existing cables, the Contractor shall submit a schedule, for approval by the FAST Director or designee, with the accurate time frames of when the existing cables are to be disconnected.

I. In all locations where fiber enters a pull box, for each cable entering the pull box or vault, cable slack shall be loosely looped through in a figure-8 or a loose loop with a minimum of 30 feet of slack in all pull boxes smaller than a Type 200 vault, unless approved by the FAST Director or designee, prior to installation. The Contractor shall leave a minimum of 60 feet of slack per conduit entrance in all Type 200 vaults or other pull boxes where fiber optic cable is to be spliced, allowing the splicing activities to take place outside the pull box above ground in a controlled environment.

J. If the pull box has racks and hooks, the Contractor shall attach the cables to racks or hooks with industry standard cable ties immediately upon entering the box.

1. In all cases each cable shall be labeled, looped, and tied independently.

2. The labeling on the fiber optic cable shall be approximately 2 feet from the entry point, and shall note the direction of the cable along with its next point of entry (i.e., FAST FIBER North to XYZ St. or FAST FIBER West to ABC Blvd.).

3. Cable ties shall be tightened to prevent cable slippage, but the cable sheath shall not be deformed or damaged.

K. The Contractor shall follow local building codes and the National Electrical Code, Article 770, inclusive of the Fine Print Notes (FPN), when installing indoor fiber optic cable.

L. The Contractor shall furnish attachment hardware, installation guides, and other necessary equipment, not specifically listed herein, as necessary to install the fiber optic cable.

680.03.02 TESTING

A. Fiber optic cable shall meet the test requirements specified below. All testing shall be performed by an experienced and certified tester of a nationally recognized certification organization.

1. Factory Testing:

a. The Contractor shall submit factory test data and related documentation from the manufacturer to the Engineer and the FAST Director or designee, prior to installing the cable.

b. This includes the index of refraction of the cable to be installed.

c. This test shall demonstrate that the attenuation for each fiber string complies with the loss budgets required by these specifications.

d. Test blue and slate fibers at 1,310 nm and 1,550 nm.

e. Submit factory results for approval by the FAST Director or designee, prior to installing the cable.

2. Pre-Installation Testing:

a. The Contractor shall test all cable prior to installation.

b. Any cable that is found to have visual cladding damage shall be rejected.

c. Test fibers at 1,310 nm and 1,550 nm.

d. Submit Optical Time Domain Reflectometer (OTDR) trace results for approval by the FAST Director or designee, prior to installing the cable.

e. OTDR results shall be approved by the FAST Director or designee, prior to installation.

3. Post-Installation Testing:

a. Testing shall conform to the American National Standards for “Measurement of Optical Fiber Cabling Components Standard,” latest revision.

b. After installation, the Contractor shall perform the following tests using the procedures of “Measurement of Optical Power Loss on Installed Single-Mode Fiber Cable Plant,” latest revision, and all standards and procedures invoked therein, subject to the following clarification:

1) OTDR Tests:

a) Conduct tests using an OTDR for each fiber.

b) Demonstrate that the attenuation for each fiber string comply with the loss budgets required by these Standards.

c) Test fibers at 1,310 nm and 1,550 nm.

d) Submit OTDR trace results for approval and acceptance by the FAST Director, or designee.

2) Power meter readings are required from all fibers. Submit power meter results for approval and acceptance by the FAST Director, or designee.

B. The Contractor shall test all fibers on the cables, identify any unacceptable losses, and make corrective actions at no additional cost. The Contractor shall replace any cable in its entirety that is not compliant with these specifications at no additional cost.

C. Following completion of all testing, and approval by the FAST Director or designee, the Contractor shall compile and submit 1 one organized test notebook in hard copy format, as well as a single electronic copy in Microsoft® Excel that includes all required test results, summary tables, splice details, circuit diagrams, and OTDR traces and power meter results of each fiber by each cable tested. The test notebook and electronic copy shall also include the following:

1. Identification number and name as appropriate.

2. A summary sheet that clearly illustrates length and measured loss versus budgeted loss for each fiber or connected fiber string as appropriate; and

3. Calculations and notations for each fiber and wavelength that include total loss, measured dB/km loss, and any anomalies over 0.1 dB.

D. FAST shall have in its possession all pre- and post-testing data prior to final approval and acceptance.

METHOD OF MEASUREMENT

680.04.01 MEASUREMENT

A. The quantity of Fiber Optic Cable (72-strand) will be measured per linear foot installed, in place, complete and operational, and successfully tested.

1. The cable shall be measured by the marking on the exterior cable sheath.
2. No separate measurement will be made for lubricant in this item.

BASIS OF PAYMENT

680.05.01 PAYMENT

A. The accepted quantity of Fiber Optic Cable (72-strand) will be paid for at the contract unit price bid per linear foot, which shall be full compensation for installing the cable and appurtenances, complete in place, and for providing labor, hardware, cable ties, single mode fiber optic cable, lubricant, conductive line locating material, water blocking material, and labeling, all as specified, as shown on the drawings, and as required by the Engineer.

1. All materials required to complete the system shall be incidental to the cable including the approval, furnishing, and installation of racks and hooks in pull boxes, for each type installed.
2. Payment for the fiber optic cable installation shall also include the cost of all fiber optic termination strips, terminations, and labeling as incidental to the item requiring the work.
3. Testing, warranty, documentation, and spare parts are considered incidental to the item requiring the work.

B. All other components of the approved Communications Distribution Cable Assembly shall be specified and paid for under Section 681, “Fiber Optic Splice and Distribution Equipment.” Testing, temporary connectors for testing, warranty, documentation, training, and spare parts are considered incidental to the item requiring the work.

C. Payment will be made under:

PAY ITEM	PAY UNIT
Fiber Optic Cable (72-strand)	Linear Foot

SECTION 681

FIBER OPTIC SPLICE AND DISTRIBUTION EQUIPMENT

DESCRIPTION

681.01.01 GENERAL

A. The equipment under this section shall consist of furnishing the fiber optic cable equipment or accessories including connectors, connector panels, splice trays, patch panels, jumper cables, cable troughs, underground splice closures, termination strips, branch cables, closet housings, pigtails, and Communications Distribution Cable Assembly (CDCA) for each splice location as determined by the drawings and specifications.

B. All other equipment not used shall be delivered to the Freeway and Arterial System of Transportation (FAST) Traffic Management Center (TMC) prior to project acceptance

   1. No partial shipments will be accepted for deliveries to the TMC.

   2. All equipment supplied on this project will be delivered as part of a single delivery, and shall be labeled clearly with the project and location designation.

C. All equipment shall be approved by the FAST Director or designee, prior to purchase.

MATERIALS/EQUIPMENT

681.02.01 UNDERGROUND SPLICE ENCLOSURES

A. Underground splice enclosures shall be cylindrical, butt-end style, corrosion resistant, gel sealed, and meet the requirements of GR-771-CORE.

   1. Underground splice enclosures shall gel seal, bond, anchor, and provide efficient routing, storage, organization, and protection for fiber optic cable and splices.

   2. The splice enclosure shall provide an internal configuration and single end cap with a minimum of 6 ports of 72-strand backbone, trunk, and branch line cables. Provide a Tyco Fiber Optic Splice Closure Model No. 450-B6-6-24-6-B3V or equivalent as approved by the FAST Director or designee.

B. All splice trays, cable baskets, and related equipment shall be supplied with the underground splice enclosure.

C. The enclosure shall have 6 stackable single fusion trays for 24 splices each to accommodate a total 144 splices, and each shall be designed specifically for housing 24 single-mode fusion splices protected by heat-shrink sleeves.

   1. The splice trays shall be easy to install and remove, and have provisions for a minimum entry of 4 buffer tubes.

   2. A storage basket for storing loose buffer tubes or single fiber shall be installed and delivered with the enclosure.

D. Splice enclosures shall have a gel seal design with both the cable jackets and core tubes sealed, without the use of other water-blocking material. The splice enclosures shall be capable of being opened and completely resealed without loss of performance.

681.02.02 COMMUNICATIONS DISTRIBUTION CABLE ASSEMBLY

A. The Contractor shall provide and install Single Mode Gator Patch CDCA Intelligent Transportation System (ITS) Drop Cable or equivalent which is factory terminated cable with epoxy filled patch panel with 12 fiber optic Straight Tip (ST) connectors as approved by the FAST Director or designee.

B. The CDCA shall be used between the fiber optic trunk line and controller at lengths as shown on the plans, with the required slack or 20 feet to 25 feet in each splice vault and pull box, as well as the 20 feet slack neatly coiled in the controller cabinet.

C. Drop cable shall be designed with an Optical Fiber Non-Conductive Riser (OFNR)-rated, all-dielectric cable that is ultraviolet-resistant and fully waterproof for outdoor applications. Cable shall have a single 3.0 mm buffer tube containing 12 color-coded fibers.

CONSTRUCTION

681.03.01 GENERAL

A. The Contractor shall provide all of the equipment for splices as noted on the drawings and in the quantities in the bid schedule.

B. Additionally, the CDCA shall be installed in the conduit from the above ground facility to the splice vault, and the CDCA shall be splice ready.

C. Once the CDCA is installed and accepted following testing, all permanent splices of the CDCA, installed by the Contractor, to the trunk line will be performed in the communications vault.

681.03.02 LABELING

A. The Contractor shall label all cables to allow effective splicing.

B. Labeling shall be done in a neat, professional manner using permanent methods and products approved by the FAST Director or designee.

C. The labels shall include all necessary information to properly identify the cable and its mating connection.

681.03.03 TESTING

A. Testing of the CDCA and related hardware in this section is included in the testing procedure in Section 680, “Fiber Optic Cable.”

METHOD OF MEASUREMENT

681.04.01 MEASUREMENT

A. The quantity of Underground Splice Enclosures will be measured for payment per each supplied, complete and operational, and successfully tested.

B. The quantity of CDCA will be measured for payment per each installed, in place, complete and operational, and successfully tested.

C. Branch line cables, splice trays, warranty, documentation, training, and labeling are considered incidental to the item requiring the delivery of the needed equipment. The branch line cable shall adhere to the specifications described in Section 680, “Fiber Optic Cable,” and will be paid for as specified in this section.

BASIS OF PAYMENT

681.05.01 PAYMENT

A. The accepted quantity of Underground Splice Enclosures delivered complete and associated cable/hardware measured as provided above, will be paid for at the Contract unit price bid per each, which shall be full compensation for the underground splice closures including gel, splice trays, cable baskets, single fusion trays, sleeves, and storage baskets.

B. The accepted quantity of CDCA installed and tested positively will be paid for at the contract unit price bid per each, which shall be full compensation for the cable assemblies including hardware, 12 ST connectors per each assembly, labor and tools for complete installation, testing, labeling, documentation, training, warranty, and splicing, all as accepted by the FAST Director or designee.

C. Payment will be made under:

PAY ITEM	PAY UNIT
Underground Splice Enclosures	Each
Communication Distribution Cable Assembly (CDCA) and Permanent Fiber Splicing	Each

SECTION 682

FIBER OPTIC TRANSCEIVER

DESCRIPTION

682.01.01 GENERAL

A. The Contractor shall furnish a Fiber Optical Transceiver/Self-Healing (OTR/SH) that interfaces the traffic controllers with the central control system using Single Mode Fiber Optic (SMFO) cable.

1. This communications device shall contain a self-healing optical ring and perform remote control of master/slave functions.
2. The OTR/SH provides an electrical signal interface for an Electronic Industry Association (EIA)-232/422/485 port and 4 SMFO interfaces (2 transmit and 2 receive) that support fault tolerant, optical counter rotating ring as well as add/drop/repeat capability allowing field controllers to be interconnected in a multi-dropped configuration.
3. The device shall be an International Fiber Systems Model No. D19130SHR, or equivalent, as approved by the Freeway and Arterial System of Transportation (FAST) Director or designee.

B. This specification is for equipment only, no installation, to be delivered to the FAST Traffic Management Center (TMC) for testing and approval prior to final acceptance.

1. The Engineer shall be notified prior to the delivery to the TMC.
2. No partial shipments will be accepted.
3. All equipment supplied on this project will be delivered during a single delivery and shall be labeled clearly with the project and location designation.

C. All equipment selection shall be approved prior to purchase by the FAST Director or designee.

MATERIALS/EQUIPMENT

682.02.01 GENERAL

A. The OTR/SH shall require no user adjustments other than switch selection of the desired interface, anti-streaming time, and master/slave operation.

B. When the OTR/SH is installed in a rack-mounted card cage, the unit shall be hot swappable with no adverse effects to the OTR/SH or other units in the cage.

C. All equipment supplied shall have a full lifetime replacement/repair warranty.

682.02.02 MECHANICAL

A. The OTR/SH shall be a surface mount device (field), or rack mount (hub) configurations, when specified.

1. The field mounted Video Optical Transceiver shall be enclosed in corrosion resistant housing that protects the internal circuitry from the environment.
2. The housing shall be provided with suitable holes for mounting to a flat surface.

B. When it is specified, the rack-mounted OTR/SH shall occupy no more than 4 rack units (RU; 7 inches of space), be of the same manufacturer, and be compatible with the 19-inch rack-mountable card cage. The rack-mounted OTR/SH shall be able to obtain all necessary power from the card cage assembly without the use of external power cables.

C. All OTR/SH shall have labeling as follows:

1. External, silk screened, labeling consisting of the device type, model number, part number, serial number, light emitting diode (LED) status indicators, connector functions, and manufacturer on the front panel and/or the housing.
2. Internal labeling shall be provided to clearly identify all dip switches and jumper positions.

D. The OTR/SH shall have LED status indicators for the following signals:

1. A looped locked, Forward Direction.
2. A loop locked, Reverse Direction.
3. B looped locked, Forward Direction.
4. B loop locked, Reverse Direction.
5. Transmit Data A.
6. Receive Data A.
7. Transmit Data B.
8. Receive Data B.
9. Power (PWR).

682.02.03 OPTICAL

A. The OTR/SH shall have the following characteristics:

1. Laser diodes operating at 1,310 nanometers.
2. Link loss budget of 20 dB minimum.
3. Less than 2 μsec optical repeating delay.
4. Straight Tip (ST) connectors: 4.
5. Minimum connection of 2 feet of cable with no optical attenuation.
6. Anti-streaming function.

B. The OTR/SH shall provide fault-tolerant self-healing data communication paths for the following scenarios:

1. Scenario 1: A self-healing ring configuration is functioning, then a cable break occurs on the working ring between 2 OTR/SHs.
2. Scenario 2: A self-healing ring configuration is functioning, then 2 cable breaks occur, 1 on the working ring and 1 on the protect ring between 2 OTR/SHs.
3. Scenario 3: A self-healing ring configuration is functioning, then a single slave OTR/SH failure occurs.

682.02.04 ELECTRICAL SIGNAL INTERFACES:

A. Data:

1. Bi-directional data communication (simplex and full duplex operating modes).
2. Switch selectable EIA-232, EIA-422, or EIA-485 multi-dropped interfaces.
3. Data rates from DC to 100 kbps.
4. Bit error rate of 10-11.
5. DB-25 connector with standard EIA 232 pinout.
6. Switch selectable anti-streaming (4 - 64 seconds, or disabled).

B. The OTR/SH shall be designed so there is no command echo of the original command received by the host computer. The OTR/SH master shall be capable of communication with at least 32 slave units on the self-healing ring.

682.02.05 CONTROL

A. The OTR/SH shall operate in either the master mode or slave mode.

1. The OTR/SH master shall transmit digital signals from a hub location to a number of field (slave) OTR/SH locations.
2. Both master and slave units shall be identical.
3. The determination of master or slave shall be accomplished by either a manual switch on the OTR/SH or by remote contact closure.
4. A closed remote contact closure would put the OTR/SH in the master mode.

682.02.06 POWER

A. The OTR/SH shall operate to specification when supplied with 120 VAC ±15 VAC, 60 Hz ±3 Hz single-phase power.

B. The use of transformers to reduce the 120 VAC prime power input to a lower level used by the OTR/SH is acceptable.

682.02.07 ENVIRONMENTAL

A. The OTR/SH shall be designed to operate from -40 degrees F to 165 degrees F with no cooling airflow, 0-95 percent relative humidity, non-condensing.

B. The OTR/SH shall be compliant with National Electronics Manufacturers Association (NEMA) TS-1/TS-2 and Caltrans Traffic Signal Control Equipment Specifications for shock, vibration, and voltage transient protection.

682.02.08 19-INCH RACK-MOUNTED CARD CAGE

A. When required at a hub location, the OTR/SH shall be able to be installed in a 19-inch rack-mounted card cage.

1. The cage height shall not exceed 4-RU.
2. The cage shall contain a fault tolerant power converter compatible with OTR/SH module power requirements.

3. The cage shall include provisions for interconnecting cabling and be designed to accommodate a minimum of 12 OTR/SH modules that shall be easily mountable and removable from the cage.

B. When installed in the cage, the OTR/SH modules shall be securable.

1. The module's maintenance indications shall not be distributed after being mounted in the drawer.

2. A failure of 1 OTR/SH module shall not impact the operation of other OTR/SH modules installed within rack-mounted cage.

682.02.09 FIBER OPTIC JUMPER CABLES

A. Four fiber optic jumper cables shall be delivered with each transceiver supplied.

B. The fiber optic jumper cables shall meet the following requirements:

1. 250 μm buffering of each fiber.

2. 900 μm buffering of each fiber applied after the initial 250 μm buffering.

3. Maximum factory measured insertion loss of 0.5 dB in accordance with EIA/Telecommunications Industry Association (TIA) 455-171.

4. Less than 0.2 dB loss when subjected to EIA/TIA-455-1B, 300 cycles, 0.5 kg.

5. Aramid yarn strength member.

6. Rugged 0.12 inch (approximate) Polyvinyl Chloride (PVC) sheathing.

7. Minimum bend radius of 12 inches following installation, 25 inches during installation.

8. Minimum tensile strength of 444N (100 pounds).

9. ST connectors that are factory terminated with strain relief.

CONSTRUCTION

682.03.01 INSTALLATION OF EQUIPMENT

A. Though no physical construction is part of this deliverable, the Contractor shall furnish all mounting hardware (i.e., machine screws, nuts, locking washers) to install the OTR/SH securely in the cabinet.

1. Mounting methods using tape, Velcro, and sticky back material will not be permitted.

2. All necessary power adapters and cabling needed to obtain power from the power distribution assembly shall be provided.

B. As noted above, the Contractor shall also supply the 4 simplex fiber optic jumper cables needed to be installed from the field termination panel (field mounted) or from the fiber optic patch panel (rack-mounted) to the 4 optical inputs of the OTR/SH.

1. Contractor shall also supply the data cables for the DB-25 data connector.

2. This consists of a 60-inch DB-25 M-M connector to plug into the OTR/SH on 1 end and the 2070N traffic signal controller on the other.

C. All OTR/SH shall be provided with protective covers on all optical connectors. The Contractor shall ensure that the protective covers remain on the optical connectors at all times when each connector is not being used.

METHOD OF MEASUREMENT

682.04.01 MEASUREMENT

A. The quantity of Shelf Mount Fiber Optic Transceivers with Cables will be measured per each complete and successfully tested.

B. The quantity of Rack Mount Fiber Optic Transceivers with Cables will be measured per each complete and successfully tested.

C. The quantity of 19-inch Rack-Mounted Card Cage will be measured per each, complete and successfully tested.

D. Each card cage or OTR/SH will be measured as a unit for furnishing each OTR/SH, complete in delivery, in accordance to the quantities on the Bid Schedule.

E. Mounting hardware and power conversion hardware, if required are incidental to the OTR/SH bid item and will not be measured or paid separately.

F. The equipment delivered will be tentatively accepted pending testing by the FAST Director or designee. Only after a series of bench tests of the devices will the final acceptance be made and documented.

BASIS OF PAYMENT

682.05.01 PAYMENT

A. The accepted quantity of Shelf Mount Fiber Optic Transceivers with Cables will be paid for at the contract unit price bid per each, which shall be full compensation for the equipment, measured as provided under Subsection 682.04.01, "Measurement," complete including warranty, delivery to FAST, optical transceiver(s), SMFO cable, hardware, housing, 4 fiber optic jumper cables per optical transceiver, data connectors, optical connector covers, and testing of the equipment as specified and as shown on the drawings.

B. The accepted quantity of Rack Mount Fiber Optic Transceivers with Cables will be paid for at the contract unit price bid per each, which shall be full compensation for the equipment, measured as provided under Subsection 682.04.01, “Measurement,” complete including warranty, delivery to FAST, optical transceiver(s), SMFO cable, hardware, 4 fiber optic jumper cables per optical transceiver, data connectors, optical connector covers, and testing of the equipment as specified and as shown on the drawings.

C. The accepted quantity of 19-inch Rack-Mounted Card Cage will be paid for at the contract unit price bid per each, which shall be full compensation for the equipment, measured as provided under Subsection 682.04.01, “Measurement,” complete including warranty, delivery to FAST, rack-mounted card cage, hardware, and testing of the equipment as specified and as shown on the drawings.

D. Payment will be made under:

PAY ITEM:	PAY UNIT
Shelf Mount Fiber Optic Transceivers (OTR/SH) with Cables	Each
Rack Mount Fiber Optic Transceivers (OTR/SH) with Cables	Each
19-Inch Rack-Mounted Card Cage	Each

SECTION 683

VIDEO OPTICAL TRANSCEIVER WITH BI-DIRECTIONAL DATA CHANNEL

DESCRIPTION

683.01.01 GENERAL

A. The Contractor shall furnish the designated quantity of Video Optical Transceiver (VOTR) pairs that interface the Closed Circuit Television (CCTV) cameras with the central control system over Single Mode Fiber Optic (SMFO) cable.

1. Each VOTR pair delivered shall provide 1 unidirectional National Television Standards Committee (NTSC) color video channel from the CCTV field location to another designated point and 1 bi-directional data channel between both locations.
2. There shall be a designated video transmitter and a video receiver.
3. The devices shall be International Fiber Systems (IFS) Model No. VT4930WDM and IFS Model No. VR4930WDM, or equivalent, as approved by the Freeway and Arterial System of Transportation (FAST) Director or designee.

B. This specification is for equipment only, no installation, to be delivered to the FAST Traffic Management Center (TMC) for testing and approval prior to final acceptance.

1. No partial shipments will be accepted.
2. All equipment supplied on this project shall be delivered during a single delivery, and shall be labeled clearly with the project and location designation.

C. The VOTR shall be able to be connected to each end of 1 single mode optical fiber with Straight Tip (ST) connections to establish a point-to-point communication topology for the locations shown on the drawings. VOTRs designed for mounting in card cages shall be hot swappable.

D. All equipment selections shall be approved by the FAST Director or designee.

MATERIALS/EQUIPMENT

683.02.01 GENERAL

A. All equipment supplied shall have a full manufacturer's warranty.

683.02.02 MECHANICAL

A. The VOTR shall be a surface mount device (field) or rack-mount (hub) configuration, when specified.

1. The field mounted VOTR shall be enclosed in corrosion resistant housing that protects the internal circuitry from the environment.
2. The housing shall be provided with suitable holes for mounting to a flat surface.

B. When it is specified, the rack-mounted VOTR shall occupy no more than 4 rack units (RU; 7 inches of space), be of the same manufacturer, and be compatible with the 19-inch rack-mountable card cage. The rack-mounted VOTRs shall obtain all necessary power from the card cage assembly without the use of external power cables.

C. All VOTRs shall have labeling as follows:

1. External, silk screened, labeling consisting of the device type, model number, part number, serial number, light emitting diode (LED) status indicators, connector functions, and manufacturer on the front panel and/or the housing.
2. Internal labeling shall be provided to clearly identify all dip switches and jumper positions.

D. The VOTR shall have LED status indicators for presence of video carrier, input power, and data transmission.

683.02.03 OPTICAL

A. The optical component shall have the following features:

1. Laser both directions (wavelength 1310/1550 nm) over 1 single mode fiber.
2. Link loss budget of 23 dB minimum.
3. ST connectors only.
4. Minimum connection of 2 feet of cable with no optical attenuation.

683.02.04 DATA

A. The data component shall have the following features:

1. Bi-directional data communications (simplex and full duplex operating modes).
2. Selectable Electronic Industry Association (EIA)-232, EIA-422, or 2-wire EIA-485 interfaces.
3. Data rates from DC to 100 kbps.
4. Bit error rate of 10-9.
5. Data receiver output (EIA-232/422) defaults to a low state in the event of a fiber break or failed data transmitter.

683.02.05 VIDEO

A. The video component shall have the following features:

1. NTSC Color, compliant with EIA/TIA-250-C for Medium-Haul Transmission and EIA-170 Video Standards.
2. Bandwidth range of 5 Hz to 6.5 MHz.
3. Signal-to-Noise Ratio > 60 dB.
4. Differential Gain < 3 percent.
5. Differential Phase < 3 degrees.
6. Tilt < 1 percent.
7. BNC Connection.

683.02.06 POWER

A. The VOTR shall operate to specification when supplied with 120 VAC ±15 VAC, 60 Hz ±3 Hz single-phase power.

B. The use of transformers to reduce the 120 VAC prime power input to a lower level used by the VOTR is acceptable. This transformer shall be supplied if necessary.

683.02.07 ENVIRONMENTAL

A. The VOTR shall be designed to operate from -40 degrees F to 165 degrees F) with no cooling airflow, 0-95 percent relative humidity, non-condensing.

B. The VOTR shall be compliant with National Electronics Manufacturers Association TS-1/TS-2 and Caltrans Traffic Signal Control Equipment Specifications for shock, vibration, and voltage transient protection.

683.02.08 19-INCH RACK MOUNTED CARD CAGE

A. When required at a hub location, the VOTR shall be able to be installed in a 19-inch rack mounted card cage.

1. The cage height shall not exceed 4 RU.
2. The cage shall contain a fault tolerant power converter compatible with VOTR module power requirements.
3. The cage shall include provisions for interconnecting cabling and be designed to accommodate a minimum of 7 VOTR modules that shall be easily mountable and removable from the cage.

B. When installed in the cage, the VOTR modules shall be securable.

1. The module's maintenance indications shall not be distributed after being mounted in the drawer.
2. A failure of 1 VOTR module shall not impact the operation of other VOTR modules installed within rack-mounted cage.

683.02.09 FIBER OPTIC JUMPER CABLES

A. Four fiber optic jumper cables shall be delivered with each transceiver supplied.

B. The fiber optic jumper cables shall meet the following requirements:

1. 250 μm buffering of each fiber.
2. 900 μm buffering of each fiber applied after the initial 250 μm buffering.
3. Maximum factory measured insertion loss of 0.5 dB in accordance with EIA/Telecommunications Industry Association (TIA)-455--171.
4. Less than 0.2 dB loss when subjected to EIA/TIA-455-1B, 300 cycles, 0.5 kg.
5. Aramid yarn strength member.
6. Rugged 0.12 inch (approximate) Polyvinyl Chloride (PVC) sheathing.
7. Minimum bend radius of 12 inches following installation, 25 inches during installation.
8. Minimum tensile strength of 444N (100 pounds).
9. ST connectors that are factory terminated with strain relief.

CONSTRUCTION

683.03.01 GENERAL

A. Though no physical construction is part of this deliverable, the Contractor shall furnish all mounting hardware (i.e., machine screws, nuts, locking washers) to install the VOTRs securely in the cabinet.

1. Mounting methods using tape, Velcro, and sticky back material will not be permitted.
2. All necessary power adapters and cabling needed to obtain power from the power distribution assembly shall be provided and secured.

B. As noted above, the Contractor shall also supply the 1 simplex fiber optic jumper cable needed to be installed from the field termination panel (field mounted) or from the fiber optic patch panel (rack mounted) to the single optical inputs of the VOTR.

C. All VOTRs shall be provided with protective covers on all optical connectors. The Contractor shall ensure that the protective covers remain on the optical connectors at all times when each connector is not being used.

METHOD OF MEASUREMENT

683.04.01 MEASUREMENT

A. The quantity of shelf mounted VOTRs with cable will be measured for payment per each delivered, complete and operational, and successfully tested.

B. The quantity of rack mounted VOTRs with cable will be measured for payment per each delivered, complete and operational, and successfully tested.

C. The quantity of 19-inch rack mounted card cage will be measured for payment per each delivered, complete and operational, and successfully tested.

D. Mounting hardware, power conversion hardware (if required), and the VOTR rack mountable card cage in the hub is incidental to the VOTR bid item and will not be measured or paid separately.

E. The equipment delivered will be tentatively accepted pending testing by the FAST Director or designee. Only after a series of bench tests of the devices will the final acceptance be made and documented.

BASIS OF PAYMENT

683.05.01 PAYMENT

A. The accepted quantity of shelf mounted VOTRs with cable delivered complete will be paid for at the contract unit price bid per each, which shall be full compensation for the VOTR(s), SMFO cable, housing(s), 4 fiber optic jumper cables per video transceiver, hardware, 1 simplex fiber optic jumper cable per video transceiver, warranty, and delivery to the FAST Director or designee.

B. The accepted quantity of rack mounted VOTRs with cable delivered complete will be paid for at the contract unit price bid per each, which shall be full compensation for the VOTR(s), SMFO cable, 4 fiber optic jumper cables per video transceiver, hardware, 1 simplex fiber optic jumper cable per video transceiver, warranty, and delivery to the FAST Director or designee.

C. The accepted quantity of 19-inch rack mounted card cage delivered complete will be paid for at the contract unit price bid per each, which shall be full compensation for the rack mounted card cage, hardware, warranty, and delivery to the FAST Director or designee.

D. Payment will be made under:

PAY ITEM	PAY UNIT
Shelf Mounted Video Optical Transceivers with Cable	Each
Rack Mounted Video Optical Transceivers with Cable	Each
19-Inch Rack Mounted Card Cage	Each

SECTION 684

LAYER 2 FIELD-HARDENED ETHERNET SWITCH

DESCRIPTION

684.01.01 GENERAL

A. This specification describes the functional, performance, environmental, submittal, documentation, and warranty requirements, as well as the method of measurement and basis of payment, for a Layer 2 Field-Hardened Ethernet Switch, herein called the field switch.

B. The Field Switch shall comply with this specification to operate within the Freeway and Arterial System of Transportation (FAST) Arterial Management System and Freeway Management System.

C. This specification is for equipment only, no installation, to be delivered to the FAST Traffic Management Center (TMC) for testing and approval prior to final acceptance.

1. The Engineer shall be notified prior to the delivery to the TMC.
2. No partial shipments will be accepted.
3. All equipment supplied on this project shall be delivered during a single delivery, and shall be labeled clearly with the project and location designation.

D. All equipment shall be approved prior to purchase by the FAST Director or designee.

MATERIALS/EQUIPMENT

684.02.01 FUNCTIONAL REQUIREMENTS

A. The field switch shall comply with the following standards:

1. Institute of Electrical and Electronic Engineers (IEEE) 802.IQ: Local and Metropolitan Area Networks, Virtual Bridged Local Area Networks.
2. IEEE 802.1P: Traffic Class Expediting and Dynamic Multicast Filtering, Draft 8.
3. IEEE 802.3X: IEEE Standards for Local and Metropolitan Area Networks; Specifications for 802.3 Full Duplex Operation.
4. IEEE 802.1W: IEEE Standards for Local and Metropolitan Area Networks, Common Specifications, Part 3; Media Access Control (MAC) Bridges, Amendment 2, Rapid Configuration.
5. Federal Communications Commission Rules and Regulations, Vol. II: Part 15 for Class A Equipment Electronic Compatibility and Susceptibility (product electromagnetic compatibility is required).
6. National Electronics Manufacturers Association (NEMA) TS-1: Section 2, Traffic Control System. The following clauses apply:
   a. 2.1.2: Voltage.
   b. 2.1.3: Frequency Range.
   c. 2.1.4: Power Interruption.
   d. 2.1.5: Temperature and Humidity, as modified herein.

e. 2.1.6: Transients, Power Service.

f. 2.1.7: Transients, Input-Output terminals.

g. 2.1.8: Non-Destruct Transient Immunity.

h. 2.1.12: Vibration.

i. 2.1.13: Shock.

7. Underwriters Laboratories, Inc. 60950: Safety Requirements for Information Technology (IT) Equipment (applicable to equipment safety).

8. Military Handbook MIL-HDBK-217F-2: Reliability Prediction of Electronic Equipment, Notice 2.

B. Detailed Requirements:

1. The field switch shall:

a. Be 6-port (minimum) 10/100 Base TX RJ-45.

b. Have a minimum of two 100 Base FX fiber optical ports.

c. Operate non-blocking, at full wire speed.

d. Support remote reset and remote management.

e. Support IGMP snooping.

f. Support IP Multicast filtering.

g. Support remote turn on/off Base TX ports.

2. The field switch shall also meet the following functionality and performance requirements:

a. Each 10/100 Base TX port shall connect via RJ-45 connector.

1) The ports shall operate as half-duplex or full-duplex (IEEE 802.3x) over 100 m segment lengths.

2) The ports shall provide auto-negotiation and Medium Dependent Interface/ Medium Dependent Interface, Crossover (MDI/MDIX) capability.

b. Each 100 Base FX (Fiber Transmission) port shall connect via fiber connectors and 9/125 µm single-mode fiber.

1) Fiber connectors shall be available as Straight Tip (ST).

2) The ports shall operate as full-duplex (IEEE 802.3x) over 15 km segment lengths.

3) The minimum link loss budget (OPB = RX (min) – LED aging) shall be greater than or equal to 15 dB.

c. The field switch shall provide the following advanced Layer 2 functions:

1) IEEE 802.1Q VLAN with support for a minimum of 128 Virtual Local Area Networks (VLAN).

2) IEEE 802.1P priority queuing.

3) IEEE 802.1W rapid spanning tree (required).

4) IEEE 802.3X flow control greater than or equal to 1,028.

5) Support automatic address learning of a minimum 4,096 Medium Access Control (MAC) addresses and greater than or equal to 1,028 static MAC address.

d. The field switch shall provide the following port security functions:

1) Ability to configure static MAC addresses.

2) Ability to disable automatic address learning per ports; known hereafter as secure port.

3) Secure ports only forward statically configured MAC addresses.

4) Trap and alarm upon any unauthorized MAC address and shutdown for programmable duration.

5) Port shutdown requires administrator to manually reset the port before communications are allowed.

6) All the above activities are done remotely.

e. The field switch shall provide the following network management functions:

1) SNMPv3 (RFC 2273).

2) RMON (RFC 1757).

3) Port Mirroring (RFC 1757).

4) Spanning Tree (IEEE 802.1D).

5) Rapid Spanning Tree (IEEE 802.1W).

f. The field switch shall support:

1) Telnet.

2) Trivial File Transfer Protocol (TFTP) or File Transfer Protocol (FTP).

3) Command Line Interface.

4) Simple Network Management Protocol (SNMP).

3. The field switch shall have an integrated web interface.

a. Reset/Reboot and firmware shall be supported via all methods listed above.

b. All parameters and settings (network management, security, Layer 2 features, and so forth) shall be user configurable through the maintenance port, web interface, Telnet, and all other supported remote management tools.

4. The field switch shall allow for stand-alone shelf mounting unit and DIN rail mounting.

5. The field switch shall have the following characteristics:

a. Power: Nominal 120 VAC, 60 Hz.

b. The unit shall be provided with all power conversion and regulation necessary to support electronics operation.

c. The power input circuitry shall be designed to protect the electronics from damage by a power surge or under-voltage condition.

d. Power consumption shall not exceed 20 watts.

6. The field switch shall include a power status indicator.
7. Physical Characteristics:
   a. 6-Port.
   b. The field switch shall not exceed 3 inches high by 17.25 inches wide by 10 inches.
   c. The weight shall not exceed 6 pounds.
8. Environmental: The field switch shall conform to functional and performance specifications as defined herein when operated in the following environment.
   a. Temperature: -4 degrees F to 165 degrees F.
   b. Humidity: 5 to 95 percent relative humidity, non-condensing.
9. Cooling shall be by convection with case acting as heat sink. No cooling fan shall be used.
10. The field switch shall have the following minimum indicators:
    a. Power: On, Off.
    b. Network status per port: Transmit, receive, link, speed.
11. Status indicators shall be light emitting diode (LED).
12. All connectors, indicators and replaceable components shall be permanently marked and traceable to the supplied documentation, including schematics and parts list. The external markings shall include the product function name, model number, serial number and manufacturer's name.
13. The field switch shall have a minimum Mean Time Between Failures (MTBF) of 40,000 hours.
14. Each unit shall have a unique MAC address. MAC address shall be derived from an address space of 10,000 sequential addresses.
15. Documentation: Upon delivery, the following minimum documentation shall be provided by the vendor with each field switch provided:
    a. Initial configuration: This document shall provide both hardware and software settings.
    b. Setup and configuration manual.
    c. Users manual.
16. Warranty:
    a. The field switch shall be warranted for a minimum of 3 years.
    b. The warranty shall guarantee the field switch to be free from defects from assembly, fabrication and materials.
    c. The warranty shall begin upon acceptance by the Contracting Agency.

CONSTRUCTION

684.03.01 BLANK

METHOD OF MEASUREMENT

684.04.01 MEASUREMENT

A. The Layer 2 Field-Hardened Ethernet Switch shall be measured per each. The mounting hardware and cabling and network management software are considered incidental to the unit and will not be measured or paid for separately.

BASIS OF PAYMENT

684.05.01 PAYMENT

A. The accepted quantity of Layer 2 Field-Hardened Ethernet Switch will be paid for at the contract unit price per each, which shall be full compensation for furnishing and configuring the unit and for all labor, material, and equipment required to facilitate an operational field switch.

B. Payment will be made under:

PAY ITEM	PAY UNIT
Layer 2 Field-Hardened Ethernet Switch	Each

SECTION 685

VIDEO ENCODER

DESCRIPTION

685.01.01 GENERAL

A. This specification describes the functional, performance, environmental, submittal, documentation, and warranty requirements, as well as the method of measurement and basis of payment, for a rugged field deployable and user selectable Moving Picture Experts Group (MPEG)-2 and MPEG-4 video encoder.

1. This video encoder will transmit data via RS-232/422 and accept standard National Television Standards Committee (NTSC) composite video signal as input, digitally compress it, and transmit it over the Freeway and Arterial System of Transportation (FAST) communication network.

2. The video encoder shall comply with this specification to operate within the FAST Arterial Management System and Freeway Management System.

B. This specification is for equipment only, no installation, to be delivered to the FAST Traffic Management Center (TMC) for testing and approval prior to final acceptance.

1. The Engineer shall be notified prior to the delivery to the TMC.

2. No partial shipments will be accepted.

3. All equipment supplied on this project shall be delivered during a single delivery, and shall be labeled clearly with the project and location designation.

C. All equipment shall be approved prior to purchase by the FAST Director or designee.

MATERIALS

685.02.01 FUNCTIONAL REQUIREMENTS

A. The video encoder shall comply with the following standards:

1. National Electronics Manufacturers Association (NEMA) TS–1: Section 2, Traffic Control System. The following clauses apply:

a. 2.1.2: Voltage.

b. 2.1.3: Frequency Range.

c. 2.1.4.1: Power Interruption.

d. 2.1.5: Temperature and Humidity, as modified herein.

e. 2.1.6: Transients, Power Service.

f. 2.1.7: Transients, Input-Output terminals.

g. 2.1.8: Non-Destruct Transient Immunity.

h. 2.1.12: Vibration.

i. 2.1.13: Shock.

2. International Organization for Standardization (ISO) 9001: Quality Assurance, MPEG-2, ISO/13818-2 Video Compression.

3. Institute of Electrical and Electronic Engineers (IEEE) 802.3: Part 3, CSMA/CD Access Method and Physical Layer Specifications.

4. Federal Communications Commission Rules and Regulations, Vol. II: Part 15 for Class A Equipment Electronic Compatibility and Susceptibility (product electromagnetic compatibility is required).

5. Underwriters Laboratories, Inc. (UL) 60950: Safety Requirements for IT Equipment (applicable to equipment safety).

6. Military Handbook MIL-HDBK-217F-2: Reliability Prediction of Electronic Equipment, Notice 2.

B. Detailed Requirements:

1. The video encoder shall support the following video features:

   a. Signal format: 30 fps, NTSC color.

   b. Resolution: 720 x 480 (full resolution).

   c. Video Settings: Contrast, saturation, brightness, and hue.

2. The video encoder shall support bi-directional serial communications over Ethernet via the following methods:

   a. Encoder serial port to decoder serial port data stream.

   b. Internet Protocol (IP) socket to encoder serial port.

3. The video encoder shall support full-duplex serial interface and data rates up to 57.6 bps.

   a. The baud rate, stop bits, data bits, and flow control shall be user configurable.

   b. The serial interface shall be transparent to the device (i.e., no additional or special protocols shall be required to communicate between the closed circuit television (CCTV) control interface and the encoder).

4. The video encoder shall support the following:

   a. Encoding Formats: The unit shall be capable of being soft configured to perform MPEG-2 ISO/13818-2 video compression and MPEG-4 ISO/14496 video compression.

   b. The encoder shall be capable of being soft configured to produce elementary, or transport stream.

   c. Bandwidth:

      1) 1.5 Mbps to 10 Mbps for MPEG-2 and 64 Kbps to 5 Mbps for MPEG-4.

      2) The data rate shall be defined as the maximum committed bandwidth to be utilized, which includes bursting.

      3) The default bandwidth for the video encoder shall be set to 5 Mbps for MPEG-2 and 1 Mbps for MPEG-4.

   d. Latency: The end-to-end latency between the video encoder and the video decoders shall be no more than 250 ms while operating at a rate of 5 Mbps.

5. The video encoder shall support the following network features:

   a. Ethernet Interface: 10/100 Mbps, Full-Duplex, Auto Negotiate (802.3), RJ-45.

b. Static IP Addressing: Class A, B, and C.

c. SNMP (MIB2).

d. Unicast and Multicast (IGMP V2).

e. Gateway Configuration.

f. Adjustable Packet Payload Size.

6. The video encoder shall support:

a. Command Line Interface.

b. Telnet.

c. Trivial File Transfer Protocol (TFTP) or FTP (new firmware download).

d. The video encoder shall have an integrated web interface that provides remote configuration.

e. Reset/Reboot and firmware upload shall be supported via all methods listed above.

f. All video (i.e., resolution, contrast, and so forth), data (i.e., baud rate, parity, and so forth), encoder (i.e., bandwidth, and so forth), and network (i.e., IP, subnet mask, gateway, and so forth) parameters and settings shall be user configurable through the maintenance port, web interface, Telnet, and all other supported remote management tools.

g. All configurations and settings shall be downloadable/exportable in document form. As a minimum, the exported settings shall include video, network, and data settings.

C. Failure and Reset Recovery: The recovery time of a hard or soft reset shall be less than 45 seconds.

D. Electrical: The video encoder shall have the following characteristics:

1. Power:

a. Nominal input voltage of 120 VAC 60 Hz.

b. The unit shall contain all power conversion and regulation necessary to support electronics operation.

2. Power consumption: Shall not exceed 70 watts.

3. All supplied video encoders shall have the same power connectors.

a. Each unit shall be provided with a power cable that is at least 5 feet in length.

b. Power cable shall be terminated with a male, 3-prong UL-listed power connector for interface with the previously stated power system.

E. Ports: The video encoder shall have the following ports:

1. Network: 10/100 Mbps RJ-45.

2. Video: Composite Bayonet Neill-Concelman (BNC) and S-Video.

3. Data:

a. Two Electronics Industry Association (EIA)-RS232/422/485, DB-9 (Female):

1) These ports shall provide data pass-through for serial control (i.e., PTZ camera control).

2) If EIA RS422 is not provided natively by the port, an EIA RS232-to-422 converter meeting all encoder environmental requirements shall be supplied.

3) RJ-45 may be provided in place of DB 9. For each RJ-45 port, an RJ-45-to-DB-9 converter shall be supplied.

b. One EIA-232 DB-9 (Female):

1) This port shall provide maintenance interface for local configuration.

2) RJ-45 may be provided in place of DB-9. For each RJ-45 port, an RJ-45-to-DB-9 converter shall be supplied.

F. Status Indicators:

1. The video encoder shall have the following minimum indicators:

a. Activity.

b. Power.

c. Video Loss.

d. Transmit.

e. Receive.

2. Status indicators shall be LED.

G. Physical Characteristics:

1. The video encoder shall not exceed 2-1/2 inches high by 12 inches wide by 13 inches deep.

2. The weight shall not exceed 10 pounds.

H. External Markings:

1. All connectors, indicators, and replaceable components shall be permanently marked and traceable to the supplied documentation, including schematics and parts list.

2. The external markings shall include the product function name, model number, serial number, and manufacturer's name.

I. Environmental:

1. The video encoder shall conform to the performance specification when operated in the following environment:

a. Temperature: -4 degrees F to 165 degrees F.

b. Humidity: 5 to 95 percent relative humidity, non-condensing.

c. The video encoder shall be conformal coated to prevent damage from blowing sand and dust.

2. The video encoder shall have a minimum Mean Time Between Failures (MTBF) of 60,000 hours.

J. MAC Address:

1. Each unit shall have a unique MAC address.

2. MAC address shall be derived from an address space of 10,000 sequential addresses.

K. Network Management Software: All custom Management Information Bases (MIBs) required for network management shall be provided for use with third party network management software.

L. IP Addressing: Each unit shall support and be delivered with 2 user settable IP addresses, 1 for command and control and 1 for video multicasting.

685.02.02 SUBMITTALS

A. The following shall be submitted by the Contractor to the Contracting Agency:

1. Acceptance Test Procedures, stand-alone and operational.
2. Training Syllabus.
3. Users Manual.
4. Parts List.
5. Description of MAC addresses scheme/space.
6. Certifications/Statements:
   a. Provide certification of conformance to all standards listed in this section.
   b. Testing for compliance will be performed by an independent party.

CONSTRUCTION

685.03.01 TESTING

A. Prior to acceptance by the Contracting Agency, the video encoder shall require testing as described below.

B. The Contractor shall absorb all costs associated with the testing including and not limited to shipping and handling, all material and equipment, and any labor required from the bidder.

C. Prior to acceptance of any video encoder, the following tests shall be performed:

1. Stand-Alone Acceptance Test (SAT):
   a. Using the FAST-approved vendor-supplied test procedures, FAST will perform the SAT in a test area provided by FAST.
   b. A vendor representative may be present during the SAT.
   c. The Contractor will provide the vendor with a schedule of the test, including time and place.
2. The SAT will be performed as follows:
   a. The video encoder will be assembled and connected to power in a stand-alone configuration.
   b. The video encoder will be powered up and allowed to initialize, boot, and run self-diagnostic tests as defined in the FAST-approved test procedures.
   c. After the video encoder has started and initialized, any additional test procedures will be executed.

d. After the test procedures have been executed, the video encoder will be allowed to run, uninterrupted, for a burn-in period of 72 hours.

e. At the end of the burn-in period, the unit will be restarted and configuration verified.

f. Upon completion of all test procedures, the Contractor will be notified of SAT acceptance or failure.

3. Operational Test:

a. After successful completion of the SAT, FAST will configure and connect the video encoder to the FAST test network.

b. A FAST-provided CCTV assembly will be connected (video and data) to the video encoder.

c. Along with the video encoder, the network will also have a video decoder unit with a video monitor and a personal computer operating the video decoder software and camera control application provided by the Contracting Agency.

d. The following tests will be performed by FAST:

1) Video Image (subjective quality acceptable to FAST).

2) Serial Data Channel both point-to-point (encoder to decoder), and IP.

3) User programmable parameters and functions.

4) Network management.

4. While connected to the network, the video encoder shall not in any way compromise the function or functions or any other connected network device.

5. Upon completion of all the tests, the Contractor will be notified of operational test acceptance or failure. If the unit fails the test, the Contractor shall supply a new unit and the test shall be restarted.

685.03.02 WARRANTY

A. The video encoder shall be warranted by the vendor for a minimum of 3 years.

1. The warranty shall be provided by the Contractor and shall guarantee the video encoder to be free from defect from assembly, fabrication, and materials.

2. The FAST and Contracting Agency may exercise the option of purchasing an extended warranty for an additional 2 years utilizing the video encoder extended 2-year warranty item as indicated in Subsection 685.05.01, “Payment.”

B. The warranty shall be provided in writing. If the normal manufacturer's warranty extends for a longer period, the video encoder shall be warranted for that period.

C. The warranty shall be measured from the date of receipt by the Contracting Agency.

1. The manufacturer shall be responsible for maintaining a list of equipment supplied and warranty information during the period of the warranty contract.

2. A report shall be submitted to FAST annually which details the status of equipment warranties.

D. Video encoders found to be defective during the warranty period shall be replaced free of charge by the manufacturer. The vendor shall be responsible for all shipping and handling costs for equipment under warranty.

E. The manufacturer shall also provide technical support coverage for all equipment and software furnished. This support shall as a minimum include the following:

1. Software and firmware upgrades.
2. Software patches.

METHOD OF MEASUREMENT

685.04.01 MEASUREMENT

A. The video encoder shall be measured per each.

B. The video encoder extended 2-year warranty shall be measured by lump sum.

BASIS OF PAYMENT

685.05.01 PAYMENT

A. The accepted quantity of video encoder will be paid at the contract unit price per each, which shall be full compensation for furnishing and configuring the unit and for all labor, material, and equipment, including all necessary jumpers, required to facilitate an operational video encoder.

B. The lump sum price for the video encoder extended 2-year warranty shall be full compensation for the extended warranty.

C. Payment will be made under:

PAY ITEM	PAY UNIT
Video Encoder	Each
Video Encoder extended 2-year warranty	Lump sum

SECTION 686

VIDEO DECODER

DESCRIPTION

686.01.01 GENERAL

A. This specification describes the functional, performance, environmental, submittal, documentation, and warranty requirements, as well as the method of measurement and basis of payment, for a rugged field deployable and user selectable Moving Picture Experts Group (MPEG)-2 and MPEG-4 video decoder.

1. This video decoder will accept serial data signal and the digitally compressed video over the Freeway and Arterial System of Transportation (FAST) Communication Network Ethernet (TCP/IP) network from a video encoder, and output the decoded video as a standard National Television Standards Committee (NTSC) composite video signal and the serial data as RS-232/422.

2. The video decoder shall be of the same manufacturer and fully compatible with the video encoder provided under Section 685, "Video Encoder."

3. The video decoder shall comply with this specification to operate within the FAST Arterial Management System and Freeway Management System.

B. This specification is for equipment only, no installation, to be delivered to the FAST Traffic Management Center (TMC) for testing and approval prior to final acceptance.

1. The Engineer shall be notified prior to the delivery to the TMC.

2. No partial shipments will be accepted.

3. All equipment supplied on this project shall be delivered during a single delivery, and shall be labeled clearly with the project and location designation.

C. All equipment shall be approved prior to purchase by the FAST Director or designee.

MATERIALS/EQUIPMENT

686.02.01 FUNCTIONAL REQUIREMENTS

A. The video decoder shall comply with the following standards:

1. International Organization for Standardization: (ISO) 9001: Quality Assurance, MPEG-2 ISO/13818-2 Video Compression and MPEG-4 ISO/14496 Video Compression.

2. Institute of Electrical and Electronic Engineers (IEEE) 802.3: Part 3, CSMA/CD Access Method and Physical Layer Specifications.

3. Federal Communications Commission Rules and Regulations, Vol. II: Part 15 for Class A Equipment Electronic Compatibility and Susceptibility (product electromagnetic compatibility is required).

4. Underwriters Laboratories, Inc. (UL) 60960: Safety Requirements for IT Equipment (applicable to equipment safety).

5. Military Handbook MIL-HDBK-217F-2: Reliability Prediction of Electronic Equipment, Notice 2.

B. Detailed Requirements:

1. The video decoder shall inter-operate with the video encoders as defined in Section 685, "Video Encoder."

2. The video decoder shall support the following video features:

   a. The unit shall be capable of being soft-configured to perform MPEG-2 ISO/13818-2 video decoding and MPEG-4 ISO/14496 video decoding.

   b. The unit shall be capable of being soft-configured to produce elementary or transport stream.

   c. Video stream of up to 10 Mbps, auto-detecting.

   d. Video frame rate up to 30 fps and resolution of 720 x 480 pixels.

   e. 30 fps NTSC color video output.

   f. The end-to-end latency between the video encoder and the video decoders shall be no more than 250 ms while operating at a rate of 5 Mbps.

3. The video decoder shall support the following network features:

   a. Ethernet Interface: 10/100 Mbps, Half/Full-Duplex, Auto Negotiate (802.3), RJ-45.

   b. Static Internet Protocol (IP) Addressing: Class A, B, and C.

   c. Simple Network Management Protocol (SNMP) (MIB1, MIB2).

   d. Unicast and Multicast (IGMP V2).

   e. Gateway Configuration.

4. The video decoder shall support:

   a. Command Line Interface.

   b. Telnet.

   c. Trivial File Transfer Protocol (TFTP) or FTP (new firmware download).

   d. The video decoder shall have an integrated web interface that provides remote configuration and management features.

   e. Reset/Reboot and firmware upload shall be supported via all methods listed above.

   f. All video (i.e., resolution, contrast, and so forth), data (i.e., baud rate, parity, and so forth), encoder (i.e., bandwidth, and so forth), and network (i.e., IP, subnet mask, gateway, and so forth) parameters and settings shall be user configurable through the maintenance port, web interface, Telnet, and all other supported remote management tools.

   g. All configurations and settings shall be downloadable/exportable in document form. As a minimum, the exported settings shall include video, network, and data settings.

C. Failure and Reset Recovery: The recovery time of a hard or soft reset shall be less than 45 seconds.

D. Electrical: The video decoder shall have the following characteristics:

1. Power:

   a. Nominal input voltage of 120 VAC 60 Hz.

b. The unit shall contain all power conversion and regulation necessary to support electronics operation.

2. Power consumption: Shall not exceed 70 watts.

3. All supplied video decoders shall have the same power connectors.

a. Each unit shall be provided with a power cable that is at least 5 feet in length.

b. Power cable shall be terminated with a male, 3-prong, UL-listed power connector for interface with the previously stated power system.

E. Ports:

1. The video decoder shall have the following ports:

a. Network: 10/100 Mbps RJ-45.

b. Video: Composite Bayonet Neill-Concelman (BNC) and S-Video.

c. Data:

1) Two Electronics Industry Association (EIA)-RS232/422/485, DB-9 (Female), supporting up to 57.6 kbps:

a) These ports shall provide data pass-through for serial control (i.e., PTZ camera control).

b) RJ-45 may be provided in place of DB 9. For each RJ-45 port, an RJ-45- to- DB 9 converter shall be supplied.

2) One EIA-232 DB-9 (Female):

a) This port shall provide maintenance interface for local configuration.

b) RJ-45 may be provided in place of DB 9. For each RJ-45 port, an RJ-45- to- DB 9 converter shall be supplied.

F. Status Indicators:

1. The video decoder shall have the following minimum indicators:

a. Activity.

b. Power.

c. Video Loss.

d. Transmit.

e. Receive.

2. Status indicators shall be light emitting diode (LED).

G. Physical Characteristics:

1. The video decoder shall not exceed 2-1/2 inches high by 12 inches wide by 13 inches deep.

2. The weight shall not exceed 10 pounds.

H. External Markings:

1. All connectors, indicators, and replaceable components shall be permanently marked and traceable to the supplied documentation, including schematics and parts list.

2. The external markings shall include the product function name, model number, serial number, and manufacturer's name.

I. Environmental:

1. The video decoder shall conform to the performance specification when operated in the following environment:

a. Temperature: 32 degrees F to 104 degrees F.

b. Humidity: 5 to 95 percent relative humidity, non-condensing.

2. The video decoder shall have a minimum Mean Time Between Failures (MTBF) of 60,000 hours.

J. MAC Address:

1. Each unit shall have a unique MAC address.

2. MAC address shall be derived from an address space of 10,000 sequential addresses.

K. Network Management Software: All custom Management Information Base (MIBs) required for network management shall be provided for use with third party network management software.

L. IP Addressing: Each unit shall support and be delivered with 2 user settable IP addresses, 1 for command and control, and 1 for video multicasting.

686.02.02 SUBMITTALS

A. The following shall be submitted by the Contractor to the Contracting Agency:

1. Acceptance Test Procedures, stand-alone and operational.

2. Training Syllabus.

3. Users Manual.

4. Parts List.

5. Description of MAC address scheme/space.

6. Certifications/Statements:

a. Provide certification of conformance to all standards listed in this section.

b. Testing for compliance will be performed by an independent party.

CONSTRUCTION

686.03.01 TESTING

A. Prior to acceptance by the Contracting Agency, the video decoder shall require testing as described below.

B. The Contractor shall absorb all costs associated with the testing including and not limited to shipping and handling, all material and equipment and any labor.

C. Prior to acceptance of any video decoder the following tests shall be performed:

1. Stand-Alone Acceptance Test (SAT):

a. Using the FAST-approved vendor-supplied test procedures, FAST will perform the SAT in a test area provided by FAST.

b. A vendor representative may be present during the SAT.

c. The Contractor shall provide the Vendor with a schedule of the test, including time and place.

2. The SAT will be performed as follows:

a. The video decoder will be assembled and connected to power in a stand-alone configuration.

b. The video decoder will be powered up and allowed to initialize, boot, and run self-diagnostic tests as defined in the FAST-approved test procedures.

c. After the video decoder has started and initialized, any additional test procedures will be executed.

d. After the test procedures have been executed, the video decoder will be allowed to run, uninterrupted, for a burn-in period of 72 hours.

e. At the end of the burn-in period, the unit will be restarted and configuration verified.

f. Upon completion of all test procedures, the Contractor will be notified of SAT acceptance or failure. If the unit fails the test, the Contractor shall supply a new unit and the test shall restart.

3. Operational Test:

a. After successful completion of the SAT, FAST will configure and connect the video decoder to the FAST Test Network.

b. Along with the video decoder, the network will also have a video encoder unit as specified in Section 685, "Video Encoder," a personal computer operating the video decoder software as specified by FAST, and the camera control application provided by FAST.

4. The following tests will be performed by FAST:

a. Video Image (subjective quality acceptable to FAST).

b. Serial Data Channel both point-to-point (encoder to decoder), and IP.

c. User programmable parameters and functions.

d. Network management.

5. While connected to the network, the video decoder shall not in any way compromise the function or functions or any other connected network device.

6. Upon completion of all the tests, the Contractor will be notified of operational test acceptance or failure. If the unit fails the test, the Contractor shall supply a new unit and the test shall be restarted.

686.03.02 WARRANTY

A. The video decoder shall be warranted by the vendor for a minimum of 3 years.

1. The warranty shall be provided by the Contractor and shall guarantee the video decoder to be free from defect from assembly, fabrication, and materials.

2. The FAST and Contracting Agency may exercise the option of purchasing an extended warranty for an additional 2 years utilizing the item number as indicated in Subsection 686.05.01, "Payment."

B. The warranty shall be provided in writing. If the normal manufacturer's warranty extends for a longer period, the video decoder shall be warranted for that period.

C. The warranty shall be measured from the date of receipt by the Contracting Agency.

1. The manufacturer shall be responsible for maintaining a list of equipment supplied and warranty information during the period of the warranty contract.

2. A report shall be submitted to FAST annually which details the status of equipment warranties.

D. Video decoders found to be defective during the warranty period shall be replaced free of charge by the manufacturer. The vendor shall be responsible for all shipping and handling costs for equipment under warranty.

E. The manufacturer shall also provide technical support coverage for all equipment and software furnished. This support shall as a minimum include the following:

1. Software and firmware upgrades.

2. Software patches.

METHOD OF MEASUREMENT

686.04.01 MEASUREMENT

A. The video decoder shall be measured per each.

B. The video decoder~~,~~ extended 2-year warranty shall be measured by lump sum.

BASIS OF PAYMENT

686.05.01 PAYMENT

A. The accepted quantity of video decoder will be paid for at the contract unit price per each, which shall be full compensation for furnishing and configuration the unit and for all labor, material, and equipment, including all necessary jumpers, required to facilitate an operational video decoder.

B. The lump sum price for video decoder extended 2-year warranty shall be full compensation for the extended warranty.

C. Payment will be made under:

PAY ITEM	PAY UNIT
Video Decoder	Each
Video Decoder extended 2-year warranty	Lump sum

SECTION 687

CLOSED CIRCUIT TELEVISION (CCTV) FIELD EQUIPMENT

DESCRIPTION

687.01.01 GENERAL

A. This specification shall govern the furnishing and installation of Closed Circuit Television (CCTV) field equipment of a CCTV microprocessor unit at designated field locations and equipment cabinets as shown on the plans.

B. This equipment will be installed by the Contractor at designated sites, and all hardware, software, and assorted components needed for the proper operation of the units shall be supplied.

C. All materials furnished, assembled, fabricated, and installed under this item shall be new, corrosion-resistant, and in strict accordance with the specifications.

D. The equipment design and construction shall utilize the latest techniques with a minimum number of parts, subassemblies, circuits, cards, and modules to maximize standardization and commonalty.

1. The equipment shall be designed for ease of maintenance.

2. All component parts shall be readily accessible for inspection and maintenance.

MATERIALS/EQUIPMENT

687.02.01 FUNCTIONAL REQUIREMENTS

A. The CCTV Field Equipment together with the CCTV central equipment in the Traffic Management Center (TMC) will form a complete CCTV system that shall meet the following requirements.

B. The video camera positioning system shall provide dual-mode day (color) and night (monochrome) video camera with optical zoom lens and a high speed positioning system.

1. The lens shall have a focal length of 3.4 mm to 119 mm (35:1) with auto/manual focus.

2. The digital zoom shall provide a range of up to 12X with an effective zoom ratio of 350:1.

3. The effective focal length shall be 3.4 mm to 1,190 mm.

4. The video camera shall have a 1/4-inch format Progressive Scan CCD image sensor and lens combination capable of providing an effective horizontal angle of view of 55.8 degrees wide angle to 17 degrees maximum telephoto.

5. The camera shall provide Wide Dynamic Range (WDR) by use of dual-shutter exposure technique.

C. The camera shall be provided with electronic stabilization using the 2 motion-frequency selectable stabilization method.

1. The pan function shall provide 360 degrees of continuous rotation, with a variable speed from 0.1 degree per second to 160 degrees per second.

2. The tilt function shall provide 180 degrees of movement 0 degree to +90 degrees to -90 degrees, with a variable speed from 0.1 degree per second to 40 degrees per second.
3. Up to 64 presets shall be available for storing and recalling zoom, pan, and tilt positions.
4. The positioner shall be capable of 8-point or 16-point compass annotations with primary direction spelled out, intermediate directions abbreviated with 2 letters, and a tour sequence defined using up to 64 preset positions.
5. All camera functions and pan and tilt functions shall be operable via RS-422 serial communications.
6. Communications protocol command set shall be the Freeway and Arterial System of Transportation (FAST) protocol.

D. Features:

1. 1/4-inch Progressive Scan Color Sensor.
2. Horizontal Resolution of 520 TV lines.
3. 35:1 (3.4 mm to 119 mm) optical zoom lens.
4. Continuous digital zoom with selectable range from OFF to 12X.
5. Effective overall focal length of 3.4 mm to 1,190 mm.
6. Electronic Image Stabilization.
7. Auto/Manual Focus.
8. Selectable long-term integration to 1/2 second with frame store video output.
9. Selectable shutter speeds from 1/2 second to 1/30,000 second.
10. Composite video output; NTSC format.
11. Adjustable color balance.
12. Crystal or Internal phase adjust line-lock, software adjustable.
13. Programmable on-screen character generator.
14. WDR by use of dual-shutter exposure technique.
15. RS-422 serial control protocol command set to FAST protocol.
16. Camera Addressing via serial control.
17. 8-point or 16-point compass annotation.
18. 3-1/2-inch diameter sealed enclosure pressurized with dry nitrogen.
19. Continuous rotation capability in either direction.
20. Variable pan speed from 0.1 degree per second to greater than 160 degrees per second (preset mode).
21. Variable tilt speed from 0.1 degree per second to 40 degrees per second.
22. 64 zoom, focus, pan and tilt preset positions, each with a unique user programmable Preset ID.

E. Camera Specifications:

1. Imager: Interline Transfer Progressive Scan CCD with mosaic-type color compensating filter.
2. Image Area: 1/4-inch Format 3.6 mm horizontal by 2.7 mm vertical.
3. Resolution: 520 horizontal, 350 vertical.
4. Picture Elements (total): 811 horizontal by 508 vertical.
5. Video Output: NTSC, 1 V p-p at 75 ohms, unbalanced.
6. Maximum Lens Aperture: f/1.4 wide angle to f/4.2 telephoto.
7. Optical Zoom Range: 35:1, 3.4 mm to 119 mm.
8. Digital Zoom Range: 1X (Off) through 12X, Smooth transition from Optical to Digital Zoom.
9. Effective Digital Focal Length: 119 mm to 1,190 mm.
10. Optical Zoom Speed: 2 speeds, from approximately 2.9 seconds to 5.8 seconds full range.
11. Horizontal Angle of View: Optical: 55.8 degrees to 1.7 degrees; at 12X Digital: 55.8 degrees to 0.17 degree.
12. Minimum Focus Distance: 40 inches in telephoto, 0.4 inch in wide angle.
13. Electronic Stabilization: 2 motion-frequency selectable stabilization method.
14. Digital Compass: 8-point or 16-point compass annotation with primary direction spelled out and intermediate directions abbreviated with 2 letters.
15. Auto Focus: Selectable Auto/Manual. Minimum scene illumination for reliable Auto Focus, 30 percent video.
16. Manual Focus Speed: 1 speed, approximately 2.0 seconds to full range.
17. Zoom and Focus Presets: 64 preset positions; focus shall be auto and, if programmed, shall display the Preset ID.
18. Flash Memory: Update firmware and new features via serial communication.
19. Long Term Integration Range (Short Shutter):
    a. Shall provide manual selection of integration duration for enhanced sensitivity.
    b. Integration times shall be 1/2 second, 1/4 second, 1/8 second, 1/15 second, and 1/30 second.
    c. Frame store video output shall provide continuous video output, updated at the integration rate.
20. Manual Shutter: Selectable shutter speeds of 1/60, 1/120, 1/180, 1/250, 1/500, 1/1,000, 1/2,000, 1/4,000, 1/10,000, and 1/30,000 second.
21. Auto Iris: Iris shall automatically adjust to compensate for changes in scene illumination and maintain constant video level output within sensitivity specifications.
22. Manual Iris:
    a. A decrease in the video level value shall give the effect of open iris.

b. An increase in the video level shall give the effect of close iris.

23. Gamma: 0.45.

24. AGC: 028 dB.

25. Color Balance: Auto Tracking Color Balance/Manual with adjustable Red and Blue Levels.

26. Signal to Noise Ratio: Greater than 50 dB.

27. Synchronization: Crystal or Phase-Adjust Line Lock on 60 Hz.

28. Sensitivity (3,200K): Scene illumination at F1.4, wide angle:

0.5 Lux at 1/60 Sec.	F1.4 Shutter	Color I.R. Cut On
0.05 Lux at 1/2 Sec.	F1.4 Shutter	Color I.R. Cut On
0.2 Lux at 1/60 Sec.	F1.4 Shutter	Monochrome mode I.R. Cut Off
0.01 Lux at 1/4 Sec.	F1.4 Shutter	Monochrome mode I.R. Cut Off

F. Camera Housing:

1. Each camera housing shall be a corrosion-resistant, tamperproof-sealed, and pressurized with 5 psi of dry nitrogen and shall include a Schrader purge fitting and 20-psi relief valve. The size of the housing shall be 3-1/2-inch diameter or smaller.

2. The camera housing shall include a loss of pressure sensor that will trigger an alarm message that will be inserted in the video output signal.

3. The enclosure shall be constructed from 6061-T6 standard aluminum tubing with a wall thickness of 0.25 inches ±0.03 inches.

   a. Internal components shall be mounted to a rail assembly.

   b. A copper-plated spring-steel ring shall be used to ensure electrical bonding of the rail assembly and components to the camera housing.

   c. The housing exterior shall be finished by pretreatment with conversion coating and baked enamel paint.

   d. The camera enclosure shall be designed to withstand the effects of sand, dust, and hose-directed water.

4. The internal humidity of the housing shall be less than 10 percent when sealed and pressurized.

   a. Desiccant packs shall be securely placed inside the housing to absorb any residual moisture and maintain internal humidity at 10 percent or less.

   b. A sun shield shall be provided to shield the entire housing from direct sunlight.

G. Mechanical Specifications (DSP Camera Assembly):

1. Weight: 4.2 pounds.

2. Dimensions:

   a. Length (less connectors): 12.0 inches.

   b. Housing Diameter: 3.5 inches.

   c. Height (including mounting base): 5.13 inches.

3. Mounting: 4 mounting nuts on bottom of base.

H. Character Generator Specifications:

1. ID characters shall be white with a black border.
2. A maximum of 6 lines of user-programmable alphanumeric text shall be displayed, plus 2 fixed lines for low-pressure indicator and privacy zones.
3. Text shall only be displayed in uppercase characters.
4. Camera ID:
   a. Up to 2 lines, each up to 24 characters long.
   b. If both lines are programmed, Line 1 of Camera ID shall always appear above Line 2 of Camera ID regardless of top or bottom selection.
5. Preset ID:
   a. 1 line, up to 24 characters long, user-programmable for each of the 64 preset positions.
   b. When a preset position is recalled, the corresponding preset ID shall be displayed.
   c. The preset ID shall remain displayed until a pan, tilt, zoom, manual focus, auto focus select, or another preset command is received.
6. Compass Annotation:
   a. 8-point or 16-point compass annotation shall be settable for a true north position.
   b. Display shall include North, NE, East, SE, South, SW, West, and NW.
   c. Position shall be able to be grouped with the site location or separate from site location.
   d. Position shall be user-selectable for a 3-second time out or permanent display and user-enabled/disabled.
7. Azimuth and Elevation:
   a. Position shall be displayed in 0 degree to 359 degrees for AZ position, +95 to -95 in elevation (EL),
   b. Position shall be user-selectable for 3-second time out or permanent display and user-enabled/disabled.
8. Low Pressure Indicator:
   a. 1-line “Low Pressure” messages shall be displayed in blinking or non-blinking mode when activated by low internal pressure.
   b. Adjustable set points by altitude shall be provided via the serial port to activate low-pressure.
   c. Message shall be user-enabled/disabled.
   d. In maintenance mode, readings of the internal pressure of the camera housing shall be displayed from 5 psi down to 1 psi, in 0.1 psi increments.
9. Internal Temperature Indicator:
   a. 1 line, in degrees C, numeric messages shall be displayed in blinking or non-blinking mode.

b. Message shall be user-enabled/disabled.

c. In maintenance mode, readings of the internal temperature of the camera housing shall be in 1 degree increments.

10. Sector Message:

a. Up to 16 sectors in 360 degrees shall be able to be defined with up to 24 characters long.

b. Message shall be programmable via the RS-422 serial communications.

I. Message Positioning:

1. Right side positioning shall be accomplished by padding left side of message with spaces.

2. Messages shall be capable of being positioned at either the top or the bottom of display.

3. Blank lines shall not displayed.

4. Any programmed line being displayed shall fill in toward the top if top positioning is selected, or toward the bottom if bottom position is selected.

J. Privacy Zones:

1. Video blanked out for up to 8 privacy zones shall be provided.

2. 1-line and numeric messages shall be displayed.

3. Message shall be displayed in blinking or non-blinking mode and be user-enabled/disabled.

4. Privacy zones shall be programmed via the RS-422 serial communications.

K. Communication and Camera Addressing Protocol:

1. Control and addressing shall be via RS-422/RS-232 optically isolated serial communications.

a. Additional protocols shall consist of Cohu, American Dynamics, Javelin, Philips/Bosch, Vicon, and Pelco-D.

b. The National Transportation Communications for ITS Protocol (NTCIP) 1205 protocol communications protocol shall be included as an option.

1) Refer to NTCIP 1205 protocol for detailed description.

2) This allows for migration to the NTCIP standard while maintaining operation of existing CCTV system protocols.

2. Upon receipt of any given command, the Camera Positioning System shall not take longer than 1.0 second to respond.

3. All programmable functions shall be stored in non-volatile memory and shall not be lost if a power failure occurs.

4. System configurations such as video privacy zones, preset text, and sector ID shall be able to be stored in a computer file.

5. A camera personality shall be able to be cloned or uploaded into a camera in the event that a camera replacement is necessary.

L. Pan and Tilt Positioning Specifications:

1. Continuous rotation capability in either direction.
2. 180 degrees of tilt movement, +90 degrees to -90 degrees unobstructed.
3. Pan Speed (Operator Control): Variable from 0.1 degree per second to 80 degrees per second.
4. Pan Speed (Preset Control): Greater than 160 degrees per second.
5. Tilt Speed (Operator Control): Variable from 0.1 degree per second to 40 degrees per second.
6. Tilt Speed (Preset Control): 40 degrees per second.
7. 64 Pan and Tilt preset positions with repeatability within ±0.5 degree.
8. The positioning system shall be invertible for mounting to a ceiling.

M. Tour Specifications:

1. 8-tour sequence shall be able to be defined.
2. The tour shall be programmed by selecting the preset position by number and then selecting a dwell time.
   a. The presets shall be able to be used in any order.
   b. The same preset shall be able to be used more than once as long as the total number of preset positions used does not exceed 32.
3. The dwell time shall define the length of time paused at each preset position, shall be from 1 second to 60 seconds, and shall be capable of being changed individually for all stops on the tour.
4. If the appropriate preset ID is programmed, it shall be displayed for each preset position used on the tour.
5. The tour shall stop upon receipt of a pan command.
6. All programmable functions shall be stored in non-volatile memory.

N. Power Requirements:

1. Operating Voltage: 89 VAC to 135 VAC, 120 VAC Nominal, 50/60 Hz ±3 Hz, and in accordance with NEMA TS-2, Section 2.1.2, "Traffic Control System."
2. The line variation specifications shall be tested to meet these specifications by an outside agency other than the camera manufacturer. The tests shall be provided upon request.
3. Primary Input Power Interruption: Comply with NEMA TS-2, Section 2.1.4, “Power Interruption.”
4. Transients Power Service:
   a. The CCTV field equipment shall comply with NEMA TS-2, Section 2.1.6, “Transients, Power Service.”
   b. The surge specifications shall be tested to meet these specifications by an outside agency other than the camera manufacturer.
   c. The tests shall be provided upon request.

5. Power consumption shall not exceed a total of 30 watts for camera//P&T driver (pan and tilt in motion).

O. Environmental Specifications:

1. Ambient Temperature Limits (Operating): -30 degrees F to 165 degrees F, NEMA TS-2, Section 2.1.5.1.

2. Ambient Temperature Limits (Storage): -50 degrees F to 185 degrees F, NEMA TS-2, Section 2.1.5.1.

3. The environmental specifications of the camera shall be tested to meet these specifications by an outside agency other than the camera manufacturer. The tests shall be provided upon request.

4. Humidity: Up to 100 percent relative humidity in accordance with MIL-E-5400T, paragraph 3.2.24.4, IP 67 rating.

5. Other: Withstand exposure to sand, dust, fungus, and salt atmospheres in accordance with MIL-E-5400T, paragraph 3.2.24.7, paragraph 3.2.24.8, and paragraph 3.2.24.9.

6. Shock: Up to 10 g's, 11 ms, in any axis under non-operating conditions, in accordance with MIL-E-5400T, paragraph 3.2.24.6.

7. Vibration: Sine vibration from 5 to 30 Hz, 1/2 g, 3-axis, 1 hour without damage.

8. Wind Loading: 150 mph wind load survivability, operability to 70 mph.

P. Mechanical Specifications:

1. Weight shall not exceed 19 pounds.

2. Dimensions: 11 inches high by 13.3 inches wide.

Q. Mounting Configurations: The Camera Positioning System shall include 5 possible mounting configurations: wall mount, pole mount, parapet mount, corner mount, and pedestal mount versions.

R. Main Interface Connector: The main interface connector shall be equivalent to an Amphenol 206036-3 with back shell 206070-1 and mating connector equivalent to an Amphenol 206037-11 with clamp 206070-1.

687.02.02 LOCAL INTERSECTION CAMERA CONTROL UNIT

A. The control unit shall provide convenient on-site camera control of camera positioning systems.

1. The unit shall offer system protocol from most major CCTV camera manufacturers.

2. The unit shall withstand the harsh operating environment associated with roadside installations.

3. Local control functions shall be accomplished using front panel switches that include pan and tilt, lens zoom, focus and iris.

4. Focus and iris shall include an auto/manual toggle with LED indication of the current state.

5. A local/remote switch shall be included that transfers control from the central system to the control unit.

6. This function shall have a built-in 5-minute timer that automatically transfers control back to the remote mode if left unintentionally in the local mode.

B. A front panel RS-232 port shall be provided that connects to a laptop PC for programming advanced camera site settings and that allows extended camera control functions.

1. 2 rear panel DB9 connectors shall provide both RS-422 and RS-232 formats for control system data connections.

2. The unit shall support most CCTV camera manufacturer's communications protocols.

C. Electrical:

1. Operating voltage - 89 VAC to 135 VAC, 47 to 63 Hz, NEMA TS-2, Section 2.1.2.

2. Mounting: EIA standard 19-inch cabinet, 1 RU.

D. Front Panel Controls:

1. Pan: 3-position momentary switch (pan right, stop, pan left).

2. Tilt: 3-position momentary switch (tilt down, stop, tilt up).

3. Zoom: 3-position momentary switch (tele, stop, wide).

4. Focus Mode: 2-position momentary switch (auto-manual) with LED indication of manual mode.

5. Focus control: 3-position momentary switch (near, stop, far).

E. Rear Panel Connectors: Camera - single multi-pin AMP for camera video, RS-422 data, and 20 VAC power.

687.02.03 WARRANTY

A. The camera shall include a 2-year warranty that includes parts and labor.

B. The 2-year period shall begin at the time of acceptance of the project.

CONSTRUCTION

687.03.01 CABLE HARNESS

A. The cables used for CCTV control, video, and 120 VAC power shall be installed as an integrated unit.

B. Cohu Model Number CA295H wiring harness or approved equal shall be used.

C. The wiring shall be installed from the CCTV unit to the in-cabinet control unit.

1. The Contractor shall be responsible for determining the length needed, and order the correct size accordingly.

2. Connectors at both ends of the cable are required.

687.03.02 DOCUMENTATION

A. Complete documentation of the system, as it is built, shall be provided by the Contractor.

1. A minimum of 2 copies of descriptive manuals and brochures for each type of electronic equipment and apparatus proposed for this project shall be supplied.

2. These documents shall contain sufficient technical data for complete evaluation. The quality, function, and capability of each deliverable item shall be described.

3. Manuals or brochures shall be originals or copies equal to originals.

687.03.03 OPERATIONAL TESTING

A. Upon completion of the system integration testing, the CCTV field equipment shall be required to complete a 30-day period of acceptable operation.

1. The system operational test shall fully and successfully demonstrate all system functions using live data and controlling all system activities.

2. Failure in any hardware item during the test period, with the exception of expendable items such as fuses and minor equipment as determined by the Engineer, shall necessitate restarting the 30-day test period for its full 30-day duration upon repair.

3. Any failure of system software, discovery of a software deficiency that causes a system malfunction, or discovery of software operation that is not in compliance with the specifications shall cause the 30-day test to be restarted in its entirety after correction of the software problem.

4. No intermittent hardware, software, communication, or control operation; malfunction not related to a specific hardware; or software malfunction shall be permitted to persist during the test period. Diagnostic testing that does not result in changes to system hardware or software shall result only in the loss of acceptable test time.

METHOD OF MEASUREMENT

687.04.01 MEASUREMENT

A. The quantity of CCTV field equipment shall be measured per each.

BASIS OF PAYMENT

687.05.01 PAYMENT

A. The accepted quantity of CCTV field equipment will be paid at the Contract unit price bid per each which shall be full compensation for the video camera, zoom lens, pan/tilt drive, camera housing, pole mount, receiver/driver, surge protection devices, and all cables, connections and hardware, measured as provided under Subsection 687.04.01, "Measurement," complete including warranty, installation, and testing of the equipment as specified and shown on the drawings.

B. Pre-assembly of CCTV equipment and components shall be considered incidental to CCTV field equipment.

C. Payment will be made under:

PAY ITEM	PAY UNIT
CCTV Field Equipment	Each

SECTION 688

REMOTE DATA RADIO COMMUNICATION SYSTEM

DESCRIPTION

688.01.01 GENERAL

A. The data radio unit for installation at remote intersection traffic signal control shall be of solid state design.

1. The data radio unit shall provide the capability of receiving digital signal transmissions from a master station data radio unit and returning transmissions to the master station data radio unit as required by the Freeway and Arterial System of Transportation (FAST) data radio system.

2. The remote station data radio unit shall be Microwave Data System (MDS) Model MDS-9710A or approved equal and shall meet the requirements below.

B. The remote data radio unit shall be configurable as a master station or remote radio.

1. The unit shall be capable of operating as a half-duplex or simplex radio and shall support all splits in duplex frequencies.

2. Full network diagnosis shall be available when operating as a master station.

3. The unit shall provide high system performance and data integrity through digital signal processing.

4. The data radio unit shall have the ability to communicate with any asynchronous protocol without extra software or programming.

MATERIALS / EQUIPMENT

688.02.01 FUNCTIONAL REQUIREMENTS

A. The remote data radio units shall conform to the following general requirements:

1. Supply Voltage: 10.5 VDC to 16.5 VDC.

2. Tx Current: 2 amps typical at 5 watts.

3. Rx Current: Less than 125 milliamps.

4. Sleep Mode: 15 milliamps nominal humidity, 95 percent at 104 degrees F, non-condensing.

5. Temperature Range: -22 degrees F to 140 degrees F.

6. Data Rate: 9,600 bps (rf).

7. Port Speed: 300 bps to 9,600 bps (rf and data) at 12.5 kHz channel spacing.

8. Bit error rate: BER x .000001.

9. Casing: Die cast aluminum.

10. Dimensions: 2-inch by 6-inch by 8-inch maximum.

11. Weight: 2.5 pounds maximum.

12. Operational Modes: Asynchronous; simplex, half-duplex.

13. Data Interface: RS-232, DB-25 Female connector supports: TXD, RXD, RTS, CTS, DCD, RUS, AUX 14, POWER, DSR, and GND.
14. Synthesizer Range: 400 kHz sliding window, manually tunable.
15. Current Consumption:
    a. RF Unit Rx/Standby: 70 milliamps maximum.
    b. RF Unit Tx: 1.6 amps nominal.
16. TX to RX Transition Time: 3 milliseconds RSSI Squelch.

B. Modem/Diagnostics: The remote data radio units shall conform to the following:
1. Modulation: Digital/CPFSK.
2. CTS Delay: 0 to 255 millisecond, programmable in 1-millisecond increments.
3. PTT Delay: 0 to 255 millisecond, programmable in 1-millisecond increments.

C. Radio Receiver: The radio receiver shall conform to the following:
1. Type: Double conversion superheterodyne.
2. Frequency Stability: ±0.00015 percent (1.5 ppm).
3. Adjacent Channel: 60 dB nominal.
4. Sensitivity 12 dB Sinad: -117 dBm nominal.
5. Spurious Rejection: 80 dB.
6. Desensitization: 65 dB at 12.5 kHz and 70 dB at 25 kHz nominal.
7. IF Selectivity: 100 dB at adjacent channel.
8. Electronic Industry Association (EIA) Intermodulation: 65 dB.
9. RSSI: Negative -112 dBm to -54 dBm.
10. Squelch Opening Time: 1.5 milliseconds.
11. Audio Outputs:
    a. Filtered: -10 dB, 600 ohm unbalanced, adjustable.
    b. Unfiltered: 40 mV RMS at 2 kHz Dev.
12. Harmonic Distortion: 3 percent maximum.

D. Radio Transmitter: The radio transmitter shall conform to the following:
1. RF Power: Adjustable between 0.5 w and 5 w at 13.6 VDC.
2. Duty Cycle: Continuous.
3. Time Out Timer: Programmable between 1 second and 255 seconds, or OFF.
4. Spurious and Harmonics: -55 dBc maximum.
5. Hum and Noise: -40 dB between 300 Hz and 3,000 Hz.
6. Audio Inputs:
    a. Filtered: -10 dBm, 600 ohms unbalanced, adjusted, at 2 kHz Dev.
    b. Unfiltered: 245 mV RMS at 2.5 kHz Dev.
7. Audio Response:

a. Filtered: Between 1 dB and -3 dB from 5 Hz to 3,000 Hz.

b. Unfiltered: 1 dB and -3 dB from 5 Hz to 4,000 Hz.

8. Frequency Stability: ±0.00015 percent (1.5 ppm).

9. Transmitter Attack Time: Less than 1 millisecond to within 100 Hz.

10. Carrier Power: Programmable from 0.1 watts to 5 watts.

11. Carrier Power Accuracy: Normal plus or minus 1.5 dB.

12. Output Impedance: 50 ohms.

E. Connectors and Harnesses:

1. All connectors and harnesses shall be furnished with each data radio unit. It is the supplier's responsibility to contact FAST to determine the type of connectors required.

2. The remote data radio unit is for use with the FAST system.

F. Power Requirements: The remote data radio units shall meet all specified requirements when the input power is 120 VAC plus or minus 10 VAC, and 55 Hz plus or minus 5 Hz.

G. Antennae Requirements:

1. A Yagi-type antennae with 9 dB gain shall be provided with each unit.

2. The antennae shall be capable of operation within the 940 MHz to 960 MHz bandwidth.

H. Software Requirements: All software necessary for the units to be fully functional shall be downloaded into the devices at the factory before shipment.

I. Compliance to FAST: All equipment supplied shall conform to the requirements of FAST.

CONSTRUCTION

688.03.01 INSTALLATION

A. The radio unit shall be installed as shown on the Drawings.

METHOD OF MEASUREMENT

688.04.01 MEASUREMENT

A. The quantity of Remote Data Radio Unit shall be measured per each.

BASIS OF PAYMENT

688.05.01 PAYMENT

A. The accepted quantity of Remote Data Radio Unit will be paid for at the contract unit price bid per each which shall be full compensation for providing and installing the radio unit and appurtenant equipment, measured as provided under Subsection 688.04.01, "Measurement," as specified, and shown on the drawings.

B. Payment will be made under:

PAY ITEM:	PAY UNIT
Remote Data Radio Unit	Each

DIVISION III

MATERIALS DETAILS

NOTE: Where pertinent, a "Manufacturer's Certificate of Compliance" covering materials as specified in this Division may be required and shall be furnished by the Contractor, when requested by the Engineer, at no cost to the Contracting Agency.

SECTION 701

HYDRAULIC CEMENT

SCOPE

701.01.01 MATERIALS COVERED

A. This specification covers the types of Hydraulic cement as defined by ASTM C150, ASTM C595, and ASTM C1157. Unless otherwise provided, the cement will be used for all Hydraulic cement concrete, mortar, cement treated base, and cement treated subgrade. The type of cement used shall be as listed in Table 1 with the minimum sack requirements in Section 501, "Portland Cement Concrete."

Table 1 - Types of Cement

Type of Cement Permitted
Type II & Fly Ash
Type MS & Fly Ash
Type IP (MS)
Type V
Type HS
Type V & Fly Ash
Type HS & Fly Ash

MATERIALS

701.02.01 GENERAL

A. Unless otherwise specified, the type of cement used shall be at the Contractor's option based on availability, and no additional compensation will be allowed for substitution of any type of cement for another.

B. Cement to be removed and replaced with fly ash shall be a minimum of 20 percent of the weight of cement. Fly ash added at the mixer shall be in an equal proportion to the weight of cement removed.

C. Class F fly ash conforming to the requirements of Section 729, "Fly Ash," shall be used.

PHYSICAL PROPERTIES AND TESTS

701.03.01 REQUIREMENTS

A. Type II and Type V Portland cements shall conform to ASTM C150 except as hereinafter provided.

B. Type IP blended hydraulic cement shall conform to ASTM C595 except as hereinafter provided.

C. Pozzolan shall conform to Subsection 702.03.04, "Pozzolans (Fly Ash)."

D. Additionally, Type II, Type V, and Type IP cements shall conform to ASTM C150 with the following requirements:

1. The cement shall not contain more than 0.60 percent by mass of alkalis calculated as Na20 plus 0.658 K20.

2. Type IP, MS, and HS cements that exceed the allowable alkali content may be used if mortar bars made and tested according to Subparagraph 1 above, using the proposed cement and a selected highly alkali-reactive aggregate, show no more than 0.05 percent expansion at 6 months.

SECTION 702

CONCRETE CURING MATERIALS AND ADMIXTURES

SCOPE

702.01.01 MATERIALS COVERED

A. This specification covers concrete curing materials, air-entraining admixtures, water retardants, pozzolans, and hydrated lime. Comply with Section 722, "Water" for mixing and curing. The Contractor shall submit a request to use any one of the following for approval by the Engineer as prescribed in Subsection 702.03.06.

REQUIREMENTS

702.02.01 BLANK

PHYSICAL PROPERTIES AND TESTS

702.03.01 CURING MATERIALS

A. Curing materials shall conform to the requirements of the following tests, except 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. The film of curing compound shall be continuous, uniform, and free from pinholes, bubbles, or blisters.:

1. Burlap Cloth made from Jute or Kenaf: AASHTO M182.
2. Waterproof Paper for Curing Concrete: AASHTO M171.
3. Liquid Membrane-Forming Compounds for Curing Concrete: ASTM C309.
4. Pigmented Curing Compound for Portland Cement Concrete pavement: ASTM C309, except the loss of water from the surface in the water retention test shall not exceed 1.50 ounces per square foot in 72 hours.
5. White Pigmented Curing Compound for Bridge Decks: ASTM C309. Type 2 Class B resin type and shall be poly-alpha-methyl-styrene with the loss of water from the surface in the water retention test shall not exceed 0.50 ounce per square foot in 24 hours or more nor 1.50 ounces per square foot in 72 hours.
6. Plastic Sheeting: ASTM C171.
7. White Polyethylene Sheeting (film) for Curing Concrete: ASTM C171.

702.03.02 AIR-ENTRAINING ADMIXTURES

A. Air-entraining admixtures shall conform to ASTM C260.

702.03.03 ADMIXTURES OTHER THAN AIR-ENTRAINING

A. These admixtures shall comply with ASTM C494 and shall be clearly marked as to Type A, B, C, D, E, F, or G.

702.03.04 POZZOLANS (FLY ASH)

A. Fly Ash admixture shall conform to Section 729, "Fly Ash."

702.03.05 HYDRATED LIME

A. Hydrated lime shall conform to ASTM C207, Type N.

702.03.06 SUBMITTAL

A. Curing compounds and admixtures shall be tested and certified in accordance with the Table 1 frequency.

1. Prior to the use of these materials, the Contractor shall submit to the Engineer for approval a document certifying that the material meets these specifications and requirements.

2. A test certificate shall be included with the certifying document.

B. The material supplier for Portland cement concrete materials, plantmix bituminous materials, or any material production that requires the use of admixtures shall attach the certificate to the mix design submittal as indicated in Table 1. All subsequent certificates shall be on file and accessible to the Engineer for audit purposes.

C. The Statute of Limitations duration for the record storage shall be as required by the Nevada Revised Statutes.

Table 1 - Quality Control Testing

Material	Certificate	Frequency
All curing materials	Sample and certification	1 per project
All admixture material	Certificate with copy of test for lot used	1 per lot

SECTION 703

BITUMINOUS MATERIALS

SCOPE

703.01.01 MATERIALS COVERED

A. This specification covers the quality of asphalt cement, liquid asphalt, emulsified asphalt, cationic emulsion, anionic emulsion and rubber-asphalt crack sealant.

REQUIREMENTS

703.02.01 CONTRACTOR'S RESPONSIBILITY

A. Bituminous material failing the test requirements of this section, including tolerances, shall be subject to Subsection 109.02, "Scope of Payment."

703.02.02 MATERIAL SOURCE RESPONSIBILITY

A. Bituminous materials supplied under these specifications shall be provided from a source authorized by the Engineer and/or IQAC. The process for authorization may be obtained from the Contracting Agency's Public Works Construction Management Division.

703.02.03 SHIPPING NOTICE

A. Shipping notices shall be mailed upon making shipment and shall contain the following information:

1. Consignee and destination,
2. Agency contract number,
3. Delivery point,
4. Date shipped,
5. Car initials or number of truck transport delivery ticket number,
6. Type and grade of material,
7. Quantity loaded,
8. Loading temperature,
9. Net quantity,
10. Signature of shipper or authorized representative,

B. When shipments 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. All sampling by the Vendor or Contractor shall be performed or observed by an NAQTC certified technician.

C. Three copies of the shipping notice shall be mailed to the Contracting Agency.

PHYSICAL PROPERTIES AND TESTS

703.03.01 REFINERY TEST REPORT

A. Refinery test reports shall be mailed to the Engineer as soon as tests have been completed, and the report shall contain the following data:

1. Date of shipment,
2. Car initials or number of truck transport delivery ticket number,
3. Destination and consignee,
4. Contracting Agency contract number (or purchase order number, if applicable),
5. Type and grade of material,
6. Certificate of grade (certify that material conforms to these specifications, and itemize results on tests performed and date of test),
7. Signature of refinery's authorized representative,

B. The certificate of compliance shall be used as a basis of permitting immediate use of the material on the job and shall represent conditional acceptance only. The certificate of compliance shall include a copy of the tests for that lot shipment.

703.03.02 ASPHALT CEMENTS

A. 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 347 degrees F.

B. These specifications cover the following viscosity grades: AC-2.5, AC-5, AC-10, AC-20, AC-30, AC-40 and the Superpave Performance Grades (PG) for the Southern Nevada region as listed in Table 1, Table 2, Table 2A, and Table 2B. The performance grades are to be used only when required in the Contracting Agency's Special Provisions for capital improvements or policy and procedures.

TABLE 1 - LOCATION OF BITUMINOUS GRADE USE

Location	Viscosity Grades
Clark County Region below 6,000 feet elevation	PG 76-22CC, AC-30, or PG 64-22*
Mountain Roads at and above 6,000 feet elevation	PG 64-34CC

* Sixty (60') right of way or less

C. The various grades set forth above shall conform to the requirements and the methods of testing shown in Table 2, Table 2A, and Table 2B.

1. Performance grade material must have been prepared from crude petroleum product.
2. The asphalt cements shall be homogenous, free from water and shall not foam when heated to 347 degrees F.
3. Blending of asphalt cements to produce a specified performance grade shall result in a uniform, homogenous blend with no separation.

4. Modified binders shall be blended at the source of supply and delivered as a completed mixture to the job site.

5. It shall not be transported via railroad car.

6. Only elastomeric Styrene Butadiene Styrene (SBS), Styrene-Butadiene (SB), Styrene-Butadiene Rubber (SBR), and Styrene Ethylbutylene Styrene (SEBS) rubber shall be added to the base binder asphalt cement, to produce a binder that complies with specification requirements.

703.03.03 LIQUID ASPHALTS

A. Liquid asphalts shall consist of materials conforming to the following classifications:

1. Rapid curing (RC) products: Paving asphalt with a penetration of approximately 85 to 100 fluxed or blended with a naphtha solvent.

2. Medium curing (MC) products: Paving asphalt fluxed or blended with a kerosene solvent.

3. Slow curing (SC) products: Natural crude oils or residual oils from crude asphaltic petroleum.

B. When tested in accordance with the standard methods of AASHTO and ASTM, the grades of liquid asphalt shall conform to the requirements specified in Table 2, Table 3, and Table 4.

703.03.04 EMULSIFIED ASPHALT

A. Emulsified asphalt for slurry seal shall conform to CQS-1h as specified in Table 6 when tested in accordance with AASHTO and ASTM.

703.03.05 SLURRY SEAL

A. The slurry seal and its components shall conform to the requirements of Table 7 when tested in accordance with AASHTO, ASTM, and ISSA procedures.

703.03.06 MICROSURFACING

A. The microsurfacing and its components shall conform to the requirements of Table 8 when tested in accordance with AASHTO, ASTM, and International Slurry Seal Association (ISSA) procedures.

703.03.07 POLYMER MODIFIED EMULSION MEMBRANE

A. This material shall consist of a polymer modified asphalt emulsion. Its role is to form a water impermeable seal at the existing pavement surface and to bond the new hot mix to the existing surface. The product shall be smooth and homogeneous and conform to the requirements in Table 10.

TABLE 2 - NEVADA TABLE 2 REQUIREMENTS FOR ASPHALT CEMENT GRADED BY VISCOSITY AT 140°F
(Grading Based on Original Asphalt)

Test	AASHTO Test Method	VISCOSITY GRADE					
		AC-2.5	AC-5	AC-10	AC-20	AC-30	AC-40
Viscosity at 140°F poise	T202	200 - 300	400 - 600	800 - 1,200	1,600 - 2,400	2,400 - 3,600	3,200 - 4,800
Viscosity at 275°F cSt, minimum	T201	125	175	250	300	350	400
Penetration at 77°F 100 g/5 seconds, minimum	T49	220	140	80	60	50	40
Flash point (C.O.C., °F minimum)	T48	325	350	425	450	450	450
Solubility in Trichloroethylene (percent, minimum)	T44	99	99	99	99	99	99
Ductility at 39°F 1 cm/min. cm minimum	T51	50	25	15	5	--	--
Tests on Residue From RTFO							
Loss on heating, percent maximum	T240	--	1	0.5	0.5	0.5	0.5
Viscosity at 140°F poise maximum	T202	1,000	2,000	4,000	8,000	12,000	16,000

TABLE 2A - PERFORMANCE GRADE FOR ORIGINAL MATERIALS

Test	Test Method	PG 76-22CC Modified	PG 64-34CC Modified	PG 64-22
Original Materials				
Flash Point Degrees (°C) - minimum	NDOT T716	230		
Viscosity (Brookfield) Maximum 3.0 Pas (3000cP) Test Temp. °C	ASTM D4402	135		
Dynamic Shear G*/sin ä = minimum 1.0 kPa @ 10 rad/s Test Temp. °C	AASHTO T315	76	64	64
Ductility at 39.2°F, 5 cm/min. cm - minimum	NDOT T746	20	30	30
#10 Sieve Test, Pass/Fail	NDOT T730	Pass		
Solubility in Trichloroethylene, percent (%) - minimum	AASHTO T44	99		
Toughness in-lb - minimum	ASTM D 5801	150	75	N/A
Tenacity in-lb - minimum	ASTM D 5801	100	50	N/A
If T&T fails, Elastic Recovery, percent (%) - minimum	AASHTO T 301	60	60	N/A

TABLE 2B - PERFORMANCE GRADE FOR RTFO AND PAV CONDITIONING

Tests On Residue From RTFO AASHTO T-240				
Test	**Test Method**	**PG 76-22CC Modified**	**PG 64-34CC Modified**	**PG 64-22**
Ductility at 39.2°F, 1 cm/min. cm - minimum	NDOT T746	5	10	10
Mass Loss, Percent (%) - maximum	NDOT T728	0.5		
Dynamic Shear, G*/sin ä = minimum 2.2 kPa @ 10 rad/s Test Temp. in °C	AASHTO T315	76	64	64
Test On Residue After PAV				
PAV, Test Temp. in °C	AASHTO R28	100	100	100
Dynamic Shear, G*/sin ä = Max 5,000 kPa @ 10 rad/s Test Temp. in °C	AASHTO T315	31	19	25
BBR - Creep Stiffness, S = 300 Mpa maximum, m-value = 0.30 minimum @ 60s Test Temp. in °C	AASHTO T313	-12	-24	-12
Direct Tension, Failure Strain = 1.0% minimum @ 1.0 mm/min. Test Temp. in °C	AASHTO T314	-12	-24	-12

TABLE 3 - UNIFORM PACIFIC COAST SPECIFICATIONS FOR RAPID CURING (RC) LIQUID ASPHALTS

Test	AASHTO Test Method	ASTM Test Method	GRADES							
			RC-70		RC-250		RC-800		RC-3000	
			Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Kinematic Viscosity at 140°F cSt	--	D2170	70	140	250	500	800	1,600	3,000	6,000
Flash Point (Tag Open Cup), °F	T79	D1310	--	--	80	--	80	--	80	--
Distillation										
Distillate percent of total distillate to 680°F	--	--	10	--	--	--	--	--	--	--
to 437°F	T78	D402	50	--	30	--	15	--	--	--
to 500°F	--		70	--	60	--	45	--	25	--
to 600°F	--	--	85	--	80	--	75	--	70	--
Residue from distillation to 680°F, volume percent by difference	--	--	55	--	65	--	75	--	80	--
Test on Reside from Distillation										
Penetration, 77°F, 100g/5 seconds	T49	D5	80	120	80	120	80	120	80	120
Ductility, 77°F, cm*	T51	D113	100	--	100	--	100	--	100	--
Solubility in Trichloroethylene, %	T44	D2042	99.5	--	99.5	--	99.5	--	99.5	--
Water, %	T55	D95	--	0.2	--	0.2	--	0.2	--	0.2
GENERAL REQUIREMENT: The material shall not foam when heated to application temperature recommended by the Asphalt Institute.										
* If ductility is less than 100, material will be accepted if ductility at 60°F is 100 minimum at a pull rate of 5 cm/min										

TABLE 4 - UNIFORM PACIFIC COAST SPECIFICATIONS FOR MEDIUM CURING (MC) LIQUID ASPHALTS

Test	AASHTO Test Method	ASTM Test Method	GRADES							
			MC-70		MC-250		MC-800		MC-3000	
			Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Kinematic Viscosity at 140°F cSt	T201	D2170	70	140	250	500	800	1,600	3,000	6,000
Flash Point (Tag Open Cup), °F	T79	D1310	100	--	150	--	150	--	150	--
Distillation										
Distillate percent of total distillate to 680°F	--	--	--	--	--	--	--	--	--	--
to 437°F	--	--	--	20	--	10	--	--	--	--
to 500°F	T78	D402	20	60	15	55	--	35	--	15
to 600°F	--	--	65	90	60	87	45	80	15	75
Residue from distillation to 680°F, volume percent by difference	--	--	55	--	67	--	75	--	80	--
Test on Reside from Distillation										
Penetration, 77°F, 100g/5 seconds	T49	D5	120	250	120	250	120	250	120	250
Ductility, 77°F, cm*	T51	D113	100	--	100	--	100	--	100	--
Solubility in Trichloroethylene, %	T44	D2042	99.5	--	99.5	--	99.5	--	99.5	--
Water, %	T55	D95	--	0.2	--	0.2	--	0.2	--	0.2
GENERAL REQUIREMENT: The material shall not foam when heated to application temperature recommended by the Asphalt Institute.										
* If penetration of residue is more than 200 and ductility at 77°F is less than 100, material will be accepted if ductility at 60°F is 100+										

TABLE 5 - UNIFORM PACIFIC COAST SPECIFICATIONS FOR SLOW CURING (MC) LIQUID ASPHALTS

Test	AASHTO Test Method	ASTM Test Method	GRADES							
			SC-70		SC-250		SC-800		SC-3000	
			Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Kinematic Viscosity at 140°F cSt	T201	D2170	70	140	250	500	800	1,600	3,000	6,000
Flash Point (Tag Open Cup), °F*	T48	D1310	150	--	175	--	200	--	250	--
Distillation										
Total Distillate to 680°F, % by volume	T78	D402	10	30	4	20	2	12	--	5
Tests on Residue From Distillation										
Kinematic Viscosity of Distillation Residue at 140°F, stokes	T201	D2170	4	70	8	85	20	140	40	350
Ductility at 77°F, 5cm/min., cm	T51	D113	100	--	100	--	100	--	100	--
Solubility in Trichloroethylene, %	T44	D2042	99.5	--	99.5	--	99.5	--	99.5	--
Water, %	T55	D95	--	0.5	--	0.5	--	0.5	--	0.5
* Flash point by Cleveland Open Cup may be used for products having a flash point greater than 175°F										

TABLE 6 - UNIFORM PACIFIC COAST SPECIFICATIONS FOR ANIONIC EMULSIFIED ASPHALTS

Test	AASHTO Test Method	ASTM Test Method	Rapid Setting				Slow Setting			
			RS-1		RS-2		SS-1		SS-1h	
			Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Test on Emulsions										
Viscosity SSF @ 77°F, sec.	T72	D88	20	100	--	--	20	100	20	100
Viscosity SSF @ 122°F, sec.	T72	D88	--	--	75	400	--	--	--	--
Settlement, 5 days, % [1]	T59	D244	--	5	--	5	--	5	--	5
Storage Stability, 1 day, % [2]	T59	D244	--	1	--	1	--	1	--	1
Demulsibility, 35ml .02N, Calcium Chloride. % [3]	T59	D244	60	--	60	--	--	--	--	--
Cement Mixing Test, %	T59	D244	--	--	--	--	--	2.0	--	2.0
Sieve Test, %	D59	D244	--	0.10	--	0.10	--	0.10	--	0.10
Residue by distillation, %	T59	D244	55	--	63	--	57	--	57	--
Test on Residue from Distillation Test [4]										
Penetration @ 77°F, 100g, 5sec.	T49	D5	100	200	100	200	100	200	40	90
Ductility @ 77°F, 5m/min., cm	T51	D113	40	--	40	--	40	--	40	--
Solubility in Trichloroethylene, %	T44	D2042	97.5	--	97.5	--	97.5	--	97.5	--

[1] The test requirement for settlement may be waived when the emulsified asphalt is used in less than 5 days' time, 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 5 days.
[2] The 24-hour 1-day storage stability test may be used instead of the 5-day settlement test.
[3] The demulsibility test shall be made within 30 days from the date of shipment.
[4] A harder base asphalt meeting current paving asphalt specifications may be specified with the provision that the test requirements on the Residue from Distillation be waived.

TABLE 7 - UNIFORM PACIFIC COAST SPECIFICATIONS FOR CATIONIC EMULSIFIED ASPHALTS

Test	Test Method		Rapid Setting				Medium Setting				Slow Setting				Quick Setting [6]			
			CRS-1		CRS-2		CMS-2S		CMS-2		CMS-2H		CSS-1		CSS-1h		CQS-1h	
	AASHTO	ASTM	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Test on Emulsions																		
Viscosity SSF @ 77°F, sec.	T72	D88	--	--	--	--	--	--	--	--	--	--	20	100	20	100	20	100
Viscosity SSF @ 122°F, sec.	T72	D88	20	100	100	400	50	450	50	450	50	450	--	--	--	--	--	--
Settlement, 5 days, % [1]	T59	D244	--	5	--	5	--	5	--	5	--	5	--	5	--	5	--	5
Storage Stability, 1 day [2]	T59	D244	--	1	--	1	--	1	--	1	--	1	--	1	--	1	--	1
Demulsibility, 35 ml 0.8% sodium dioctyl sulfosuccinate, % [3]	T59	D244	40	--	40	--	--	--	--	--	--	--	--	--	--	--	--	--
Coating Ability/Water Resistance:	T59	D244	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Coating, dry aggregate			--	--	--	--	Good	--	Good	--	Good	--	--	--	--	--	--	--

Coating, after spraying			--	--	--	--	Fair	--	Fair	--	Fair	--	--	--	--	--	--	--
Coating, wet aggregate			--	--	--	--	Fair	--	Fair	--	Fair	--	--	--	--	--	--	--
Coating, after spraying			--	--	--	--	Fair	--	Fair	--	Fair	--	--	--	--	--	--	--
Particle Charge Test	T59	D244	Positive		Positive		Positive		Positive		Positive		Positive [5]		Positive [5]		Positive	
Sieve Test, %	T59	D244	--	0.10	--	0.10	--	0.10	--	0.10	--	0.10	--	0.10	--	0.10	--	0.10
Cement Mixing Test, %	T59	D244	--	--	--	--	--	--	--	--	--	--	--	2.0	--	2.0	--	--
Distillation																		
Oil Distillate by volume of emulsion, %	T59	D244	--	3	--	3	--	20	--	12	--	12	--	--	--	--	--	--
Residue, %	T59	D244	60	--	65	--	60	--	65	--	65	--	57	--	57	--	60	--
Tests on Residue from Distillate Test [4]																		
Penetration, 77°F, 100g, 5sec.	T49	D5	100	250	100	250	100	250	100	250	40	90	100	250	40	90	45	60
Ductility, 77°F, 5cm/min., cm	T51	D113	40	--	40	--	40	--	40	--	40	--	40	--	40	--	40	--
Solubility in Trichloroethylene, %	T44	D2042	97.5	--	97.5	--	97.5	--	97.5	--	97.5	--	97.5	--	97.5	--	97.5	--

[1] The test requirement for settlement may be waived when the emulsified asphalt is used in less than 5 days' time, 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 5 days.
[2] The 24-hour 1-day storage stability test may be used instead of the 5-day settlement test.
[3] The demulsibility test shall be made within 30 days from the date of shipment.
[4] A harder base asphalt meeting current paving asphalt specifications may be specified with the provision that the test requirements on the Residue from Distillation be waived.
[5] Must meet a PH requirement of 6.7 maximum (ASTM E70) if the Particle Charge Test result is inconclusive.
[6] Does not apply to polymer modified emulsion.

TABLE 8 SPECIFICATION FOR SLURRY SEAL MIX

TEST ON MIXTURE	TEST METHOD	REQUIREMENTS
Residual Asphalt, % of dry wt. of aggregate	--	7.5 - 13.5
Consistency, flow	ASTM D3910/ISSA T106	2 - 3 cm
Wet Cohesion, 30-minute set	ISSA T139	12 -13 kg/cm
Wet Cohesion, 60-minute set	ISSA T139	20 - 21 kg/cm
Set Time, 30 minutes	ASTM D3910	Negative
Excess Asphalt by LWT and Sand Adhesion	ASTM T109	50 g/ft² max.
Wet Stripping, % coating	ASTM T114	90 min.
Wet track Abrasion (6-day soak)	ASTM D3910/ISSA T100	75 g/ft² max.
Wet track Abrasion (1-hour soak)	ASTM D3910/ISSA T100	75 g/ft² max.
System Compatibility	ISSA T115	Pass
Mix time @ 77°F	ASTM D3910/ISSA T113	Controllable to 180 sec. minimum

TABLE 9 SPECIFICATION FOR MICRO-SURFACING MIX

TEST ON MIXTURE	TEST METHOD	REQUIREMENTS
Residual Asphalt, % of dry wt. of aggregate	--	5.5 - 9.5
Wet Cohesion, 30-minute set	ISSA T139	12 kg/cm

TABLE 9 SPECIFICATION FOR MICRO-SURFACING MIX

TEST ON MIXTURE	TEST METHOD	REQUIREMENTS
Wet Cohesion, 60-minute set	ISSA T139	20 kg/cm
Excess Asphalt by LWT and Sand Adhesion	ISSA T109	50 g/ft² max.
Wet Stripping, % coating	ISSA T114	90 min.
Wet track Abrasion (6-day soak)	ASTM D3910/ISSA T100	75 g/ft² max.
Wet track Abrasion (1-hour soak)	ASTM D3910/ISSA T100	50 g/ft² max.
Mix time @ 77°F	ASTM D3910/ISSA T113	Controllable to 120 sec minimum
Mix time @ 104°F	ASTM D3910/ISSA T113	Controllable to 120 sec minimum
Lateral Displacement	ISSA T147	5% max.
Classification Compatibility	ISSA T144	(AAA, BAA) 11 grade points minimum

Table 10 - SPECIFICATION FOR POLYMER MODIFIED EMULSION MEMBRANE

TEST ON EMULSION	Method	Min.	Max.
Viscosity @ 77°F, SSF	ASTM D88	20	100
Sieve Test, %	AASHTO T59	--	0.05
24-Hour Storage Stability, % [1]	AASHTO T59	--	1
Residue from Distillation @ 400°F, %	AASHTO T59	63	--
Oil portion from distillation ml of oil per 100 g emulsion [2]	AASHTO T59	63	--
TEST ON RESIDUE FROM DISTILLATION			
Solubility in TCE, % [3]	AASHTO T44	97.5	--
Elastic Recovery @ 50°F, % [4]	AASHTO T301	58	--
Penetration @ 77°F, 100 g, 5 sec, dmm	AASHTO T49	60	150

[1] After standing undisturbed for 24 hours, the surface shall show no white, milky colored substance, but shall be a smooth homogeneous color throughout.

[2] ASTM D244 with modifications to include a 400°F ± 10°F maximum temperature to be held for a period of 15 minutes. Alternatively, ASTM D244 (Sections 21-27) Residue by Evaporation may be utilized as a surrogate procedure. However, Residue by Distillation is preferred and shall be used as the reference procedure.

[3] ASTM D5546, "Standard Test Method for Solubility of Asphalt Binders in Toluene by Centrifuge," may be substituted where polymers block the filter in Method D2042.

[4] ASTM D5976, "Standard Specification for Type I Polymer Modified Asphalt Cement for Use in Pavement Construction," Section 6.2 with exception that the elongation is 20 cm and the test temperature is 50°F.

SECTION 704

BASE AGGREGATES

SCOPE

704.01.01 MATERIALS COVERED

A. This specification covers the quality and size of mineral materials used in base courses, trench backfill, or other construction locations.

B. The term Source shall mean any of the following:

1. A permanent commercial location.
2. Contractor manufactured material either commercial or on-site.

704.01.02 REFERENCE CODES AND STANDARDS:

A. Related Interagency Quality Assurance Committee (IQAC) procedures at:

www.accessclarkcounty.com/depts/public_works/Pages/iqac.aspx (IQAC website)

REQUIREMENTS

704.02.01 GENERAL

A. The mineral aggregate shall be the crushed and screened product from approved aggregate deposits, except that Type I aggregate base need not be crushed. The Engineer reserves the right to prohibit the use of aggregates from any source when:

1. 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.
2. The character of the material is such, in the opinion of the Engineer, that undue additional costs may be accrued by the Contracting Agency.

B. The mineral aggregate shall be clean, hard, durable, free from any frozen lumps, deleterious matter, and harmful adherent coatings. Crushed Portland cement concrete and asphaltic concrete pavement will be permitted, subject to the requirements of these specifications. No materials subject to regulation as hazardous wastes as defined in the Nevada Administrative Code 444.8565 shall be allowed.

704.02.02 IQAC SOURCE QUALIFICATION

A. For expediting of material source and type approvals, a listing of qualified materials has been provided on the IQAC website.

B. Any listed material is considered qualified for use without a material testing submittal. However, this does not relieve the Contractor of project testing of the material as required in these specifications.

C. The IQAC posted materials indicated in Table 1 are subject to reapproval ""annually for continued posting on the IQAC website. The procedure is annotated in Subsection 704.04.02, "IQAC Annual Material Prequalification."

Table 1 – IQAC Materials that Require Annual Qualification

Type II Aggregate Base
Type II Controlled Low Strength Material (CLSM)

Table 2 – Materials that Require 6-Month Qualification

Type II blended with recycled Portland Cement Concrete

704.02.03 DEFICIENCIES

A. 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.

PHYSICAL PROPERTIES AND TESTS

704.03.01 PLASTIC LIMITS

A. When specified, aggregates shall conform to the applicable requirements of the following table:

Table 3 – Plastic Limits

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

704.03.02 DRAIN BACKFILL

A. This aggregate shall conform to the following requirements:

Table 4 – Drain Rock Gradation Acceptance Limits

Sieve Sizes	Percentage by Dry Weight Passing Sieve		
	3-Inch Size	2-Inch Size	3/4-Inch Size
3-Inch	100	--	--
2-Inch	90-100	100	--
1-1/2-Inch	70-100	95-100	--
3/4-Inch	0-50	50-100	100
1/2-Inch	--	--	95-100
3/8-Inch	0-10	0-55	70-100
No. 4	--	0-25	0-70
No. 8	0-5	0-15	--
No. 200	0-3	0-3	0-3

B. Unless otherwise specified in the contract documents, the Contractor may use any of the sizes.

Table 5 – Drain Backfill Durability Acceptance Limits

Source Requirement Test	3-Inch Size	2-Inch Size	3/4-Inch Size
Percentage of Wear (500 Rev.)	45% Maximum	45% Maximum	45% Maximum

704.03.03 TYPE I AGGREGATE BASE

A. This aggregate shall conform to the following requirements:

Table 6 – Type I Gradation Acceptance Limits

Sieve Sizes	Percentage by Dry Weight Passing Sieve	
	3-Inch Size	2-Inch Size
3-Inch	100	--
2-Inch	90-100	100
1-1/2-Inch	--	95-100
1-Inch	--	70-90
No. 4	30-65	30-65
No. 16	15-40	15-40
No. 200	2-12	2-12

Table 7 – Type I Acceptance Limits

Project Control Test	Test Method	Requirements
Sieve Analysis	AASHTO T27	Table 6
Sampling Aggregate from Calibrated Conveyor stream or belt cut[1]	AASHTO T2	--
Plasticity Index	AASHTO T90[2]	Table 3
Liquid Limit	AASHTO T89	35 Maximum
Resistance (R Value)	ASTM D2844	60 Minimum
Percentage of Wear (500 Rev.)	AASHTO T96	45% Maximum

704.03.04 TYPE II AGGREGATE BASE

A. This aggregate shall conform to the following requirements:

Table 8 – Type II Gradation Acceptance Limits

Sieve Sizes	Percentage by Dry Weight Passing Sieve
1-Inch	100
3/4-Inch	90-100
No. 4	35-65
No. 16	15-40
No. 200	2-10

[1] Sampling from a stockpile permitted only after approval of the Engineer; the conveyor device shall be calibrated every 3 months and record attached to sample document.

[2] Test specimens shall be prepared following the dry preparation procedure AASHTO T87.

Table 9 – Type II Acceptance Limits

Quality Control Test	Test Method	Requirements
Sieve Analysis	AASHTO T27	Table 8
Sampling Aggregate from Calibrated Conveyor stream or belt cut[3]	AASHTO T2	--
Fractured Faces	Nev. T230	70% Minimum
Plasticity Index	AASHTO T90[4]	Table 3
Liquid Limit	AASHTO T89	35 Maximum
Resistance (R Value) or Resilient Modulus	ASTM D2844	78 Minimum for road base
	AASHTO T307	35,000 psi minimum for road base
Percentage of Wear (500 Rev.)	AASHTO T96	45% Maximum
Total Available Water Soluble Sulfates[5]	AWWA 3500-NaD AWWA 4550 E	Less than 0.3% by dry weight of soil.

B. Type II Plantmix Aggregate as specified in Subsection 705.03.01, "Plantmix and Roadmix Bituminous Base and Surface Aggregate, Types Two Fine and Coarse and Three," may be used in lieu of Type II Base Aggregate as specified above.

704.03.05 TYPE III AGGREGATE

A. The soluble sulfate content shall not exceed 0.3 percent by dry weight of soil. The mineral shall be clean, hard, durable, free from any frozen lumps, deleterious matter, and harmful coatings. In addition thereto, the material shall conform to the gradation requirements of Type II aggregate base in accordance with Subsection 704.03.04, "Type II Aggregate Base," with the following property testing:

Table 10 – Type III Acceptance Limits

Quality Control Test	Test Method	Requirements
Sieve Analysis	AASHTO T27	Table 8
Sampling Aggregate from Calibrated Conveyor stream of belt cut[6]	AASHTO T2	--
Plasticity Index	AASHTO T 90[7]	Table 3
Liquid Limit	AASHTO T 89	35 Maximum
No. 200 Sieve	AASHTO T 27	2-15%
Total Available Water Soluble Sulfates[8]	AWWA 3500-NaD AWWA 4550 E	Less than 0.3% by dry weight of soil

704.03.06 CRUSHED ROCK

A. Crushed rock shall be the product from approved aggregate deposits and shall only be used as directed by the Contracting Agency. The mineral aggregate shall be clean, hard,

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[3] Sampling from a stockpile permitted only after approval of the Engineer; the conveyor device shall be calibrated every 3 months and record attached to sample document.
[4] Test specimens shall be prepared following the dry preparation procedure AASHTO T87.
[5] Required only for placement around waterline pipe.
[6] Sampling from a stockpile permitted only after approval of the Engineer.
[7] Test specimens shall be prepared following the dry preparation procedure AASHTO T87.
[8] Required only for placement around waterline pipe.

durable, free from any frozen lumps, deleterious matter, and harmful coatings. In addition thereto, the material shall conform to the following gradation requirements:

Table 11 – Crushed Rock Gradation Acceptance Limits

Sieve Sizes	Percentage of Weight Passing
3/8-Inch	100
No. 4	20-80
No. 200	0-15

Table 12 – Crushed Rock Acceptance Limits

Quality Control Test	Test Method	Requirements
Sieve Analysis	AASHTO T 27	Table 11
Sampling Aggregate From Calibrated Conveyor stream of belt cut[9]	AASHTO T 2	----------
Fractured Faces	Nev. T 230	90% Minimum
Plasticity Index	AASHTO T 90[10]	Table 3
Liquid Limit	AASHTO T 89	35 Maximum
Percentage of Wear (500 Rev.)	AASHTO T 96	45% Maximum
Total Available Water Soluble Sulfates[11]	AWWA 3500-NaD AWWA 4550 E	Less than 0.3% by dry weight of soil

704.03.07 CONTROLLED LOW STRENGTH MATERIAL (CLSM)

A. CLSM shall consist of a low-strength, self-leveling concrete material composed of various combinations of cement, fly ash, aggregate, water, and chemical admixtures. CLSM shall have a design compressive strength at an age of 28 days within the ranges required below for the specified class:

1. Class I - (50 to 150 psi): Specified where the maximum strength is of primary concern due to the desire to have material that can be excavated in the future with relative ease.

2. Class II – (100 to 300 psi): Specified where the minimum strength is of primary concern for pipe support.

3. Class Special (as shown in project specifications or drawings): Specified where project unique criteria, such as erosion control, are the primary concern.

4. Class I and II CLSM:

   a. The mix shall result in a product having a slump in the range of 6 to 10 inches at the time of placement.

   b. The Source of Contractor shall submit a mix design for approval by the Engineer prior to placement.

   c. The mix design shall be supported by laboratory test data verifying the potential of the mix to comply with the requirements for these specifications.

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[9] Sampling from a stockpile permitted only after approval of the Engineer; the conveyor device shall be calibrated every 3 months and record attached to sample document.

[10] Test specimens shall be prepared following the dry preparation procedure AASHTO T87.

[11] Required only for placement around waterline pipe.

B. CLSM shall be proportioned in general compliance with the methods outlined in ACI 211.1-91, reapproved 1997, "Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete." The following materials shall be used:

1. Cement shall meet the requirements of Section 701, "Hydraulic Cement." Type V cement shall be used unless otherwise specified.

2. Fly ash shall meet the requirements of Section 729, "Fly Ash." Fly ash not meeting the requirements of Section 729, "Fly Ash," may be used if prior testing indicates to the satisfaction of the Engineer the ability of the CLSM with this fly ash to meet these specifications.

3. Water shall meet the requirements of Section 722, "Water."

4. Aggregates shall have 100 percent by total weight of the aggregate passing the 1 inch screen and 15 percent or less passing the No. 200 sieve. The aggregate shall meet the plastic limits requirements of Subsection 704.03.01, "Plastic Limits."

5. Chemical admixtures shall meet the requirements of Subsection 702.03.02, "Air-Entraining Admixtures," and Subsection 702.03.03, "Admixtures Other Than Air-Entraining."

   a. Other admixtures specifically approved for CLSM may be used.

   b. All materials proportions shall be measured and the CLSM mixed in accordance with Section 501, "Portland Cement Concrete."

   c. Other proportion measuring and CLSM mixing systems are acceptable, if control can be demonstrated to be satisfactory to the Engineer.

   d. These other methods include continuous feed, volumetric measurement of proportions, and pug mill and continuous mixing plants.

C. If the CLSM mix does not produce a flowable consistency or exhibits excessive bleeding, the mix shall be adjusted.

1. Excessive bleeding is considered to occur when water flows from the CLSM in a manner that causes disturbance or displacement of the exposed surface of the CLSM.

2. Mix adjustments shall include, but not be limited to: aggregate gradation, cementitious material content, admixtures, water content, or a combination of adjustments.

D. The testing procedures for approval of CLSM mix designs by the IQAC or if required in the contract special provisions shall be as follows:

1. The material Source, which may be the Contractor, shall cast one set of six each 4-inch diameter by 8-inch high specimens in split cylinders.

2. No rodding method shall be used for the placement of the CLSM into the cylinders.

3. All field curing and environmental protection shall conform to AASHTO T23, "Test Methods for Making and Curing Concrete Test Specimens in the Field."

4. The cast specimens shall then be laboratory-cured in a 100 percent humidity, temperature-controlled concrete cure room (cure tanks shall not be used).

5. Compressive strength testing shall be performed in accordance with AASHTO T22 and T23 with samples from each set at the ages of 7, 28, and 90 days.

6. A report of the results shall be submitted to the Engineer.

E. Class Special: The compressive strength testing procedures shall be as specified in the project specifications or on the project drawings.

F. **Bonded Aggregate Fill (BAF):**

1. This material is a crushed rock-cement slurry consistency.
2. BAF may be used only with the prior approval of the Engineer.
3. The material Source shall have it designed under the responsible charge of a Nevada PE, and the mix shall consist of a gap-graded 1/2-inch maximum nominal size crushed gravel with a 1-sack minimum Type V cement and water slurry.
4. The material shall be plant mixed and placed from a truck.
5. Due to the gap-graded nature of the material, it shall not be used where water drainage is an issue and in all cases shall use dams as specified in Subsection 208.03.16, "Drain Backfill."
6. This procedure does not require concrete cylinder break testing; however, it does require a visual inspection and shall be documented in a report to the Engineer summarizing the inspection to be performed as follows:
   a. After the first batch is placed and initially cured, excavate to the bottom of the pipe or structure.
   b. If a self-supporting vertical face is maintained, the material is functioning properly.

704.03.08 AGGREGATE FOR PORTLAND CEMENT TREATED BASE

A. This aggregate shall conform to the following requirements:

Table 13 – Portland Cement Treated Base Gradation Acceptance Limits

Sieve Sizes	Percentage by Dry Weight Passing Sieve
3-Inch	100
2-Inch	90-100
No. 4	35-75
No. 200	20

Table 14 – Portland Cement Treated Base Acceptance Limits

Test	Test Method	Requirements
Sieve Analysis	AASHTO T27	Table 13
Sampling Aggregate from Calibrated Conveyor stream or belt cut[12]	AASHTO T2	1/1000 Tons per day or portion thereof
Percentage of Wear (500 Rev.)	AASHTO T96	45% Maximum

B. 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 or cement.

[12] Sampling from a stockpile permitted only after approval of the Engineer. The conveyor device shall be calibrated every 3 months and record attached to sample document.

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.

704.03.09 SHOULDERING MATERIAL

A. This aggregate shall conform to the following requirements:

Table 15 – Shouldering Material Acceptance Limits

Sieve Sizes	Percentage by Dry Weight Passing Sieve
1-Inch	100
3/4-Inch	90-100
No. 4	35-65
No. 16	15-40
No. 200	2-6

SOURCE QUALITY CONTROL TESTING

704.04.01 GENERAL

A. There are 2 testing aspects to Source material acceptance.

1. Testing by the Source for annual posting on the IQAC website of qualified materials.
2. Contractor project quality control Source testing for non-qualified materials.

B. The acceptance of the Source material shall be at the production plant while the acceptance of the Contractor-placed material is at the project site.

C. Any laboratory submitting to an agency shall be R-18 AASHTO accredited in the appropriate test method in accordance with Table 16, "Source Quality Control Testing Requirements," where applicable and testing reviewed and stamped by a Nevada professional engineer who has responsible charge of the work. The use of a professional engineer by the Source could be the Source staff engineer or third party, but the professional engineer must have responsible charge of the testing and/or inspection.

704.04.02 IQAC ANNUAL MATERIAL PREQUALIFICATION

A. Each individual location or "pit" shall be referred to as a "Source." The responsibility for testing and inspection is the material Source. Material shall be tested, inspected, and certified in accordance with Table 16 "Source Quality Control Testing Requirements." The Source shall submit to the IQAC agency engineer assigned for that Source. The reviewing agency is listed on the IQAC website page next to the Source material.

B. Test data shall be included with the certifying document.

C. The maximum qualification period is 1 year, or 6 months for aggregate blended with crushed concrete. The entire qualification process shall be completed, in accordance with the sections above, prior to the first day of April, or for aggregates blended with crushed concrete, the first day of April and the first day of October of each year. This includes, but is not limited to, submittal, agency review, all required retesting, and qualification from the IQAC member.

704.04.03 NON-PREQUALIFIED MATERIALS

A. If the material is not posted on the IQAC web page, the Source may elect to submit non-prequalified material to the Engineer for approval prior to use that complies with the above noted specification and shall have been tested within 60 days of the intended use.

704.04.04 SUBMITTAL

A. All tests specified in this section shall be performed.

1. The report(s) shall include any graphical representation of plotted data such as the R-value or the Proctor value(s) along with the pit name and location.

2. The most current ASTM, AASHTO, NDOT, and AWWA methods shall be used when performing the tests.

B. All samples shall be "cut" from the "belt." When circumstances do not allow for sampling during production, the Source shall coordinate with the Engineer to identify an alternative plan for sampling.

C. <u>IQAC Annual Submittal</u>

1. For the purposes of IQAC submittal, the Engineer is the IQAC reviewing agency as noted on the IQAC web page.

2. For the annual submittal by the supplier, the material to be approved for use as aggregate shall be obtained and "split" by an AASHTO accredited laboratory with the Engineer present at the time the sample is obtained with the sample large enough for a full suite of testing for the Source and Engineer.

3. The Engineer shall be notified a minimum of 48 hours prior to obtaining the sample.

4. If the Engineer is not present during the sampling of the material, the results for that sample will not be accepted.

5. Sampling shall be performed during normal working hours for the Engineer.

6. If the Source laboratory results are in compliance with the above noted specifications, Source shall submit the test report to the Engineer within 21 days of sampling requesting the review and approval of the materials for the proposed use of the material.

7. Notification by the Source of samples not in compliance with the above noted specifications is requested but not required. Samples without notification or a qualification submittal within the 21-day period will be assumed by the IQAC to be outside the above noted specifications.

8. The agency Engineer for a particular pit may accommodate minor adjustments for "tuning" of an operation. This courtesy shall not be extended during the qualification process.

D. <u>Non-prequalified materials (materials not posted on the IQAC list)</u>

1. The material to be approved for use as aggregate shall be obtained and "split" by an AASHTO accredited laboratory with the Engineer present at the time the sample is obtained with the sample large enough for a full suite of testing for the Source and Engineer.

a. The Engineer shall be notified a minimum of 48 hours prior to obtaining the sample.

b. If the Engineer is not present during the sampling of the material, the results for that sample will not be accepted.

c. Sampling shall be performed during normal working hours for the Engineer.

d. If the Source laboratory results are in compliance with the above noted specifications, the Source shall submit the test report to the Engineer within 21 days of sampling with a letter requesting the review and approval of the materials report for the proposed use of the material.

2. Notification by the Source of samples not in compliance with the above noted specifications is requested but not required.

a. Samples without notification or a qualification submittal within the 21-day period will be assumed by the IQAC to be outside the above noted specifications.

b. The Source shall submit the material test report to the Engineer no earlier than 60 days and no later than 14 days prior to use.

3. The qualification is for one project only.

704.04.05 REPORT FORMAT

A. The report shall be prepared and stamped by, or under the direction of, a professional engineer registered in the state of Nevada. The report shall be on the standard IQAC[13] form and shall include the pit name and location. The report shall include the following:

1. Recommendation by the Source Professional Engineer.

2. The testing results in accordance with the appropriate Table 16, "Source Quality Control Testing Requirements," test methods and reporting requirements, along with any graphs and charts.

B. When "no exceptions" are taken, a conditional posting on the web site will be provided by the IQAC within 10 days of the receipt of the submittal.

C. Discrepancies between test results will be reviewed on a case-by-case basis. The Engineer will notify the aggregate producer of substantial test variations within 10 days of receipt of the qualification submittal.

704.04.06 SAMPLING AND TESTING

A. When the Contractor/Material Source or Engineer acquires aggregate samples at an aggregate production plant, the plant shall provide a calibrated mechanical means for obtaining samples.

1. If a mechanical means is not provided, a belt cut from a stopped conveyor will be required.

2. Any mechanical sampling device shall be approved by the Engineer prior to starting the respective phase of the project, or shall have been approved as part of a prior plant inspection by the Engineer or the Engineer’s representative.

3. The sampling device shall be so constructed to provide for simultaneous "cutting" of the entire section of material being discharged or conveyed, and so constructed that small representative samples may be taken frequently and these samples combined to form the complete sample.

4. The reference method for the mechanical procedure shall be a "belt cut" sample taken from a stopped conveyor belt.

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[13] The form is on the IQAC website, or use an Agency approved form

5. 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.

B. Test results run from samples taken will be furnished to the Engineer by the Contractor or the Contractor's representative. The results of such tests shall not be the basis for final acceptance of the material.

C. Sampling for final acceptance of materials will be as required in the appropriate USS sections and in general shall comply with the AASHTO requirements, where applicable, and with any exception to the method(s) listed on the IQAC website.

Table 16 – Source Quality Control Testing Requirements[14]

Spec Section	Description	Item	Reference Specification and/or Test Procedure	Frequency
704.03.02, 704.03.03, 704.03.04, 704.03.08	Drain Rock	Submittal	IQAC and/or Agency Requirements	Annually for IQAC Source Approval OR per project
	Type I, Type II Aggregate	Sampling from calibrated conveyor stream or belt cut	AASHTO T2	1/day at plant
	Cement treated base	Sieve Analysis	AASHTO T11 & T27	1/day at plant
		Percentage of Wear (500 Rev.)	AASHTO T96	Annually for Source Approval OR per project
704.03.04, 704.03.05, 704.03.06	Drain rock, Type II, and Type III aggregate around water pipe	Total Available Water Soluble Sulfates[15]	AWWA 3500-NaD AWWA 4550 E	1/month at plant
704.03.03, 704.03.04	Type I and Type II Aggregate	Plasticity Index	AASHTO T90[16]	1/day at plant
		Liquid Limit	AASHTO T89	1/day at plant
		Resistance (R Value) or Resilient Modulus	ASTM D2844	Annually for IQAC Source Qualification OR per project
			AASHTO T307	Annually for IQAC Source Qualification OR per project
704.03.07	CLSM	Mix Design	USS 704.03.07	Annually for IQAC Source Qualification OR per project
		Compressive Strength	USS 208.02.07 & AASHTO T22, T23	Annually for IQAC Source Qualification OR per project
	CLSM-BAF	Visual Inspection Report	USS 208.02.07 Split cylinders	Annually for IQAC Source Qualification OR per project

[14] Review the IQAC website for any exceptions to the listed test methods.
[15] Required only for placement around waterline pipe
[16] Test specimens shall be prepared following the dry preparation procedure AASHTO T87

SECTION 705

AGGREGATES FOR BITUMINOUS COURSES

SCOPE

705.01.01 MATERIALS COVERED

A. 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

A. The mineral aggregate shall be the crushed and screened product of approved deposits.

B. The Engineer reserves the right to prohibit the use of aggregates from any source when:

1. The character of the material is such, in the opinion of the Engineer, as to make improbable the furnishing of aggregates conforming to these specifications; or
2. The character of the material is such, in the opinion of the Engineer, that undue additional costs may be accrued by the Contracting Agency; or
3. The maximum allowable water absorption of either coarse or fine aggregate exceeds 2.5 percent when tested in accordance with ASTM C127 (coarse aggregate) and ASTM C128 (fine aggregate).

C. The mineral aggregate shall be clean, hard, durable, and free from frozen lumps, deleterious matter, and harmful adherent coatings.

D. When producing plantmix aggregate, all natural fines passing the No. 4 sieve shall be screened from the coarse aggregate and may be reintroduced into the mix at a rate not to exceed 20 percent by dry weight of the combined aggregates.

E. The natural fines may be used only when all applicable mix design criteria have been met.

705.02.02 DEFICIENCIES

A. If the product of any deposit is deficient in the fraction passing the No. 50 sieve, additional filler from other approved deposits meeting the physical requirements may be added.

B. The added material shall be fed to the drier in a uniform manner from a separate stockpile.

C. If the added material is a commercial mineral filler, it shall be uniformly fed directly to the plant. This shall not 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 TWO FINE AND COARSE AND THREE

A. The aggregate shall conform to this subsection.

B. Test specimens shall be prepared following dry preparation procedure described in ASTM D4318, Section 10.2 through Section 10.2.5.

TABLE 1 – PLANTMIX AND ROADMIX AGGREGATE GRADATION

Sieve Sizes	Percent By Weight Passing Sieve		
	Type 2 Coarse Arterials	Type 2 Fine Residential/Collector	Type 3
1-Inch	100	100	--
3/4-Inch	84-97	90-100	--
1/2-Inch	66-82	78-94	100
3/8-Inch	56-72	68-84	90-100
No. 4	35-50	50-65	55-85
No. 8	23-38	30-49	32-67
No. 50	5-19	7-25	7-27
No. 200	2-7	2-9	2-10

TABLE 2 – PLANTMIX AND ROADMIX AGGREGATE SPECIFICATIONS

Project Tests	Test Methods	Requirements
Sieve Analysis	AASHTO T27	Above
Sampling Aggregate	ASTM D75	--
Fractured Faces	NEV. T230	Traffic Category I: 90% Minimum (2 fractures minimum) 95% Minimum (1 fracture minimum)
		Traffic Category II: 35% Minimum (2 Fractures minimum)
Plasticity Index	ASTM D4318	All Traffic Categories: 6 Maximum
Liquid Limit	ASTM D4318	All Traffic Categories: 35 Maximum
Methylene Blue Test	AASHTO TP57	10 Maximum
Fine Aggregate Angularity	AASHTO T33	Traffic Category I: 45%

Source Tests	Test Methods	Requirements
Stripping Test	ASTM D1664	Satisfactory
Percentage of Wear (500 Rev.)	ASTM C131	All Traffic Categories: 35% Maximum
Elongation @ 5:1	ASTM D4791	Traffic Category I: 10% Maximum
Soundness Test	ASTM C88	All Traffic Categories: 8% Maximum
Deleterious Materials	ASTM C142	All Traffic Categories: 0.3% Maximum

705.03.02 BLANK

705.03.03 PLANTMIX BITUMINOUS OPEN-GRADED SURFACE AGGREGATE

A. The aggregate shall conform to the following requirements:

TABLE 3 – OPEN GRADE AGGREGATE GRADATION

Sieve Sizes	Percentage By Weight Passing Sieve
1/2-Inch	100
3/8-Inch	90-100
No. 4	35-55
No. 8	5-15
No. 200	0-3

TABLE 4 – OPEN GRADE AGGREGATE SPECIFICATIONS

Project Tests	Test Methods	Requirements
Sieve Analysis	AASHTO T27	Above
Sampling Aggregate	ASTM D75	--
Fractured Faces	NEV. T230	90% Minimum (2 fractures minimum)

Source Tests	Test Methods	Requirements
Percentage of Wear (500 Rev.).	ASTM C131	37% Maximum

705.03.04 COMMERCIAL MINERAL FILLER

A. Commercial mineral filler shall conform to ASTM C977 for quicklime, ASTM C1097 for hydrated lime, and ASTM D3910 and ASTM D242 for slurry seal and microsurfacing.

B. Sampling of the mineral aggregate and mineral filler shall conform to AASHTO T2/ASTM D75 methods.

1. All aggregate shall be from the same source.
2. No field blending will be allowed.

C. When tested according to the following tests, the mineral aggregate shall meet the following requirements:

TABLE 5 - MINERAL FILLER AGGREGATE GRADATION

Property	Test Method	Specification
Sand Equivalent	AASHTO T176/ ASTM D2419	50 Minimum for Slurry and 65 Minimum for Microsurfacing
Plasticity Index	ASTM D4318	NP
Soundness, %	AASHTO T104/ ASTM C88	15 Maximum (using NA_2SO_4)
Abrasion Resistance, %	AASHTO T96/ ASTM C131	30 Maximum. Abrasion test shall be run on the aggregate before it is crushed.

D. When tested in accordance with AASHTO T27, AASHTO T11, ASTM C136, and ASTM C117, the mineral aggregate with mineral filler shall conform to the gradations indicated below. Percentage passing shall not vary from the high limit to the low limit on any 2 consecutive sieves.

705.03.05 SCREENINGS

A. The screenings shall conform to the following requirements:

TABLE 6 – SCREENINGS GRADATION

Sieve Sizes	Percentage By Weight Passing Sieve	
	1/2-Inch	3/8-Inch
1/2-Inch	100	--
3/8-Inch	90-100	100
No. 4	15-35	20-45
No. 16	0-4	0-6
No. 200	0-2	0-2

TABLE 7 SCREENINGS SPECIFICATIONS

Project Tests	Test Methods	Requirements
Sieve Analysis	AASHTO T27	Above
Sampling Aggregate	ASTM D75	--
Fractured Faces	NEV. T230	90% Minimum (2 fractures minimum)

Source Tests	Test Methods	Requirements
Percentage of Wear (500 Rev.)	ASTM C131	37% Maximum

705.03.06 SAND BLOTTER

A. The sand shall conform to the following requirements:

TABLE 8 – SAND BLOTTER GRADATION

Sieve Sizes	Percentage By Weight Passing Sieve
1/2-Inch	100
No. 4	90-100
No. 16	30-75
No. 200	0-12

TABLE 9 – SAND BLOTTER SPECIFICATIONS

Project Tests	Test Methods	Requirements
Sieve Analysis	AASHTO T27	Above
Sampling Aggregate	ASTM D75	--
Organic Impurities	ASTM C40	--

TABLE 10 - ISSA, TYPE I GRADATION

Sieve Size	Mix Design Range (Percentage By Weight Passing Each Sieve)	Stockpile Tolerance
3/8-Inch	100	0
No. 4	100	0
No. 8	90-100	±5%
No. 16	65–90	±3%
No. 30	40-65	±3%
No. 50	25-42	±3%
No. 100	15-30	±2%
No. 200	10-20	±2%

TABLE 11 - ISSA, TYPE II GRADATION

Sieve Size	Mix Design Range (Percentage By Weight Passing Each Sieve)	Stockpile Tolerance
3/8-Inch	100	0
No. 4	90-100	±5%
No. 8	65-90	±5%

TABLE 11 - ISSA, TYPE II GRADATION

Sieve Size	Mix Design Range (Percentage By Weight Passing Each Sieve)	Stockpile Tolerance
No. 16	45-70	±3%
No. 30	30-50	±3%
No. 50	18-30	±3%
No. 100	10-21	±2%
No. 200	5-15	±2%

TABLE 12 - ISSA, TYPE III GRADATION

Sieve Size	Mix Design Range (Percentage By Weight Passing Each Sieve)	Stockpile Tolerance
3/8-Inch	100	0
No. 4	70-90	±5%
No. 8	45-70	±5%
No. 16	28-50	±3%
No. 30	19-34	±3%
No. 50	12-25	±3%
No. 100	7-18	±2%
No. 200	7-15	±2%

705.03.07 SET CONTROL ADDITIVES

A. The type and quantity of additives in slurry seal and microsurfacing mix shall be determined by the material mix design and conform to the applicable sections of ASTM D3910 and ISSA T102.

705.03.08 PLANTMIX AND ROADMIX ASPHALT CONCRETE SURFACE COURSE UTACS TYPE S1 THROUGH S3

A. The Ultrathin Asphalt Concrete Surface (UTACS) shall use one of the gradation types listed below as required by the Engineer.

Table 13 - Ultrathin Asphalt Concrete Surface (UTACS) Gradations

Sieve Size	Type S1	Type S2	Type S3	Tolerance
3/4-Inch[1]	--	--	100	--
1/2-Inch	--	100	85-100	±6
3/8-Inch	100	85-100	60-80	±6
No. 4	40-55	22-40	22–38	±4
No. 8	19-32	19-32	19-32	±4
No. 16	15-25	15-23	15-23	±3
No. 30	10-18	10-18	10-18	±3
No. 50	8-13	8-13	8-13	±3
No. 100	6-10	6-10	6-10	±3
No. 200	4-7	4-7	4-7	±2

B. Coarse aggregate testing shall comply with Table 2. Coarse aggregate is defined as aggregate that is retained on and above the No. 4 sieve.

Table 14 UTACS Coarse Aggregate Specifications

Tests	Method	Limit
Los Angeles abrasion value, % loss	AASHTO T96	35 Maximum
Soundness, % loss	AASHTO T104	18 Maximum
Magnesium Sulfate or Sodium Sulfate	AASHTO T104	12 Maximum
Flat & Elongated Ratio, % @ 3:1	ASTM D4791	25 Maximum
% Crushed, single face	ASTM D5821	95 Minimum
% Crushed, Two or more Mechanically crushed faces	ASTM D5821	85 Minimum
Micro-Deval, % loss	AASHTO TP58	18 Maximum

C. For the Los Angeles abrasion value, the values shown for these tests are targets for aggregate selection purposes. The results of these tests should not be the sole basis for rejection.

D. Fine aggregate testing shall comply with Table 3.

Table 15 - UTACS Fine Aggregate Specifications

Tests	Method	Limit
Sand Equivalent	AASHTO T176	45 minimum
Methylene Blue (on materials passing 200)	AASHTO TP57	10 maximum
Uncompacted Void Content	AASHTO T304	40 minimum

E. Values for sand equivalent shown for these tests are targets for aggregate selection purposes. If the finished bituminous mixture passes the AASHTO T283 requirement in the Mix Design section, the sand equivalent and methylene blue requirements may be waived.

SECTION 706

AGGREGATES FOR PORTLAND CEMENT PRODUCTS

SCOPE

706.01.01 MATERIALS COVERED

A. This specification covers the quality and size of aggregates used in Portland cement products.

REQUIREMENTS

706.02.01 GENERAL

A. 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:

1. 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.
2. The character of the material is such that, in the opinion of the Engineer, undue additional costs may be accrued by the Contracting Agency.

B. For mix design approval, the proposed proportions of coarse, intermediate, and fine aggregate, combined mathematically by volume or mass, shall produce a mixture within the grading limits for combined aggregates as shown in Table 1 (not applicable to lightweight concrete):

Table 1 - Grading Limits of Combined Aggregates

Sieve Size	Percentage Passing				
	1-1/2-inch Max.	1-inch Max	3/4-inch Max.	1/2-inch Max	3/8-inch Max.
2-inch	100	--	--	-	-
1-1/2-inch	87-100	100	--	-	-
1-inch	65-90	97-100	100	-	-
3/4-inch	48-82	70-100	80-100	100	-
1/2-inch	--	--	--	90-100	100
3/8-inch	39-57	43-70	46-70	70-90	70-100
No. 4	30-45	32-48	34-50	45-60	47-70
No. 8	23-38	23-42	24-42	38-56	34-55
No. 16	15-33	15-34	17-34	24-38	23-43
No. 30	8-24	8-25	10-25	13-27	15-33
No. 50	4-13	4-15	5-15	7-17	7-20
No. 100	1-5	2-7	2-7	0-6	2-8
No. 200	0-5	0-5	0-5	0-5	0-5

C. If the Contractor prefers a finer gradation for the purpose of slip-form operations, the following gradation is permitted with approval of the Engineer.

Table 2 - Gradation for Slip-Form Operations

Sieve Size	Percentage Passing	
	1-1/2-inch Max.	3/4-inch Max.
2-inch	100	--
1 1/2-inch	87-100	--
1-inch	65-97	100
3/4-inch	48-91	80-100
1/2-inch	--	--
3/8-inch	39-70	46-74
No. 4	30-54	34-54
No. 8	23-38	24-50
No. 16	15-33	17-38
No. 30	8-24	10-29
No. 50	4-13	5-19
No. 100	1-5	2-9
No. 200	0-5	0-5

D. If the Contractor proposes to use an admixture other than an air-entraining agent, Contractor shall state the complete brand name and the quantity proposed to be used per sack of cement.

E. Should the Contractor change Contractor's source of supply, Contractor shall submit in writing to the Engineer the new gradation before their intended use.

F. In addition to the coarse, intermediate, and fine aggregates meeting the individual source requirements, the combined gradation shall meet the following source requirement:

Table 3 - Alkali-Silica Reaction

Source Requirement Test, Combined Aggregates	Test Method	Requirement
Accelerated Detection of Potentially Deleterious Expansion of Mortar Bars Due to Alkali-Silica Reaction	AASHTO T303	0.10% Max. Expansion[1]

G. Previous AASHTO T303 qualified aggregates for concrete mix designs will not automatically qualify for approval. Submit new AASHTO T303 test results with concrete mix design.

H. Perform this test on the coarse, intermediate, and fine aggregates together, combined in the same proportions as the proposed mix design.

1. The test may be performed on each size separately and the results combined mathematically.

2. Perform the test using the proposed sources together with proposed job cement and job pozzolan or other admixture, if used.

3. The pozzolan and silica fume quantities will be considered as cement in meeting the requirements of cement in Table 2 of Subsection 501.03.04, "Classification and Proportions."

[1] This requirement applies to all aggregate used in the concrete bridge structures, including approach slabs, reinforced concrete boxes, walkways, or sidewalks on the bridge structure itself, and all concrete bridge rail.

I. Prior to mix design approval, the Contracting Agency reserves the right to verify the AASHTO T303 test results, using the sources and proportions of materials as indicated by the mix design.

J. Conduct another test upon changes in source of cementitious materials, including fly ash, or changes in cement type or mitigating admixture suppliers.

PHYSICAL PROPERTIES AND TESTS

706.03.01 COARSE AGGREGATE

A. The aggregate shall conform to the following table requirements:

Table 4 - Percentage by Weight Passing Sieve

Sieve Size	Size No. 3 2-inch to 1-inch	Size No. 4 1-1/2-inch to 3/4-inch	Size No. 7 1/2-inch to No. 4	Size No. 57 1-inch to No. 4	Size No. 67 3/4-inch to No. 4	Size No. 357 2-inch to No. 4	Size No. 467 1-1/2-inch to No. 4
2-1/2-inch	100	--	--	--	--	100	--
2-inch	95-100	100	--	--	--	95-100	100
1-1/2-inch	35-70	90-100	--	100	--	--	95-100
1-inch	0-15	20-55	--	95-100	100	35-70	--
3/4-inch	--	0-15	100	--	90-100	--	35-70
1/2-inch	0-5	--	90-100	25-60	--	10-30	--
3/8-inch	--	0-5	40-70	--	20-55	--	10-30
No. 4	--	--	0-15*	0-10*	0-10*	0-5	0-5

*Not more than 5 percent shall pass No. 8 Sieve.

NOTE: Sizes No. 357 and No. 467 shall each be split into 2 sizes. Size No. 357 shall be furnished in stockpile or bunker in Sizes No. 3 (2-inch to 1-inch) and Size No. 57 (1-inch to No. 4.) Size No. 467 shall be furnished in stockpile or bunker in Size No. 4 (1-1/2-inch to 3/4-inch) and Size No. 67 (3/4-inch 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.

Table 5 - Coarse Aggregate Properties

Tests	Test Method	Requirements
Sieve Analysis	AASHTO T27	Above
Sampling Aggregate	ASTM D75	--
Material Passing 200 Sieve	AASHTO T27	1% Maximum
Percentage of Wear (100 Rev.)	ASTM C131	10% Maximum
Percentage of Wear (500 Rev.)	ASTM C131	50% Maximum
Soundness (5 Alternations) (sodium sulfate)	AASHTO T104	9% Maximum Loss
Cleanness Value min.	CALIF 227	71 706.03.01.B.1
Clay Lumps	AASHTO T112	1% Maximum
Potential Reactivity	AASHTO T303	Innocuous 706.03.01.B.2

B. Thin or elongated pieces (length greater than 5 times maximum thickness) shall not exceed 15 percent by weight.

1. When 2 or more stockpiles are to be combined, each stockpile shall have a cleanness value of at least 65 with a minimum combined cleanness value of 71 calculated by the percent of material used from each stockpile.

2. If the material from a proposed source fails this test requirement, the material may still be used for concrete aggregate provided that it is incorporated in an approved mix design with an approved Type F or Type N Pozzolan, or with a Type IP cement.

C. If a pozzolan is used for this purpose, use 1 part pozzolan to 4 parts of cement by mass. The pozzolan quantity shall be considered as cement in meeting the required minimum cement content. If a Type IP cement is used for this purpose, the use of pozzolan is not required.

706.03.02 LIGHTWEIGHT AGGREGATES

A. These aggregates shall conform to the following requirements:

Table 6 - Lightweight Aggregate Gradation

	Percentage of Weight Passing Sieve			
Sieve Size	**Fine Natural**	**Fine Lightweight**	**1-inch Size Coarse**	**3/4-inch Size Coarse**
1-inch	--	--	95-100	100
3/4-inch	--	--	--	90-100
1/2-inch	--	--	25-60	--
3/8-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	--	--	--

Table 7 - Lightweight Aggregate Properties

Tests	**Test Method**	**Requirements**
Sieve Analysis	AASHTO T27	Above 706.03.02.A.1 below
Sampling	ASTM D75	--
Unit Weight (loose oven dry) Fine Aggregate 70 lb/ft^3	Nev. T487	Maximum 706.03.02.A.2 below
Unit Weight (loose oven dry) Coarse Aggregate 55 lb/ft^3		
Unit Weight (loose oven dry) Combined Fine and Coarse Aggregate 65 lb/ft^3		
Organic Impurities	ASTM C40	Satisfactory 706.03.02.A.3 below
Clay Lumps	AASHTO T112	2.0% Maximum
Test for Staining Materials	ASTM D330	Satisfactory 706.03.02.A.4 below
Mortar Making Properties of Sand	ASTM C87	95% Minimum 706.03.02.A.5 below

1. With the following exceptions: The weight of the test sample for the fine lightweight aggregate shall be in accordance with Table 8, and the aggregate when mechanically

sieved shall be sieved for only 5 minutes. The test sample for coarse aggregate shall consist of no less than 0.1 cubic foot of the material used for the determination of unit weight.

Table 8 - Weight of Sieve Test Sample for Fine Lightweight Aggregates

Nominal Weight of Aggregate		Weight of Test Sample	
(lbs/ft^3)	**kg/m^3**	**Grams**	**Oz.**
25-35	401-561	150	5.3
35-45	561-721	200	7.0
45-55	721-881	250	8.8
55-65	881-1042	300	10.6
65-70	1042-1122	350	12.3

2. The unit weight of successive shipments of lightweight aggregate shall not differ by more than 10 percent from that of the sample submitted for acceptance tests.

3. 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.

4. Aggregates tested and showing stain darker than "heavy stain" (stain index of 80) shall be tested by chemical procedure, and aggregates that contain 1.5 mg or more of ferric oxide (Fe_20_3) per 200 gram sample shall be rejected for use.

5. Fine Aggregate failing in the test for organic impurities (ASTM C40) may be used provided that when tested for effect of organic impurities on strength of mortar, the relative strength at 7 and 28 days calculated in accordance with ASTM C87 is not less than 95 percent.

706.03.03 FINE AGGREGATE

A. This aggregate shall conform to the following requirements:

Table 9 - Fine Aggregate Gradation

Sieve Sizes	Percentage by Weight Passing Sieve
3/8-inch	100
No. 4	95-100
No. 16	45-80
No. 50	10-35
No. 100	2-12
No. 200	0-5

Table 10 - Fine Aggregate Properties

Tests	Test Method	Requirements
Sieve Analysis	AASHTO T27	Above
Sampling Aggregate	ASTM D75	--
Soundness (5 alternations) (sodium sulfate)	AASHTO T104	10% Maximum Loss
Clay Lumps	AASHTO T112	1.0% Maximum
Lightweight Pieces in Aggregate (less than 2.0 sp. gr.)	AASHTO T113	1.0% Maximum

Table 10 - Fine Aggregate Properties

Tests	Test Method	Requirements
Organic Impurities	ASTM C40	Satisfactory 706.03.03.A.2 below
Mortar Making Properties	ASTM C87	95% Minimum 706.03.03.A.1 below

1. Aggregates tested and showing color darker than the standard shall be rejected unless they pass the mortar making properties test in accordance with ASTM C87.
2. Fine aggregate failing in the test for organic impurities (ASTM C40) may be used provided that when tested for effect of organic impurities on strength of mortar, the relative strength of 7 and 28 days calculated in accordance with ASTM C87 is not less than 95 percent.
3. If the material from a proposed source fails this test requirement, the material may still be used for concrete aggregate provided that it is incorporated in an approved mix design with an approved Type F or Type N Pozzolan, or with a Type IP cement.
   a. If a pozzolan is used for this purpose, use 1 part pozzolan to 4 parts of cement by mass.
   b. The pozzolan quantity shall be considered as cement in meeting the required minimum cement content.
   c. The limitation on replacement of cement with pozzolans at a minimum of 20 percent in Subsection 501.02.03, "Admixtures," is hereby waived to meet this requirement.
   d. If a Type IP cement is used for this purpose, the use of pozzolan is not required.

706.03.04 GROUT AND MORTAR SAND

A. This aggregate shall conform to the following requirements:

B. Sand for grout and mortar shall conform to the size requirements of Subsection 706.03.03, "Fine Aggregate," except if the Contractor elects, Contractor may screen the sand over a No. 8 screen to produce the following:

Table 11 - Grout Aggregate Gradation

Sieve Sizes	Percentage by Weight Passing Sieve
No. 8	100
No. 50	15-40
No. 100	0-10
No. 200	0-5

Table 12 - Grout Aggregate Properties

Tests	Test Method	Requirements
Sieve Analysis	AASHTO T27	Above
Sampling Aggregate	ASTM D75	-----
Organic Impurities	ASTM C40	Satisfactory 706.03.04.B.2
Mortar Making Properties	ASTM C87	95% Minimum 706.03.04.B.1

1. Aggregates tested and showing color darker than the standard shall be rejected unless they pass the mortar making properties test in accordance with ASTM C87.

2. Fine aggregate failing in the test for organic impurities (ASTM C40) may be used provided that when tested for effect of organic impurities on strength of mortar, the relative strength at 7 and 28 days calculated in accordance with ASTM C87 is not less than 95 percent.

706.03.05 RIPRAP GROUT

A. The mix design for the placing requirements addresses 2 placement methods:

1. Direct discharge from the transit mixer.
2. Placement by small diameter line pumping methods.

B. Two typical mixtures that would meet the above minimum requirements are as follows:

Table 13 - Proportions for 1.0 Cubic Yard of Grout

	Pump Method Approx. Volume (Cu. Ft.)	Transit Mixer Discharge Approx. Volume (Cu. Ft.)
Pea Gravel	3.5	7.6
Washed Concrete Sand	10.6	7.6
Water	6.5	5.9
Type V cement	3.5	3.1
Fly Ash class F	1.6	1.4
Balance Air	1.3	1.4

C. Factors which shall be considered for a given grout mix are:

1. Fine and coarse aggregates.
2. Consistency.
3. Elapse time between placement and initial set.
4. Length of time between batching and placement during which continuous or intermittent mixing is required.

D. Materials used in the production of riprap grout shall meet the minimum following material standards:

1. Fine and Coarse Aggregate: ASTM C33; Section 206, "Structure Excavation."
2. Portland Cement: ASTM C150, Type V; Section 701, "Hydraulic Cement."
3. Fly Ash: ASTM C618; Section 729, "Fly Ash."
4. Water: Section 722, "Water."
5. Air Entraining Admixture: ASTM C260; Section 702, "Aggregates for Portland Cement Products."

E. A trial batch shall be placed for review by the Engineer for final approval for the project.

F. The Engineer shall be provided with a legible ticket with each load of grout delivered to the project site which shall contain the following information:

1. Name of Vendor.
2. Name of Contractor.

3. Number of Cubic Yards in the Load.
4. Actual Weights of Cement and of each Size of Aggregate.
5. Amount of Water Added at the Plant.
6. Amount of Water in the Aggregate.
7. Brand and Type of Cement.
8. Brand and Amount of Admixture.
9. Time and Date of Batching.

SECTION 707

JOINT MATERIAL

SCOPE

707.01.01 MATERIAL COVERED

A. 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, and so forth.

REQUIREMENTS

707.02.01 BLANK

PHYSICAL PROPERTIES AND TESTS

707.03.01 JOINTS

A. Materials for joints in concrete structures shall comply with provisions specified below.

707.03.02 POURABLE JOINT SEALER

A. The materials specified in this subsection shall be supplied and installed in weakened plane joints, contraction joints, and construction joints when required by the Engineer and as shown on the drawings.

B. Joint Sealant:

1. 2-component polyurethane pourable joint sealant (ACI 504R, Table 1, Type IV).
2. Sealant shall be able to expand and compress plus or minus 25 percent movement as the joint opens and closes.
3. Sealant shall be self-leveling for flat surfaces and non-sagging for sloped and vertical joints.
4. Sealant shall meet or exceed requirements of Table 1 below.

Table 1 - Minimum Requirements for Pourable Joint Sealer

Material Characteristics	Self-Leveling	Non-Sagging
Application Temperature	40 to 100 degrees F	40 to 100 degrees F
Service Range	-40 to 170 degrees F	-40 to 170 degrees F
Curing Rate	Tack-free Time: 1-2 hours Final Cure: 3-5 days	Tack-free Time: 6-8 hours Final Cure: 3 days
Tear Strength (ASTM D624)	--	45 lbs/in
Shore A Hardness (ASTM D2240)	45 ±5 (21-day)	25 ±5
Tensile Properties (ASTM D412):		
Tensile Strength	550 psi (21-day)	120 psi (at break)
Elongation	700% (at break)	500%
Modulus of Elasticity (100%)	150 psi	70 psi
Adhesion in Peel, Concrete Substrate (Fed Spec TT-00227E):		
Peel Strength	>30 pounds	25 pounds
% Adhesion Loss	0%	0%

C. No material shall be used that has skinned over or settled in the container to the extent that it cannot be easily redispersed by hand stirring to form a smooth uniform product.

D. Each container shall be clearly labeled or each delivery of material in the tanks of 2-component equipment shall be accompanied with a ticket showing designation (Component A or B), the manufacturer's name, lot or batch number, date of manufacture, date of packaging, date, if any, beyond which the polyurethane sealant shall not be used without additional testing and approval, and manufacturer's instructions for use.

E. The sealant shall be machine mixed and placed with equipment that accurately proportions and mixes the 2 components and extrudes the mixed material into the joint.

1. Such equipment shall be of a type approved by the manufacturer of the sealant and all manufacturer's instructions shall be followed.

2. Polyurethane liquid components that have been exposed to the atmosphere for more than 24 hours shall not be used.

F. Primer:

1. Special material furnished by the manufacturer of the sealant to improve bond of polyurethane sealant to concrete.

2. Primer shall be applied to the sides of the groove and to all exposed vertical surfaces in the joint prior to placing the polyurethane sealant.

3. The primer shall be dry prior to placing the sealant.

4. Contaminated primer shall be removed and replaced.

707.03.03 CHANNEL EXPANSION JOINT (1-INCH OR LESS)

A. The materials specified in this subsection shall be supplied and installed in expansion joints with widths 1-inch or less designed for channels included in Clark County Regional Flood Control District's Master Plan.

B. Joint Sealant:

1. 2-component polyurethane pourable joint sealant (ACI 504R, Table 1, Type IV).

2. Sealant shall be able to withstand up to plus or minus 25 percent movement.

3. Sealant shall be self-leveling for flat surfaces and non-sagging for slopes.

4. The sealant shall meet or exceed requirements of Table 1 in Subsection 707.03.02, "Pourable Joint Sealer."

C. No material shall be used that has skinned over or settled in the container to the extent that it cannot be easily redispersed by hand stirring to form a smooth uniform product.

D. Each container shall be clearly labeled or each delivery of material in the tanks of 2-component equipment shall be accompanied with a ticket showing designation (Component A or B), the manufacturer's name, lot or batch number, date of manufacture, date of packaging, date, if any, beyond which the polyurethane sealant shall not be used without additional testing and approval, and manufacturer's instructions for use.

E. The sealant shall be machine mixed and placed with equipment that accurately proportions and mixes the 2 components and extrudes the mixed material into the joint.

1. Such equipment shall be of a type approved by the manufacturer of the sealant and all manufacturer's instructions shall be followed.

2. Polyurethane liquid components that have been exposed to the atmosphere for more than 24 hours shall not be used.

F. Joint Filler: Preformed, ASTM D1752, Type I (sponge rubber) or inert, preformed, closed cell, polypropylene material.

G. Bond Breaker Tape:

1. Adhesive backed polyethylene tape meeting or exceeding the following:

a. Adhesive Strength: 35 ounces/inch width.

b. Tensile Strength: 20 pounds./inch width.

c. Mil thickness: 14.

2. Size tape so that it covers the entire back surface of the joint without extending up the concrete slabs.

3. In joints that have considerable width variation, 1 tape may be lapped over another to accomplish total backside coverage.

4. Bond breaker tape shall be thick enough to permit easy handling and proper insertion.

H. Backer Rod:

1. Non-absorbent expanded, closed cell polyethylene foam.

2. The backer rod shall be approximately 25 percent larger in diameter than the width of the joint to be sealed.

3. Other back-up materials (paper, rope and open cell foam) are unacceptable.

4. The backer rod shall be compatible with the sealant, and no bond or reaction shall occur between the backer rod and sealant.

707.03.04 EXPANSION JOINT (1-INCH OR LESS)

A. The materials specified in this subsection shall be supplied and installed in expansion joints with widths 1-inch or less designed for structures other than those listed in Subsection 707.03.03, "Channel Expansion Joint (1-Inch or Less) Filler."

B. Joint Sealant:

1. 2-component polyurethane pourable joint sealant (ACI 504R, Table 1, Type IV).

2. Sealant shall be able to withstand up to plus or minus 25 percent movement.

3. Sealant shall be self-leveling for flat surfaces and non-sagging for slopes.

4. The sealant shall meet or exceed requirements of Table 1 above.

C. No material shall be used that has skinned over or settled in the container to the extent that it cannot be easily redispersed by hand stirring to form a smooth uniform product.

D. Each container shall be clearly labeled or each delivery of material in the tanks of 2-component equipment shall be accompanied with a ticket showing designation (Component A or B), the manufacturer’s name, lot or batch number, date of manufacture, date of packaging, date, if any, beyond which the polyurethane sealant shall not be used without additional testing and approval, and manufacturer’s instructions for use

E. The sealant shall be machine mixed and placed with equipment that accurately proportions and mixes the 2 components and extrudes the mixed material into the joint.

1. Such equipment shall be of a type approved by the manufacturer of the sealant and all manufacturer's instructions shall be followed.

2. Polyurethane liquid components that have been exposed to the atmosphere for more than 24 hours shall not be used.

F. Joint Filler:

1. Preformed filler conforming to AASHTO M213 or ASTM D1751 (fiber type).

2. Filler material shall be punched or drilled to admit dowels where called for on the plans.

3. Filler for each joint shall be furnished in a single piece for the full depth and width required for the joint unless otherwise specified by the Engineer.

4. When the use of more than 1 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.

G. Bond Breaker Tape:

1. Adhesive backed polyethylene tape meeting or exceeding the following:

a. Adhesive Strength: 35 ounces/inch width.

b. Tensile Strength: 20 pounds./inch width.

c. Mil thickness: 14.

2. Size tape so that it covers the entire back surface of the joint without extending up the concrete slabs.

3. In joints that have considerable width variation, 1 tape may be lapped over another to accomplish total backside coverage

4. Bond breaker tape shall be thick enough to permit easy handling and proper insertion.

H. Backer rod:

1. Non-absorbent expanded, closed cell polyethylene foam.

2. The backer rod shall be approximately 25 percent larger in diameter than the width of the joint to be sealed.

3. Other backer materials (paper, rope and open cell foam) are unacceptable.

4. The backer rod shall be compatible with the sealant and no bond or reaction shall occur between the backer rod and sealant.

707.03.05 EXPANSION JOINT (GREATER THAN 1-INCH)

A. The materials specified in this subsection shall be supplied and installed in expansion joints with widths greater than 1-inch.

B. Joint Sealant:

1. Impermeable closed-cell, cross-linked, ethylene vinyl acetate, low density polyethylene copolymer, nitrogen blown foam material.

2. Joint sealant shall have a minimum working movement range of 60 percent compression and 30 percent tension.
3. The sealant shall meet or exceed the requirements listed in Table 2 below.
4. Joint sealant shall have 1/8-inch" deep by 1/8-inch wide grooves spaced at 1/4 inch to 1/2 inch along both sides of the joint and running the entire length of the joint to increase bond surface area.
5. Joint sealant material shall be resistant to degradation due to ultraviolet radiation or shall be coated with a material that provides adequate protection.
6. The joint sealant shall be installed with a width 25 percent greater than width of joint opening at a near neutral condition.
7. All direction changes in joint sealant shall be done using heat welding method.
8. Joint sealant shall be installed using all of manufacturer's recommendations.
9. Joint sealant shall be installed prior to significant joint movement after concrete placement.

C. Contractor shall prevent construction equipment from traversing joint after sealant has been placed or adequate steps shall be taken to protect sealant from construction traffic.

Table 2 - Minimum Requirements for Preformed Joint Sealer

Material Characteristics	Physical Requirements
Service Range	-94 degrees F to 160 degrees F
Tensile Strength	115 lb/in^2
Elongation at break	255%
Tear Resistance (ASTM D624)	16 lb/in^2
Water Absorption (ASTM D3575, Suffix L)	0.2 lb/ft^2
Density	2.8–3.4 lb/ft^3

D. Joint Filler: Inert, preformed, closed cell, polypropylene material.

E. Bond Breaker Tape:

1. Adhesive backed polyethylene tape meeting or exceeding the following:
   a. Adhesive Strength: 35 ounces/inch width.
   b. Tensile Strength: 20 pounds./inch width.
   c. Mil thickness: 14.
2. Size tape so that it covers the entire back surface of the joint without extending up the concrete slabs.
3. In joints that have considerable width variation, 1 tape may be lapped over another to accomplish total backside coverage.
4. Bond breaker tape shall be thick enough to permit easy handling and proper insertion.

F. Bonder: 2-component, 100 percent solid epoxy adhesive designed to bond joint material to steel, cured concrete, or wood.

707.03.06 RUBBER GASKETS

A. The ring gaskets shall conform to AASHTO M198.

707.03.07 WATERSTOPS

A. Waterstops shall conform to the following requirements:

1. 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.

2. This compound shall contain not less than 72 percent by volume of new plantation rubber.

NATURAL RUBBER.

Test	Test Method	Requirements
Tension Testing of Vulcanized Rubber	ASTM D412	Tensile strength: 3,500 psi minimum Elongation at breaking: 550 percent Unit stress (300 percent): 1,100 psi minimum Unit stress (500 percent): 2,800 psi minimum
Test for Accelerated aging of Vulcanized Rubber by the Oxygen Pressure Method	ASTM D572	After 7 days in air at 158 degrees F (±2 degrees F) or after 48 hours in oxygen at 158 degrees F (±2 degrees F) and 300 psi, 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

SYNTHETIC RUBBER

Test	Test Method	Requirements
Tension Testing of Vulcanized Rubber	ASTM D412	Tensile strength 2,500 psi minimum Elongation at breaking of 425 percent.
Test for Accelerated aging of Vulcanized Rubber by the Oxygen Pressure Method	ASTM D572	After 7 days in air at 158 degrees F (±2 degrees F) or after 48 hours in oxygen at 158 degrees F (±1 degree F) and 300 psi, 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

POLYVINYL CHLORIDE

Test	Test Method	Requirements
Polyvinyl Chloride Waterstops	Corps of Engr CRD-C 572	Compliance with paragraph 6

707.03.08 ASPHALT PLANK

A. Asphalt plank shall conform to ASTM D517 for Plain Asphalt Plank.

707.03.09 PREFORMED ELASTIC JOINT SEALER

A. Preformed elastic joint sealer and lubricant adhesive shall conform to AASHTO M220.

B. The lubricant adhesive shall be homogeneous and shall remain workable from 5 degrees F to 120 degrees F.

1. Each lot of the adhesive shall be in containers with the manufacturer's name or trademark and the date of manufacture plainly marked.

2. Adhesive shall be stored at a temperature of 50 degrees F to 80 degrees F and shall be used within 270 days after the date of its manufacture.

C. The lubricant adhesive shall conform to the following requirements:

1. Average new weight per gallon, pounds: 7.84 ±5%.

2. Solids content by weight, percent: 22 - 28.

D. 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 that have been tested by a reputable testing laboratory, recognized by the Contracting Agency.

1. The testing laboratory shall certify that the materials meet these specifications and requirements.

2. The Contractor shall furnish the Contracting Agency with these certifications prior to using the material.

707.03.10 SUBMITTAL

A. Material shall be tested and certified in accordance with the Table 3 frequencies.

1. Prior to the use of these materials, the Contractor shall submit to the Engineer for approval a document certifying that the material meets these specifications and requirements.

2. The test shall be performed in an accredited laboratory such as the American Association for Laboratory Accreditation (A2LA) or other as approved by the Engineer.

3. A test certificate shall be included with the certifying document.

4. Subsequent submittals shall be reviewed by the Contractor for compliance then transmitted to the Engineer.

B. The Statute of Limitations duration for the record storage shall be as required by the Nevada Revised Statutes.

Table 3 - Quality Control Inspection and Testing

Product	Subsection	Reference	Submittal	Frequency
Joint Sealant	707.03.02 707.03.03	Table 1 requirements	Certification with copy of tests	1 per lot
	707.03.04	ACI 504R, Table 1, Type IV		
	707.03.05	Table 2 requirements		
Joint Filler	707.03.03	Tested per ASTM D1752 Type I	Certification with copy of tests	1 per lot
	707.03.04	AASHTO M213		
	707.03.05	Inert, preformed, closed cell, polypropylene material	Certification	1 per lot
Backer Rod	707.03.03 707.03.04	Non-absorbent expanded, closed cell polyethylene	Certification	1 per lot

Bond Breaker Tape	707.03.03 707.03.04 707.03.05	Adhesive strength 35 ounces/in width Tensile Strength 20 lb/in width Thickness 14 mil minimum	Certification with copy of tests	1 per lot
Rubber Gaskets	707.03.06	AASTHO M198		
Waterstops Natural and Rubber	707.03.07	ASTM D412 ASTM D572 ASTM D2240		
Waterstops Polyvinyl Chloride	707.03.07	Corps of Engr CRD-C 572		
Asphalt Plank	707.03.08	ASTM D517		
Preformed Elastic Joint Sealer	707.03.09	AASHTO M220		

SECTION 708

CONCRETE AND CLAY PIPE AND DRAINS

SCOPE

708.01.01 MATERIALS COVERED

A. This specification covers the quality of clay pipe, nonreinforced concrete pipe, and reinforced concrete pipe used for culverts, siphons, pressure conduits, and storm drains and also the quality of perforated pipe used in underdrains.

1. The quality of pipe used for sanitary sewers shall be as specified in Section 630, "Sanitary Sewers."

2. Quality control testing and inspection requirements are in Subsection 708.04.01, "Production Quality Control Inspection and Testing."

B. Concrete pipe that is precast shall be manufactured in an annually certified plant.

1. Certification shall be by the American Concrete Pipe Association (ACPA).

2. The quality program from the certification process and this specification shall be initially submitted to the Regional Transportation Commission Specification Subcommittee for approval.

3. Once approved, the facility is considered "Authorized" and submittals of the QC program will not be required on a per-project basis unless required in the project specifications.

C. Design in accordance with AASHTO LRFD Bridge Design Specifications, Section 12, and to withstand a backfill dead load of 120 pounds per cubic foot and an HS-20 live load, unless otherwise shown in the contract or approved by the Engineer. The minimum cover over a pipe shall be placed on the plans and/or specifications being submitted for plan review.

D. The design shall consider any flotation effects with the use of controlled low strength material for backfill.

E. For storm drain application, the design shall consider the abrasion effects of parameters outlined in the Clark County Regional Flood Control District design manual or Federal Highway Administration (FHWA) publication FHWA-DF-88-003, "Federal Lands Highway Project Development and Design Manual."

F. The trench section installation configuration as demonstrated in Figure 1 in Section 208, "Trench Excavation and Backfill," shall only be permitted when approved by the Engineer.

G. The designing engineer shall comply with the intent of the pipe material as defined as either rigid or flexible in conformance with the AASHTO LRFD Bridge Design and Construction Specifications and this section.

1. Special attention shall be given to the sidewall material properties as this section assumes a minimum AASHTO A1 or A3 material.

2. Other sidewall material type shall be given special consideration for minimum trench widths, the use of CLSM, or other critical processes that would affect the pipe ability to withstand the load and shall also be noted on the plans and specifications for the project.

H. The type of pipe and applicable installation requirement (trench and embankment) to be used as demonstrated by the design and approved by the Engineer shall be clearly noted on the drawings and specifications along with installation procedures that may differ from this section.

I. The design shall include definition of either rigid or flexible pipe as defined by the South African Standard SABS 0102 as outlined on the Clark County QAQC web page:

www.accessclarkcounty.com/depts/public_works/Pages/iqac.aspx

J. The minimum design life before first maintenance on all pipes shall be 50 years. The definition of first maintenance is as follows:

1. **Rigid Pipe or Box - Reinforced Concrete:** Point of exposed reinforcement from normal designed use

2. **Rigid Pipe – Nonreinforced:** The least value of the thickness from designed use by a reduction of 25 percent or 1 inch.

K. Joints shall be specified in accordance with the following:

Table 1- Joint Types

Pipe Type	Joint Type	Description	Test Pressure	Application
Non-pressure	Silt Tight	Mastic or Rubber Gasketed	2.0 psi	Storm
Pressure	Water Tight (pressure)	Rubber Gasketed	10.8 psi	Storm

708.01.02 BASIS OF MANUFACTURED LOT ACCEPTANCE

A. Unless otherwise specified or designated by the Engineer, pipe shall be accepted based on manufacture's tests and inspection as indicated in Subsection 708.04.01, "Production Quality Control Inspection and Testing," Table 1.

B. The Contractor shall submit to Engineer manufacturer's Certificate of Compliance for each type of pipe furnished, in accordance with the provisions of Subsection 106.05, "Certificates of Compliance," and these specifications.

1. The certificate shall certify that the pipe complies with the specifications and shall include the pipe classification, diameter, and the date of manufacture.

2. The batch test results of each material lot delivered to the project shall be attached to the certificate.

REQUIREMENTS

708.02.01 BLANK

PHYSICAL PROPERTIES AND TESTS

708.03.01 REINFORCED CONCRETE PIPE

A. Reinforced concrete pipe shall conform to the following requirements:

1. **Circular Pipe:** ASTM C76, ASTM C1417.

2. **Elliptical Pipe:** ASTM C507.

B. The above ASTM specifications are clarified and amended as follows:

1. Reinforced Concrete Pipe (RCP) ASTM C76, Basis of Manufactured Lot Acceptance. Unless otherwise specified or designated by the Engineer, pipe shall be accepted based on the authorized status of the facility and visual defects or imperfections as delivered to the site.

2. Reinforced Concrete Arch Pipe (RCAP) ASTM C507, Reinforced Concrete Elliptical Pipe (RCEP) Basis of Manufactured Lot Acceptance. Unless otherwise specified or designated by the Engineer, pipe shall be accepted based on the authorized status of the facility and visual defects or imperfections as delivered to the site.

C. **Materials:**

1. **Cement and Fly Ash:**

a. Unless otherwise specified, cement shall be Type V, Type IP, or Type V and fly ash, and shall conform to Section 701, "Hydraulic Cement."

b. Fly ash shall be Class F and conform to Section 729, "Fly Ash."

2. **Concrete:** Unless otherwise specified, Portland cement concrete shall be as specified in Section 501, "Portland Cement Concrete."

3. **Synthetic Fibers:**

a. Polypropylene fibers may be used, with the approval of the Engineer, as a nonstructural manufacturing material.

b. Only Type III synthetic fibers designed and manufactured specifically for use in concrete and conforming to ASTM C1116 shall be accepted.

4. **Admixtures:** Unless otherwise specified or approved by the Engineer, admixtures conforming to Section 702, "Concrete Curing Materials and Admixtures," shall be acceptable for use.

D. All D-load and/or compressive strength requirements shall be met prior to shipment.

708.03.02 NONREINFORCED CONCRETE PIPE

A. This pipe shall conform to ASTM C14 for the specified diameters and strength classes.

708.03.03 PERFORATED CONCRETE PIPE

A. This pipe shall conform to ASTM C444 for the specified diameters and strength classes.

708.03.04 CLAY PIPE

A. This pipe shall conform to AASHTO M65 for pipe with full circular cross section, for the specified diameter and strength class.

B. When specified, the bell shall have integral spacer lugs to provide for an annular opening and self-centering feature.

708.03.05 BLANK

708.03.06 BLANK

708.03.07 BLANK

708.03.08 BLANK

708.03.09 REINFORCED CONCRETE PRESSURE PIPE

A. This pipe shall conform to AWWA C300, AWWA C301, AWWA C302, and ASTM C361.

TESTING AND INSPECTION

708.04.01 PRODUCTION QUALITY CONTROL INSPECTION AND TESTING

A. Material shall be tested, inspected, and certified in compliance with the Table 2 frequency.

B. The laboratory shall be R-18 AASHTO accredited in the appropriate test method, where applicable, and testing reviewed and stamped by a Nevada professional engineer who has responsible charge of the work.

1. Any structural integrity test shall be reviewed and stamped by a Nevada professional engineer who has responsible charge of the work.

2. Chemical testing does not require a professional engineer's review and stamp.

C. Review the Clark County web site for any exceptions to the test methods listed below at http://www.accessclarkcounty.com/pubworks/iqac/QA.htm.

Table 2 – Inspection and Testing

Product/Material	Subsection	Referenced Specification or Test Procedure	Requirement	Frequency
Concrete Pipe				
Plant QC Program	708.01.01	ACPA	Certified annually	1 per new plant or revision
Reinforced Concrete Pipe	708.03.01	ASTM C76, ASTM C1417	Design submittal	1 per type
		ASTM C76, Section 5.1.2	Basis of manufactured lot acceptance	See Components below
Reinforced Concrete Elliptical Pipe	708.03.01	ASTM C507, Section 5.1.1 and ASTM C655, Section 9	Design submittal	1 per type
		ASTM C76, Section 5.1.2	Basis of manufactured lot acceptance	See Components below
Nonreinforced Concrete Pipe	708.03.02	AASHTO M315 and ASTM C14	Design submittal	1 per type
		ASTM C14	Basis of manufactured lot acceptance	See Components below
Perforated Concrete Pipe	708.03.03	ASTM C444	Design submittal	1 per type
			Basis of manufactured lot acceptance	See Components below
Reinforced Concrete Pressure Pipe (Water)	708.03.09	AWWA C300, AWWA C301, and AWWA C302	Design submittal	1 per type
			Basis of manufactured lot acceptance	See Components below

Table 2 – Inspection and Testing				
Product/Material	**Subsection**	**Referenced Specification or Test Procedure**	**Requirement**	**Frequency**
Components				
Cement	708.03.01	Section 701	Certificate with test of Batch lot	1 per batch or heat lot
Curing Compound and Admixtures	708.03.01	Section 702		
Fly Ash	708.03.01	Section 729		
Steel Wire Steel Welded Wire Steel Wire Welded Deformed Steel Wire Welded Wire Deformed		Section 713		
Aggregates Coarse and Fine		AASHTO M6 and AASHTO M80	Sieve Analysis	1 per day for QA of External Source
Concrete		Section 501	Design submittal	1 per new design and renewal each year
		AASHTO T22	Compressive Strength	1 set per production day per design
Pipe	708.03.01	ASTM C655	D-Load testing	Annually per size and class
	708.03.01	Applicable AWWA and ASTM methods	Inspection of diameter, wall thickness, steel area, product marking (size and length), length	Each piece
Pressure Pipe Joint	708.01.01	ASTM C497 and ASTM C443	Hydrostatic Test	1 per setup or change

SECTION 709

METAL AND THERMOPLASTIC PIPE

SCOPE

709.01.01 MATERIAL COVERED

A. This specification covers the quality of metal pipes, metal arch pipes, metal end sections, structural plate pipe, perforated metal pipe, and thermoplastic pipe used for culverts, drainage structures, conduits, underdrains, and storm sewer.

B. The quality of pipe for the sanitary sewer shall be in accordance with Section 630, "Sanitary Sewers," or Responsible Agency specifications.

C. Plastic pipe shall be manufactured in an annually certified plant.

1. Certification shall be by the Plastic Pipe Institute (PPI) or other Contracting Agency approved program.
2. The quality program from the certification process and this specification shall be initially submitted to the Regional Transportation Commission Specification Subcommittee for approval.
3. Once approved, the facility is considered "Authorized" and submittals of the QC program will not be required on a per-project basis unless required in the project specifications.

D. The metal pipe manufacturer shall be authorized and be annually certified by a procedure approved by the Regional Transportation Commission Specification Subcommittee.

1. The Quality Program used for the certification and this specification shall be submitted prior to construction activities.
2. Once approved, the facility is considered "Authorized" and submittals of the QC program will not be required on a per-project basis unless required in the project specifications.
3. All pipes shall be clearly marked with certification program identification.

E. Design in accordance with AASHTO LRFD Bridge Design Specifications, Section 12, and to withstand a backfill dead load of 120 pounds per cubic foot and an HS-20 live load, unless otherwise shown in the contract or approved by the Engineer. The minimum cover over a pipe shall be placed on the plans and/or specifications being submitted for plan review.

F. The design shall consider any flotation effects with the use of controlled low strength material for backfill.

G. For storm drain application, the design shall consider the abrasion effects of parameters outlined in the Clark County Regional Flood Control District design manual or Federal Highway Administration (FHWA) publication FHWA-DF-88-003, Federal Lands Highway Project Development and Design Manual.

H. The trench section installation configuration as demonstrated in Figure 1 in Section 208, "Trench Excavation and Backfill," shall only be permitted when approved by the Engineer.

I. The designing engineer shall comply with the intent of the pipe material as defined as either rigid or flexible in conformance with the AASHTO LRFD Bridge Design and Construction Specifications and this section.

1. Special attention shall be given to the sidewall material properties as this section assumes a minimum AASHTO A1 or A3 material.

2. Other sidewall material type shall be given special consideration for minimum trench widths, the use of CLSM, or other critical processes that would affect the pipe ability to withstand the load and shall also be noted on the plans and specifications for the project.

J. The type of pipe and applicable installation requirement (trench and embankment) to be used as demonstrated by the design and approved by the Engineer shall be clearly noted on the drawings and specifications along with installation procedures that may differ from this section.

K. The design shall include definition of either rigid or flexible pipe as defined by the South African Standard SABS 0102 as outlined on the Clark County QAQC web page:

www.accessclarkcounty.com/depts/public_works/Pages/iqac.aspx

L. The minimum design life before first maintenance on all pipes shall be 50 years. The definition of first maintenance is as follows:

1. **Flexible Pipe:** Point of first perforation from designed use.

M. Joints shall be specified in accordance with the following:

Table 1 - Joint Types

Pipe Type	Joint Type	Description	Test Pressure	Application
Non-pressure	Silt Tight	Rubber Gasketed	2.0 psi	Storm
Pressure	Water Tight (pressure)	Rubber Gasketed	10.8 psi	Storm

The amount of corrugation coverage for the joint shall be fully engaged in accordance with the banding requirements for the pipe being testing.

REQUIREMENTS

709.02.01 BASIS OF MANUFACTURED LOT ACCEPTANCE

A. Unless otherwise specified or designated by the Engineer, pipe shall be accepted based on manufacturer's tests and inspection as indicated in Subsection 709.04.01, "Production Quality Control Inspection and Testing," Table 4 through Table 7.

B. The Contractor shall submit to Engineer the manufacturer's Certificate of Compliance for each type of pipe furnished, in accordance with Subsection 106.05, "Certificate of Compliance," and these specifications.

1. The certificate shall certify that the pipe complies with the specifications, and shall include the pipe classification, diameter, and the date of manufacture.

2. The batch test results of each material lot delivered to the project shall be attached to the certificate.

PHYSICAL PROPERTIES AND TESTS

709.03.01 CORRUGATED METAL PIPE AND PIPE ARCHES

A. These conduits and the coupling bands shall conform to AASHTO M36 for the specified sectional dimensions and coating.

B. Special sections, such as elbows, tees, and wyes for these conduits shall be of the same gauge as the conduit to which they are joined, and shall conform to AASHTO M36.

C. When metal end sections are required, the following requirements shall pertain:

1. Metal end sections shall be of the gauge shown on the plans.
2. The end of the pipe shall be furnished with annular corrugations to conform to metal end sections so that no leakage results from the connection; however, other designs may be used if approved by the Engineer.
3. Where connector sections are used, the connector section shall be helical or annular as required to match the type of pipe used.

D. Gauges of conduits shall conform to the requirements shown on the plans.

E. Connecting bands may be 2 gauges lighter than that used for pipe but not more than 12 gauge or less than 18 gauge. Unless otherwise approved by the Engineer, 2-piece bands shall be required for pipe greater than 48 inches in diameter.

F. Pipe thickness and coating shall be designed to withstand native soil corrosivity factors including, but not limited to, pH and electrical resistivity of the soil, for a minimum life of 50 years to first perforation.

G. The electrical resistivity of the soil shall be determined by California Test Method 643, "Method for Estimating the Service Life of Steel Culverts."

1. Test Method 643 will also be used to determine the anticipated service life for galvanized pipe.
2. For pipe coatings other than galvanized, the estimated service life shall be determined by applying appropriate correction factors to the value determined by California Test Method 643, or as indicated in the following sections.

709.03.02 BITUMINOUS COATED CORRUGATED METAL PIPE AND PIPE ARCHES

A. These conduits and the coupling bands shall conform to AASHTO M36 for the specified sectional dimensions and gauges, and to AASHTO M190 for the type of bituminous coating.

1. Coupling bands shall be fully coated with bituminous material.
2. Shop-formed elliptical pipe and shop strutted pipe shall be furnished where specified.

B. Special sections, such as elbows and flared end sections, for these conduits shall be of the same gauge as the conduit to which they are joined, and shall conform to AASHTO M190. Coating and invert paving shall be of the type specified.

709.03.03 ALUMINIZED TYPE II COATED CORRUGATED STEEL PIPE

A. This pipe shall conform to AASHTO M36 and more specifically to the metallic coating specification AASHTO M274.

B. In addition, the use of aluminized Type II coated corrugated steel pipe shall be limited by the following conditions:

1. Minimum Resistivity R > 1500 for 5 < pH < 9

2. Minimum Resistivity R > 1000 for 6.1 < pH 8.2

709.03.04 CORRUGATED ALUMINUM PIPE

A. This pipe shall conform to AASHTO M196.

B. In addition, the use of corrugated aluminum pipe shall be limited by the following condition in accordance with FHWA-DF-88-003, Federal Lands Highway Project Development and Design Manual:

1. Minimum Resistivity R > 500 ohm-cm and 4 < pH < 9

709.03.05 POLYMER COATED CORRUGATED STEEL PIPE

A. This pipe shall conform to AASHTO M36 and more specifically to the coating specification AASHTO M245.

B. In addition, the use of polymer coated corrugated steel pipe shall be limited by the following condition:

1. Minimum: Resistivity R > 250 ohm-cm and 3 < pH < 12

709.03.06 CONCRETE LINED CORRUGATED STEEL PIPE

A. This pipe shall conform to Subsection 709.03.03, "Aluminized Type II Coated Corrugated Steel Pipe," for pipe and to ASTM A849 except as modified by the following concrete lining specifications:

1. **Composition.** Concrete for the lining shall be composed of cement, fine aggregate, and water that are well mixed and of the consistency to produce a dense, homogeneous, non-segregated lining.

2. **Mixture.**

a. The aggregates shall be sized, graded, proportioned, and thoroughly mixed with proportions of cement and water to produce a homogeneous concrete mixture of such quality that the pipe will conform to this specification.

b. In no case, however, shall the concrete mixture be less than a 6-sack mix in accordance with Section 701, "Hydraulic Cement."

B. The lining shall have a minimum thickness of 1/8 inch above the crest of the corrugations.

C. The lining shall be applied:

1. To produce a homogeneous non-segregated lining throughout.

2. In a 2-course application.

D. The lining shall be mechanically trowelled.

709.03.07 CORRUGATED METAL PIPES FOR DOWNDRAINS

A. Downdrain flumes and pipe shall conform AASHTO M36.

B. Type III inlets shall conform to AASHTO M36.

C. Type I and Type II inlets shall conform to ASTM A525 except 2.00 ounce coating shall be required.

D. When specified, pipe, flumes, and inlets shall be bituminous coated conforming to AASHTO M190.

E. All anchor assemblies, hardware, and accessories shall conform ASTM A153 and ASTM A123.

709.03.08 CORRUGATED METAL PIPE FOR UNDERDRAINS

A. This pipe shall conform to AASHTO M36, Type III for the specified diameters.

B. Unless otherwise specified, any 1 of the first 3 classes shown may be furnished.

709.03.09 BITUMINOUS COATED CORRUGATED METAL PIPE FOR UNDERDRAINS

A. This pipe shall conform to AASHTO M36 and shall be coated with the bituminous material to meet AASHTO M190, Type A coating, except that minimum coating thickness shall be 0.03 inch.

B. Coupling bands shall be full coated.

C. The specified minimum diameter for perforations shall apply after coating.

709.03.10 THERMOPLASTIC, PLASTIC PIPE CULVERTS AND DRAINS

A. Plastics are composed of thermoplastic and thermosetting resins such as acrylonitile butadiene styrene (ABS), polyethylene (PE), polyvinyl chloride (PVC), fiber-reinforced (CCFRPM or FRP), or saturated fibers (CIPP).

B. For this specification, the applicable plastics are PE and PVC and are generally identified by cell classification in accordance with AASHTO M294 and M304.

   1. The cell classification is a series of numbers and letters that correspond to the ranges of properties in the plastic compound.

   2. The pipe strength is expressed as pipe stiffness as psi per linear inch, the product of the initial flexural modulus, and pipe wall cross section moment of inertia.

C. PE pipe shall conform to AASHTO M252 and AASHTO M294.

D. PVC pipe shall conform to AASHTO M278 and AASHTO M304.

E. Thermoplastic pipe shall be fabricated in accordance with this section.

F. Thermoplastic pipe or end sections greater than a 30-inch diameter shall not be allowed within a minimum of 8 feet of an open outfall.

G. The thermoplastic material properties shall comply with this section.

H. Joints shall be specified in accordance with the following Table 2.

Table 2 - Joint Types

Pipe Type	Joint Type	Description	Test Pressure	Application
Corrugated HDPE (D), (S)	Silt Tight	Bell/Spigot O-Ring	2.0 psi	Storm
Ribbed HDPE, Ribbed PVC, Spiral Wound PVC, Corrugated HDPE, Corrugated PVC	Water Tight (pressure)	Bell/Spigot O-Ring	10.8 psi	Storm

I. Reference specifications:

1. **Corrugated Polyethylene Pipe, Type S:**

   a. Type S corrugated polyethylene pipe shall be manufactured from high density polyethylene (HDPE) virgin compounds with the exception that up to 3 percent grindings from original pipe trimming may be reintroduced.

   b. The pipe shall conform to AASHTO M252 for pipe sizes 4 inches to 10 inches, and AASHTO M294 for pipe sizes 12 inches to 60 inches, unless otherwise specified herein or in the Special Provisions.

   c. The pipe wall shall be corrugated exterior construction with a smooth inner liner.

2. **Corrugated Polyethylene Pipe, Type D:**

   a. Type D corrugated PE pipe shall be manufactured from HDPE virgin compounds with the exception that up to 3 percent grindings from original pipe trimming may be reintroduced.

   b. Nominal sizes of 42 inches through 60 inches shall conform to AASHTO M294, unless otherwise specified herein or in the Special Provisions.

   c. The pipe shall consist of an essentially smooth waterway braced circumferentially or spirally with projections or ribs joined to an essentially smooth outer wall.

   d. Both walls shall be fused to, or continuous with, the internal supports.

3. **Ribbed Profile Wall or Spiral Wound Polyethylene Pipe:**

   a. Ribbed wall PE pipe shall be manufactured from HDPE virgin compounds with the exception that up to 3 percent grindings from original pipe trimming may be reintroduced.

   b. The pipe shall conform to ASTM F894.

   c. The pipe wall shall be of either solid or hollow rib exterior construction with a smooth inner surface.

4. **Ribbed Profile Wall or Spiral Wound Polyvinyl Chloride Pipe:**

   a. Ribbed profile wall PVC pipe shall be manufactured from PVC virgin compounds and shall conform to AASHTO M304, unless otherwise specified herein or in the Special Provisions.

   b. The pipe wall shall be of solid rib exterior construction with a smooth inner surface.

5. **Corrugated Polyvinyl Chloride Pipe with a Smooth Interior:**

   a. Corrugated profile wall PVC pipe shall be manufactured from PVC virgin compounds and shall conform to ASTM F949, unless otherwise specified herein or in the Special Provisions.

   b. The pipe wall shall be corrugated exterior construction with a smooth inner liner.

6. **Solid Wall Polyvinyl Chloride Pipe:**

   a. Solid wall PVC pipe and fittings shall be type PSM PVC pipe and fittings in accordance with ASTM D3034, SDR 35, or ASTM F679 with a T-1 wall thickness or Class P550 PVC pipe and fittings conforming to AASHTO M278.

b. Additives and fillers shall not exceed 10 parts by weight per 100 parts of PVC resin in the material compound.

7. **Acrylonitrile Butadiene Styrene Composite Pipe:**

a. Acrylonitrile butadiene styrene (ABS) composite pipe shall conform to AASHTO M264.

b. Couplings shall be Type SC.

c. The ends of the pipe shall be formed so that, when laid together and jointed, the pipe will form a continuous line with a smooth interior surface.

d. Immediately prior to assembling the pipe joints, the exposed cross-sectional ends of the pipe shall be coated with the same adhesive cement used for joining the couplings to the pipe.

8. **Special Fittings:**

a. Special fittings such as elbows, tees, and wyes for these conduits shall be of the same material as the conduits to which they are joined, and shall conform to applicable requirements for type of material being used.

b. When thermoplastic pipe end sections are required, the following requirements shall pertain:

1) End fittings shall be of the sizes shown on the plans.

2) The end of the pipe shall be furnished with corrugation to conform to the end fittings. However, other designs may be used if approved by the Engineer.

3) Where connector fittings are used, the connector fittings shall be helical or annular as required to match the type of pipe used.

709.03.11 CORRUGATED POLYETHYLENE PIPE FOR PERFORATED UNDERDRAINS

A. Type CP pipe shall conform to AASHTO M252 for nominal sizes of 3 inches through 10 inches, and to AASHTO M294 for nominal sizes of 12 inches through 60 inches.

B. Type SP pipe shall conform to AASHTO M252 for nominal sizes of 4 inches through 10 inches, and to AASHTO M294 for nominal sizes of 12 inches through 60 inches.

709.03.12 STRUCTURAL PLATE PIPE, ARCHES, AND PIPE ARCHES

A. This pipe shall conform to AASHTO M167 for steel and to AASHTO M219 for aluminum.

709.03.13 DUCTILE IRON PIPE

A. This pipe shall conform to ASTM A74, for "Sanitary Sewer Pipe" or with AWWA C151,for "Culinary Water Pipe," as applicable.

709.03.14 STEEL WATER PIPE

A. This pipe shall conform to AWWA C200.

709.04.01 PRODUCTION QUALITY CONTROL INSPECTION AND TESTING

A. Material shall be tested, inspected, and certified in accordance with the frequencies table below and submitted to the Engineer as required in the approved, authorized quality control program.

B. If the facility is not authorized, then prior to the use of these materials, the Contractor shall submit to the Engineer for approval a document certifying that the material meets these specifications and requirements.

1. Test and inspection data shall be included with the certifying document.

2. Subsequent submittals and reports shall be reviewed by the Contractor for compliance, then transmitted to the Engineer for approval.

C. The laboratory shall be accredited by American Association for Laboratory Accreditation (A2LA) or by another nationally recognized program approved by the Engineer in the appropriate test method, where applicable.

1. Any structural integrity test shall be reviewed and stamped by a Nevada professional engineer who has responsible charge of the work.

2. Chemical testing does not require a professional engineer review and stamp.

D. Review the Clark County web site for any exceptions to the test methods listed below at www.accessclarkcounty.com/depts/public_works/Pages/iqac.aspx

Table 3 - Quality Control Inspection and Testing - General

Product	Subsection	Reference	Requirement	Frequency
Plant QC Program, Plastic Pipe	709.01.01	AASHTO M294, Appendix A and Plastic Pipe Institute or other Agency approved program	Certified annually	1 per new plant or revision
Plant QC Program, Metal Pipe		AASHTO M294, Appendix A and Agency approved program		
All Pipe	709.03.01 through 709.03.14	Applicable AASHTO and/or ASTM standards	Design submittal	1 per type

Table 4 - Plastic PE Pipe

Product/Material	Subsection	Referenced Standard or Test Procedure	Requirement	Frequency
Pipe				
Corrugated PE Pipe, Type S, and Type D	709.03.10.I.1 709.03.10.I.2 709.03.11	Applicable AASHTO standards; AASHTO M252 AASHTO M294 AASHTO M304	Basis of manufactured lot acceptance	See Components below
Ribbed Profile Wall or Spiral Wound PE Pipe	709.03.10.I.3	Applicable AASHTO standards; ASTM F894		

Table 4 - Plastic PE Pipe				
Product/Material	**Subsection**	**Referenced Standard or Test Procedure**	**Requirement**	**Frequency**
Components				
Pipe Raw Material		ASTM D1505 ASTM D1238 ASTM F2136 AASHTO M294	Resin Test, Density, Melt Index, SP-CLS Test, ESCR Test 32-hour	1 per lot
Gasket		Name of Gasket Manufacturer and Type; ASTM F477	Gasket Volume and Durability Test	
Pipe		AASHTO M294 ASTM D638 ASTM D790	Pipe Stiffness, Flattening, and Brittleness tests, Elongation, Tensile Strength, Modulus of Elasticity, Unit Weight	3 per week or 1 per lot, whichever is greater
		ASTM D5397	NCTL Test	1 per lot
		AASHTO M294	ESCR Test	
Pipe Joint		ASTM D3212	Joint Hydrostatic Test	1 per setup or change
		AASHTO M294	Joint Shear Test	
Inspection		AASHTO M294 ASTM D2122 ASTM F894	Wall Thickness, Inside Diameter, Length, Markings	Each piece

Table 5 - PVC Pipe				
Product/Material	**Subsection**	**Referenced Standard or Test Procedure**	**Requirement**	**Frequency**
Pipe				
Ribbed Profile Wall or Spiral Wound PVC Pipe, Corrugated PVC	709.03.10.I.4	Applicable AASHTO standards; AASHTO M304; ASTM F949, Section 10.E	Basis of manufactured lot acceptance	See Components below
Solid Wall PVC Pipe	709.03.10.I.6	Applicable AASHTO standards; ASTM D3034, SDR 35, or ASTM F679		
Components				
Pipe Raw Material		ASTM D1505 ASTM D1238 ASTM F2136	Resin Test, Density Melt Index, SP-NCLS Test	1 per lot
		AASHTO M304, ASTM F2136	ESCR Test 32-hour	
Gasket		Name of Gasket Manufacturer and Type; ASTM F477	Gasket Volume and Durability Test	

Table 5 - PVC Pipe				
Product/Material	**Subsection**	**Referenced Standard or Test Procedure**	**Requirement**	**Frequency**
Pipe		AASHTO M304	Pipe Stiffness, Flattening, and Brittleness tests, Elongation, Tensile Strength, Modulus of Elasticity, Unit Weight	3 per week or 1 per lot, whichever is greater
		ASTM D2152	Acetone Immersion	1 per lot
		ASTM D5397	NCTL Test	
		AASHTO M264	ESCR Test	
Pipe Joint		ASTM D3212	Joint Hydrostatic Test	1 per setup or change
		AASHTO M304	Soil Tight Joint	
Inspection		AASHTO M304 and ASTM D2122, ASTM D3034, or ASTM F679	Wall Thickness, Inside Diameter, Length, Markings	Each piece

Table 6 - ABS Pipe				
Product/Material	**Subsection**	**Referenced Standard or Test Procedure**	**Requirement**	**Frequency**
Pipe				
ABS Composite Pipe	709.03.10.I.7	Applicable AASHTO standards; AASHTO M264 (ASTM D2680)	Basis of manufactured lot acceptance	See Components below
Components				
Pipe Raw Material		ASTM D1505 ASTM D1238 ASTM F2136	Resin Test, Density, Melt Index, SP-NCLS Test	1 per lot
		ASTM D1693 ASTM F2136	ESCR Test 32-hour	
		ASTM D2152	Extrusion Quality	
Gasket		Name of Gasket Manufacturer and Type; ASTM F477	Gasket Volume and Durability Test	
Pipe		AASHTO M264 ASTM D2412 ASTM D638 ASTM D790	Pipe Stiffness, Flattening, and Brittleness tests, Elongation, Tensile Strength, Modulus of Elasticity, Unit Weight	3 per week or 1 per lot, whichever is greater
		ASTM D2152	Acetone Immersion	1 per lot
		ASTM D5397	NCTL Test	
		AASHTO M264	ESCR Test	
Pipe Joint		ASTM D3212	Joint Hydrostatic Test	1 per setup or change
Inspection		ASTM D2680 ASTM D2122	Wall Thickness, Inside Diameter, Length, Markings	Each piece

Table 7 - Metal Pipe				
Product/Material	**Subsection**	**Referenced Standard or Test Procedure**	**Requirement**	**Frequency**
Pipe				
Corrugated Metal Pipe and Pipe Arches (and Bituminous Coated)	709.03.01 709.03.02 709.03.05 709.03.06 709.03.07 709.03.08 709.03.09	Applicable AASHTO/ ASTM standards; AASHTO M36 or AASHTO M196	Basis of manufactured lot acceptance	See Components below
Aluminized Type II Coated Corrugated Steel Pipe	709.03.03	Applicable AASHTO/ ASTM standards;		
Corrugated Aluminum Pipe	709.03.04	Applicable AASHTO/ ASTM standards;		
Concrete Lined Corrugated Steel Pipe	709.03.06	Applicable AASHTO/ ASTM standards;		
Structural Plate Pipe and Pipe Arches	709.03.12	Conform to the Contract Special Provisions		
Ductile Iron Pipe	709.03.13			
Steel Water Pipe	709.03.14			
Components				
Pipe Raw Material		AASHTO M218 and ASTM A924	Certification of Tension Test and Base Metal Analysis, Corrugated Metal Pipe and Pipe Arches	1 set per lot
		AASHTO M274 and ASTM A463	Certification of Tension Test and Base Metal Analysis, Aluminized Type II Coated Corrugated Steel Pipe	
		AASHTO M218	Certification of Tension Test and Base Metal Analysis, Concrete Lined Corrugated Steel Pipe	
		AASHTO M196 AASHTO M197 ASTM B209	Certification of Tension Test and Base Metal Analysis, Corrugated Aluminum Pipe	
Sheet (Coil)		AASHTO M197 AASHTO M218 AASHTO M274	Thickness	Each coil
Corrugation		AASHTO M36, Section 7.2	Profile	Each setup
Band MTLS		AASHTO M36 Section 9	Thickness and Width	
Lock Seam		AASHTO T249	Inspection and Tensile Test	Each day

Table 7 - Metal Pipe				
Product/Material	**Subsection**	**Referenced Standard or Test Procedure**	**Requirement**	**Frequency**
Pipe Coating		AASHTO M218 AASHTO M190 AASHTO T65 ASTM A754	Thickness (Corrugated Metal Pipe and Pipe Arches including Bituminous Coated)	Each piece
		AASHTO M274 AASHTO T213 or ASTM A754	Supplier Certificate of Thickness for Corrugated Aluminum, Aluminized Steel, and Concrete-Lined Steel (excluding water pipe)	Per lot
Pipe		AASHTO M218 ASTM A924	Thickness, Diameter (Corrugated Metal Pipe and Pipe Arches including Bituminous Coated)	Each piece
Pipe Inspection		AASHTO M36 Section 8.1.1	Dimensions	Each setup per shift
		AASHTO M36 Section 9 AASHTO M196 Section 10.1	Workmanship	Each piece
Pressure Pipe Joint		ASTM D3212	Hydrostatic Test	1 per setup or change

SECTION 710

STRUCTURAL AND EYEBAR STEEL

SCOPE

710.01.01 MATERIAL COVERED

A. This specification covers the quality of structural and eyebar steel used in highway structures.

REQUIREMENTS

710.02.01 DEFECTS

A. Finished rolled material shall be free from cracks, flaws, injurious seams, laps, blisters, ragged and imperfect edges, and other defects.

B. Material shall have a smooth, uniform finish, and shall be straightened in the mill before shipment.

C. Material shall be free from loose mill scale, rust pits, and other defects affecting its strength or durability.

D. The Engineer may reject material that Engineer deems unsuitable for the purpose intended even though the material meets the mill tolerances.

710.02.02 CHARPY V-NOTCH TEST

A. All steel used in and designated as main load carrying members subject to tensile stress shall comply with all the requirements specified for Charpy V-notch test in the various AASHTO standards for the steel involved.

B. Sampling and testing procedures shall be in accordance with the applicable AASHTO standards.

PHYSICAL PROPERTIES AND TESTS

710.03.01 STANDARD STEEL

A. This steel shall conform to AASHTO M270 Grade 36.

710.03.02 HIGH STRENGTH-LOW ALLOY STRUCTURAL MANGANESE VANADIUM STEEL

A. This steel shall conform to AASHTO M270 Grade 50.

710.03.03 HIGH TENSILE STRENGTH BOLTS

A. This steel shall conform to ASTM A325.

710.03.04 STAINLESS STEEL BOLTS

A. This steel shall conform to ASTM A276.

710.03.05 WELDED SEAMLESS STEEL PIPE

A. This steel shall conform to ASTM A53, Grade B.

710.03.06 COLD-FORMED WELDED AND SEAMLESS CARBON STEEL STRUCTURAL TUBING IN ROUNDS AND SHAPES

A. This steel shall conform to ASTM A500, Grade B, except the minimum tensile strength shall be 55,000 psi.

710.03.07 SHEAR STUD CONNECTORS

A. This steel shall conform to ASTM A108, Grade 1015 or Grade 1020.

B. Flux-retaining caps shall be low carbon grade suitable for welding and shall conform to ASTM A109.

710.03.08 PINS AND ROLLERS

A. Pins or rollers 9 inches or less in diameter shall be forged and heat treated cold finished carbon-steel shafting.

B. Pins or rollers more than 9 inches in diameter shall be forged and heat treated in accordance with ASTM A235.

SECTION 711

ALUMINUM FOR BRIDGE RAIL

SCOPE

711.01.01 MATERIAL COVERED

A. This specification covers the quality of aluminum alloy used in bridge rail.

REQUIREMENTS

711.02.01 BLANK

PHYSICAL PROPERTIES AND TESTS

711.03.01 ALUMINUM ALLOY FOR PIPE

A. This pipe shall conform to ASTM B241, Alloy 6061-T6 or Alloy 6063-T6.

711.03.02 ALUMINUM ALLOY TUBING

A. This tubing shall conform to ASTM B221, Alloy 6061-T6 or Alloy 6063-T6.

711.03.03 CAST ALUMINUM ALLOY

A. This alloy shall conform to AASHTO M193, Alloy A344-T4.

711.03.04 ALUMINUM ALLOY SHIMS

A. This alloy shall conform to ASTM B209, Alloy 1100-0.

SECTION 712

MISCELLANEOUS METAL

SCOPE

712.01.01 MATERIAL COVERED

A. This specification covers the type and quality of miscellaneous metals used on various construction projects.

REQUIREMENTS

712.02.01 BLANK

PHYSICAL PROPERTIES AND TESTS

712.03.01 STEEL CASTINGS

A. This steel shall conform to ASTM A27, Grade 65-35.

712.03.02 GRAY IRON CASTINGS

A. These castings shall conform to ASTM A48, Class 30.

712.03.03 MALLEABLE CASTINGS

A. These castings shall conform to ASTM A47, Grade 32510.

712.03.04 WROUGHT IRON PLATES

A. These plates shall conform to ASTM A42.

712.03.05 BRONZE CASTINGS

A. These castings shall conform to ASTM B22, Copper Alloy No. 863.

712.03.06 WELDING MATERIALS

A. 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

A. This steel ("H" piles and sheet piling) shall conform to ASTM A36.

712.03.08 STEEL SHELL FOR PILES

A. This steel shall conform to ASTM A252, Grade 2.

SECTION 713

REINFORCEMENT

SCOPE

713.01.01 MATERIALS COVERED

A. This specification covers the quality of bar steel, fabricated reinforcement, and welded steel wire used in the reinforcement of concrete.

REQUIREMENTS

713.02.01 BLANK

PHYSICAL PROPERTIES AND TESTS

713.03.01 BAR STEEL REINFORCEMENT

A. 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
Axle-Steel Deformed Bars for Concrete Reinforcement	ASTM A996	Grade 40, 60
Spiral Reinforcement	ASTM A615	Grade 60

713.03.02 FABRICATED STEEL BAR OR ROD MATS REINFORCEMENT

A. This steel shall conform to ASTM A184.

713.03.03 WELDED STEEL WIRE FABRIC REINFORCEMENT

A. This steel shall conform to ASTM A185.

713.03.04 PRESTRESSING STEEL

A. Prestressing reinforcement shall be high tensile strength steel wire, high-tensile strength 7-strand wire, or high tensile strength alloy bars as called for on the plans or in the Special Provisions.

B. High-tensile strength steel wire shall conform to ASTM A421, except that steel may be made by the basic oxygen process.

C. High-tensile strength 7-strand wire shall conform to ASTM A416, Grade 270.

D. High-tensile-strength alloy bars shall be stress relieved and then cold stretched to a minimum of 130,000 psi. After cold stretching, the physical properties shall be as follows:

Minimum Ultimate Tensile Strength	145,000 psi
Minimum Yield Strength, Measured by the 0.7 Percent Extension, Under Load Method Shall Be Not Less Than	130,000 psi
Minimum Modulus of Elasticity	25,000,000 psi
Minimum Elongation in 20-bar Diameters After Rupture	4 percent
Diameter Tolerance	+0.03 inch, -0.01 inch

E. Testing Prestressing Reinforcement and Anchorages:

1. All wire, strand, or bars to be shipped to the site shall be assigned a lot number and tagged for identification purposes.

2. Anchorage assemblies to be shipped shall be likewise identified.

F. 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.

G. 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.

H. The Contractor 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.

1. **Pretensioning Method.**

a. For pretensioned strands, samples at lease 5 feet long shall be furnished of each strand size.

b. A sample shall be taken from each end of every coil.

2. **Post-Tensioning Method.** The following lengths shall be furnished:

a. For wires requiring heading: 5 feet.

b. For wires not requiring heading: sufficient length to make up 1 parallel-lay cable 5 feet long consisting of the same number of wires as the cable to be furnished.

c. For strand to be furnished with fittings: 5 feet between near ends of fittings.

d. For bars to be furnished with threaded ends and nuts: 5 feet between threads at ends.

3. **Anchorage Assemblies.** 2 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

A. This steel shall conform to ASTM A82.

SECTION 714

PAINT AND PAVEMENT MARKINGS

SCOPE

714.01.01 MATERIALS COVERED

A. This specification covers the quality, color, and number of applications of paint used for painting the various materials of construction.

1. The raw materials for use in the various paint formulas shall conform to the specifications designated by federal or military serial number or paint material code number under the various paint classifications hereinafter specified.
2. Subsequent amendments to the specifications quoted shall apply to all raw materials and finished products.
3. No "or equal" substitutions for any specified material shall be made without written consent of the Engineer.
4. State specification numbers referred to are California State Specifications unless otherwise noted.

B. Comply with Section 715, "Galvanizing," for galvanized coatings.

REQUIREMENTS

714.02.01 CERTIFICATES

A. The Contractor shall furnish the Engineer with written certification that all required tests have been satisfactorily completed and that the materials tested comply with all of the requirements. Samples will be taken when required by the Engineer.

B. Prior to using any material, the Contractor shall provide the Engineer with a written "Certification of Compliance" from the manufacturer of the material. The certification shall:

1. Include the manufacturer's name, business address, and location of the manufacturing plant.
2. Identify the specifications and include 1 copy.
3. Show the quantity of materials supplied for each color, batch number, and date of manufacture.

C. Manufacturer's lab test results shall be supplied upon request of the Engineer. No pavement marking material shall be used which is not on the Qualified Products List (QPL) established by the Nevada Department of Transportation (NDOT). The current NDOT QPL is available at http://www.nevadadot.com/reports_pubs/QPL/ .

PHYSICAL PROPERTIES AND TESTS

714.03.01 IRON AND STEEL USE ITEM CLASSIFICATIONS

A. **Zinc-Rich Primer, Organic Vehicle Type (State Spec. 8010-61J-36):**

1. This specification covers a 1-package, thermoplastic, organic zinc-rich primer whose mechanism of drying is that of solvent release.

2. This primer is intended for use only on blast cleaned open steel structures exposed to the air.

3. This coating is intended for spray application. Limited application can be made by brushing.

B. **Pre-Treatment, Vinyl Wash Primer (State Spec. 8010-61J-27):**

1. This specification covers a wash primer formulated specifically for application prior to painting clean aluminum, galvanized surfaces, or surfaces previously coated with an organic or inorganic zinc-rich primer.

2. This primer is also used on blast cleaned steel when specified and is mandatory as an undercoat under vinyl paint systems.

C. **Vinyl Primer, Red Iron Oxide Type (State Spec. 8010-61J-23):**

1. This specification covers a ready-mixed, vinyl-red oxide paint for use on properly prepared metal surfaces which have been treated with Pre-Treatment Vinyl Wash Primer (State Spec. 8010-61J-27).

2. This paint should be applied alternately with Vinyl Primer, Red Iron Oxide - Titanium Dioxide Type (State Spec. 8010-61J-24) to provide a primer coating which may consist of 1 or more applications of each vinyl primer.

3. Either State Specification 8010-61J-23 or 8010-61J-24 may be used for the initial application.

4. This paint is formulated primarily for spray application.

D. **Aluminum Vehicle Varnish (State Spec. 8010-91B-75):**

1. This specification covers an aluminum vehicle clear varnish and general all purpose phenolic base spar mixing varnish.

2. This varnish should not be used on surfaces and in pigment combinations where yellowing will be objectionable.

E. **Aluminum Paint, Finish Coat, (State Spec. 8010-61J-45):**

1. This specification covers a phenolic resin varnish base aluminum paint, suitable for use as a finish coat.

2. This paint is formulated for use on structural steel and interior and underwater surfaces of steel water tanks and similar exposed surfaces.

3. This paint shall be furnished in 2-compartment containers and shall be mixed fresh each day.

F. **Vinyl Paint, Aluminum Finish Coat (State Spec. 8010-61J-25):**

1. This specification covers a vinyl type aluminum paint for use on properly prepared metal surfaces that have been treated with Pre-Treatment, Vinyl Wash Primer (State Spec. 8010-61J-27) or specified vinyl undercoats.

2. This paint is primarily formulated for spray application.

3. This paint shall be furnished in 2-compartment containers and shall be mixed fresh each day.

G. **Burnt Umber Tint Finish Coat (State Spec. 8010-61J-41):**

1. This specification covers a ready-mixed burnt umber tint paint suitable for use as a finish coat on properly prepared structural steel surfaces.
2. This paint may be applied by spray or brush.

H. **Burnt Sienna Finish Coat (State Spec. 8010-61J-53):**

1. This specification covers a ready-mixed burnt sienna paint suitable for use as a finish coat on properly prepared structural steel surfaces.
2. This paint may be applied by spray or brush.

I. **Green Finish Coat (State Spec. 8010-61J-47):**

1. This specification covers a ready-mixed green paint suitable for use as a finish coat on properly prepared structural steel surfaces.
2. This paint may be applied by spray or brush.

J. **Vinyl Green Finish Coat (State Spec. 8010-61J-40):**

1. This specification covers a ready-mixed green vinyl finish paint for use on properly prepared metal surfaces that have been treated with Pre-Treatment, Vinyl Wash Primer (State Spec. 8010-61J-27), or specified vinyl undercoats.
2. This paint is formulated primarily for spray application.

K. **Vinyl Iridescent Green Finish Coat (State Spec. 8010-91B-43):**

1. This specification covers a ready-mixed iridescent green vinyl finish paint for use on properly prepared metal surfaces that have been treated with Pre-Treatment, Vinyl Wash Primer (State Spec. 8010-61J-27), or specified vinyl undercoats.
2. This paint is formulated primarily for spray application.

L. **Tan Finish Coat (State Spec. 8010-61J-51):**

1. This specification covers a ready-mixed, tan paint suitable for use as a finish coat on properly prepared structural steel surfaces.
2. This paint may be applied by spray or brush.

M. **White Tint Base Finish Vinyl Coat (State Spec. 8010-71C-35):**

1. This specification covers a ready-mixed, white tint base, vinyl finish paint for use on properly prepared metal surfaces which have been treated with Pre-Treatment, Vinyl Wash Primer (State Spec. 8010-61J-27).
2. This paint is formulated primarily for spray application.

N. **Enamel; Exterior White, Metal (State Spec. 8010-61J-09):**

1. This specification covers a fast drying, exterior, white enamel, primarily for use on metal, or for other exterior surfaces where gloss and durability are requisite.
2. This paint shall conform to the provisions of Military Specification MIL-E-1115A.

O. **Enamel; Traffic Signal, Lusterless, Black (State Spec. 8010-61J-13):**

1. This specification covers a lusterless, black enamel for use in painting traffic signal hoods, shields, and other surfaces.

2. When used on bare aluminum or zinc, Pre-Treatment, Vinyl Wash Primer (State Spec. 8010-61J-27) shall be used first to ensure proper bond.

P. **Enamel; Traffic Signal, Dark Olive Green (State Spec. 8010-41B-A):**

1. This specification covers an enamel for use on signal poles.
2. This paint is formulated as a finishing coat to be used over Pre-Treatment, Vinyl Wash Primer (State Spec. 8010-61J-27).

Q. **Enamel; Traffic Signal, Yellow (School Bus Yellow):**

1. This specification covers high-gloss enamel for use on signal poles.
2. This paint is formulated as a finishing coat to be used over Pre-Treatment, Vinyl Wash Primer (State Spec. 8010-61J-27).
3. School bus yellow shall conform to Federal Color No. 13432 as shown in Table V of Federal Standard No. 595a.

R. **Enamel; Traffic Signal, Silver:**

1. This specification covers an enamel for use on signal poles.
2. This paint is formulated as a finishing coat to be used over Pre-Treatment, Vinyl Wash Primer (State Spec. 8010-61J-27).
3. The silver shall conform to Federal Color No. 17178 as shown in Table IX of Federal Standard No. 595a.

714.03.02 TIMBER USE ITEM CLASSIFICATIONS

A. **Wood Primer Latex Base:**

1. This specification covers a ready-mixed, priming paint for use on unpainted wood or exterior wood work.
2. This paint shall comply, in all respects, with Federal Specification TT-P001984, except that it shall dry hard in not more than 12 hours.

B. **Paint, Latex Base for Exterior Wood, White and Tints:**

1. This specification covers a ready-mixed paint for use on wood surfaces subject to outside exposures.
2. This paint shall comply in all respects with Federal Specification TT-P96D.
3. Unpainted wood shall first be primed with Wood Primer conforming to Subsection 714.03.02, paragraph A, "Wood Primer, Latex Base."

C. **Enamel; Sign Post, Black (State Spec. 8010-61J-08):**

1. This specification covers a gloss black enamel for use on wood or metal.

714.03.03 CONCRETE USE ITEMS

A. Concrete end posts (bridges), raised traffic bars, and miscellaneous concrete specified to receive paint.

Purpose	Number of Coats	Color	General Type	Formulated or Specification
Finish	1	White	Water Thinned	Acrylic Resin or Synthetic Latex Alkyd Emulsion

714.03.04 ALUMINUM USE ITEM

A. Aluminum bridge railing and posts specified to receive paint shall be prepared for painting with a coat of Pre-Treatment, Vinyl Wash Primer conforming to Subsection 714.03.01, paragraph B, "Pre-Treatment, Vinyl Wash Primer (State Spec. 8010-61J-27)."

B. The Contractor may use any of the paint systems specified for use on iron or steel in Subsection 714.03.01, "Iron and Steel Use Item Classifications," for painting aluminum, and shall submit to the Engineer for approval a letter indicating Contractor's choice of system as required for iron or steel.

714.03.05 PAINT FOR TRAFFIC STRIPING, PAVEMENT MARKING, AND CURB MARKING - GENERAL

A. These specifications are intended to cover ready-mixed paints of a consistency suitable for use on highway pavements and curbing, either asphaltic or Portland cement concrete type.

B. Reference specifications and standards shall be Federal Specifications, latest revision, as herein noted, or Federal Test Method Standard No. 141, latest revision, as called for and amended in these specifications.

C. Paint shall be homogenous, free of contaminant, and of a consistency suitable for use in the capacity for which it is specified.

1. Finished paint shall be well ground and the pigment shall be properly dispersed in the vehicle according to the requirements of the paint.

2. The dispersion shall be of such nature that the pigment does not settle badly, does not cake or thicken in the container, and does not become granular or curdled.

3. Any settlement of pigment in the paint shall be a thoroughly wetted soft mushy mass permitting the complete and easy vertical penetration of a paddle.

4. Settled pigment shall be easily redispersed, with minimum resistance to the smooth uniform product of the proper consistency.

5. The manufacturer shall include in the paint the necessary additives for control of sagging, pigment settling, leveling, drying, drier absorption and skinning, or other requisite qualities of a satisfactory working material.

6. The paint shall possess satisfactory properties, in all respects, that affect its application and curing.

D. All manufactured paint shall be prepared at the factory ready for application. The addition of thinner or other material to the paint after the paint has been shipped will not be permitted unless otherwise specified in the contract Special Provisions.

714.03.06 PAVEMENT MARKINGS

A. **Type 2:**

1. Type 2 pavement marking material shall be a durable retroreflective pavement marking for use on asphalt or concrete pavements transverse markings such as crosswalks and stop bars, and for word/symbol markings, that are subjected to severe wear conditions such as repeated shear action from stop, start, or turn movements.

2. Type 2 materials are as follows:

a. **Preformed Pavement Marking Tape**: This material shall meet the minimum requirements set forth in ASTM D4505 except as modified below.

b. Whiteness Index: The daylight color of the white striping shall have a minimum initial whiteness index of sixty (60) as determined in Practice E313. Color shall be determined using 0/45 or 45/0 geometry.

c. Retroreflectance:

1) White preformed marking tape shall have the following initial minimum retroreflectance values as measured in accordance with ASTM D4061.

2) Retroreflectance values shall be expressed as coefficient of retroreflected luminance (R_L) in millicandelas per square foot per footcandle (mcd/ft^2/fc).

Entrance Angle	86.0°	86.5°	88.8°
Observance Angle	0.2°	1.0°	1.05°
R_L (mcd/ft^2/fc)	550	300	250

d. Skid Resistance: The surface of the retroreflective pavement marking tape shall provide an initial minimum average skid resistance value of 45 BPN when tested in accordance with ASTM E303.

e. Durability:

1) The durability of the pavement marking material shall be the percentage of the marking material remaining on the pavement surface in satisfactory working condition.

2) The initial value shall always be established at 100 percent.

f. Performance Requirements:

1) Type 2 pavement marking material, when applied according to the recommendations of the manufacturer, shall provide a neat, durable marking that will not flow or distort due to the temperature if the pavement surface remains stable.

2) The material shall be weather resistant and, through normal traffic wear, shall show no fading that will significantly impair the intended use of the marking throughout its useful life.

3) Pavement marking tape shall show no lifting or shrinkage and shall show no significant tearing, roll back, or other signs of poor adhesion.

4) Type 2 pavement marking material shall also meet the performance criteria establish in the table below.

Performance Factor*	**Heavy Traffic** (greater than 6,000 ADT per lane)	**Medium and Light Traffic** (6,000 ADT or less per lane)
Retained Retroreflectivity	74	40
Durability	90%	75%
Whiteness Index	10	10
Whiteness Index (0.5 million vehicle passes)	20	20

*Values for the performance factors are retained values which shall be determined after the markings have been in place a minimum of one (1) year and subjected to a minimum 4,000,000 vehicle passes per lane.

g. Installation and Warranty

1) The markings shall be applied in accordance with the manufacturer's instructions.

2) Contractor shall provide to Engineer the manufacturer's written installation instructions and a recommendation for the type of adhesive to be used prior to installation of materials.

3) The marking material and installation shall have a minimum 1-year warranty.

B. **Type 1:**

1. Type 1 pavement marking material shall be a durable retroreflective pliant pavement marking for use on asphalt or concrete pavements for longitudinal markings such as edge lines and lane lines.

2. The color of the marking material shall be white or yellow and conform to standard highway colors.

3. Type 1 materials shall be as follows

a. **Preformed Pavement Marking Tape:** This material shall meet minimum requirements set forth in ASTM D4505 except as modified below:

1) Retroreflectance:

a) White and yellow preformed marking tape shall have the following initial minimum retroreflectance values as measured in accordance with the testing procedures of ASTM D4601.

b) Retroflectance values shall be expressed as coefficient of retroreflected luminance (RL) in millicandelas per square foot per footcandle (mcd/ft2/fc).

	White			**Yellow**		
Entrance Angle	86.0º	86.5º*	88.8°	86.0º	86.5º*	88.8°
Observance Angle	0.2º	1.0º	1.05°	0.2º	1.0º	1.05°
R_L (mcd/ft^2/fc)	800	600	400	700	500	300

2) Skid Resistance: The surface of the retroreflective pavement marking tape shall provide an initial minimum average skid resistance value of 45 BPN when tested in accordance with ASTM E303.

b. **Preformed Thermoplastic Tape (Yellow Markings Only):**

1) The preformed retroreflective marking material shall consist of a resilient polymer thermoplastic with uniformly distributed retroreflective beads throughout its entire cross section.

2) The markings shall be fusible to asphalt and Portland cement concrete pavements by the normal heat of a propane torch as recommended by the manufacturer.

c. **Paint:**

1) Traffic paint used for pavement markings shall conform to material requirements listed in the following subsections:

a) Subsection 714.03.05, "Paint for Traffic Striping, Pavement Marking, and Curb Marking - General,"

b) Subsection 714.03.07, "Fast Dry Traffic Paint,"

c) Subsection 714.03.09, "Ready-Mixed Traffic Stripe Paints."

2) Requirements for retroreflective beads used with the application of this material are listed in Subsection 714.03.12, "Reflective Material."

d. **Epoxy Paint (Yellow Marking Only):**

1) Epoxy paint marking material shall consist of a 100 percent solid, 2-part system formulated and designed to provide a simple volumetric mixing ration of 2 components.

2) Epoxy paint used for pavement markings shall conform to materials requirements listed in Subsection 714.03.10, "Epoxy Paint for Traffic Markings."

3) Requirements for retroreflective beads used with the application of this material are listed in Subsection 714.03.12, "Reflective Material."

e. **Polyurea Paint:**

1) Polyurea paint marking shall consist of a 100 percent solid, 2-part system formulated and designed to provide a simple volumetric mixing ratio of 2 components.

2) Polyurea paint used for pavement markings shall conform to materials requirements listed in Subsection 714.03.10, "Epoxy Paint for Traffic Markings."

3) Requirements for retroreflective beads and reflective elements used with the application of this material are listed in Subsection 714.03.12, "Reflective Material."

f. Durability:

1) The durability of the pavement marking material shall be the percentage of the marking material remaining on the pavement surface in satisfactory working condition.

2) The initial value shall always be established at 100 percent.

g. Performance Requirements:

1) Type 1 pavement marking material, when applied according to the recommendations of the manufacturer, shall provide a neat, durable marking that will not flow or distort due to the temperature if the pavement surface remains stable.

2) The material shall be weather resistant and, through normal traffic wear, shall show no fading that will significantly impair the intended use of the marking throughout its useful life.

3) Pavement marking tape shall show no lifting or shrinkage and shall show no significant tearing, roll back, or other signs of poor adhesion.

4) Type 1 pavement marking material shall also meet the performance criteria established in the table below.

Performance Factors	**Heavy Traffic** (greater than 6000 ADT per lane)		**Medium and Light Traffic** (6000 ADT or less per lane)	
	White	**Yellow**	**White**	**Yellow**
Retained Retroreflectivity	200	150	100	100
Durability	98%	95%	93%	93%
Whiteness Index	6	45	6	40

*Values for the performance factors are retained values which shall be determined after the markings have been in place a minimum of one (1) year and subjected to a minimum 4,000,000 vehicle passes per lane.

h. Installation and Warranty:

1) The markings shall be applied in accordance with the manufacturer's instructions.

2) Contractor shall provide to Engineer the manufacturer's written installation instructions and a recommendation for the type of adhesive to be used prior to installation of materials.

3) The marking material and installation shall have a minimum 1-year warranty.

i. Qualified Products List:

1) The Nevada Department of Transportation (NDOT) maintains a Qualified Products List (QPL) of all products available that satisfy the requirements of these specifications and have proven effective in field tests. The current NDOT QPL is available at: http://www.nevadadot.com/reports_pubs/QPL/.

714.03.07 FAST DRY TRAFFIC PAINT

A. Type 2 (Heatable) Fast Dry White, Type 2 (Heatable) Fast Dry Yellow, Type 1 Fast Dry White, and Type 1 Fast Dry Yellow shall comply with any western state specification valid at the time of use in addition to meeting Subsection 714.03.05, "Paint for Traffic Striping, Pavement Marking, and Curb Marking – General, and listed on the NDOT QPL.

B. Fast dry traffic paint shall be applied at the film thickness of 15 mils to 20 mils and shall dry to "no traffic pickup" within 3 minutes.

C. The "no traffic pickup" time shall be determined by ASTM D711.

714.03.08 ALL PURPOSE BLACK TRAFFIC PAINT - PAINT FORMULA 235

A. All purpose Black Traffic Paint - Paint Formula 235 shall comply with any western state specification valid at the time of use, and listed on the NDOT QPL.

714.03.09 READY-MIXED TRAFFIC STRIPE PAINTS

A. Where ready-mixed paints are specified, they shall be suitable for use on either asphalt concrete or Portland cement concrete.

714.03.10 EPOXY PAINT FOR TRAFFIC MARKINGS

A. Epoxy traffic paints shall be a 2-component marking material suitable for use on either asphalt concrete or Portland cement concrete.

B. Mixing of 2 components shall be performed as recommended by the manufacturer.

C. Epoxy paint shall only be applied if air temperature is a minimum of 50 degrees F at the time of marking installation.

D. If the manufacturer of the marking material requires a minimum air temperature different than detailed above, the higher temperature shall be used.

E. If material needs heating prior to application, no fumes shall be exuded that are toxic or injurious to persons or property.

F. Epoxy paint shall dry to "no traffic pickup" within 45 minutes.

714.03.11 POLYUREA PAINT FOR TRAFFIC MARKINGS

A. Polyurea traffic paints shall be a 2-component marking material suitable for use on either asphalt concrete or Portland cement concrete.

B. Mixing of 2 components shall be performed as recommended by the manufacturer.

C. Polyurea paint shall be applied if air temperature is a minimum of 40 degrees F at the time of marking application.

D. If the manufacturer of the marking material requires a minimum air temperature different than detailed above, the higher temperature shall be used.

E. If material needs heating prior to application, no fumes shall be exuded that are toxic or injurious to person or property.

F. Polyurea paint shall be dry to “no traffic pickup” within 5 minutes.

714.03.12 REFLECTIVE MATERIAL

A. Reflective material shall consist of retroreflective beads and of the final coat of traffic paint or epoxy paint and polyurea paint prior to setting, so that the beads will have proper adhesion.

B. Special care shall be taken with rapid dry paint and epoxy paint materials.

C. Retroreflective beads shall conform to Federal Specification TT-B-1325B and shall be mechanically applied at a rate recommended by the manufacturer to achieve performance criteria established in Section 714.03.06, "Pavement Markings."

D. Retroreflective beads shall be applied to pavement markings, curbs, and crosswalks by use of a dispensing device developed for this purpose or other methods approved by the Engineer.

E. The Engineer may authorize the use of traffic paint containing pre-mixed retroreflective beads.

1. The type, gradation, quantity, and quality of the pre-mixed retroreflective beads shall be approved prior to the manufacture of the traffic paint.

2. In addition to the specified pre-mixed beads, additional beads may need to be mechanically applied when the traffic paint is applied.

714.03.13 AIR POLLUTION

A. All paint shall meet the requirements of the Clark County Department of Air Quality and Environmental Management (DAQEM).

714.03.14 TEST REPORTS AND CERTIFICATION

A. At the time of delivery of each shipment of material, the Contractor shall, upon request, deliver to the Engineer certified copies of the manufacturer's test report.

B. The test report shall indicate the name of the manufacturer, type of material, date of manufacture, quantity, applicable State Specification Number and specification, manufacturer's lot or batch number, and results of the required tests.

1. The test report shall be signed by an authorized representative of the manufacturer.

2. The certified test reports and the testing required in connection therewith shall be at no cost to the Contracting Agency.

SECTION 715

GALVANIZING

SCOPE

715.01.01 MATERIALS COVERED

A. This specification covers the quality and thickness of galvanizing used on various material when called for on the plans or designed in the specifications.

REQUIREMENTS

715.02.01 BLANK

PHYSICAL PROPERTIES AND TESTS

715.03.01 PRODUCTS 1/8-INCH THICK AND THICKER

A. Galvanizing of products fabricated from rolled, pressed, and forged steel shapes, plates, bars, and strip shall conform to ASTM A123.

715.03.02 GUARDRAIL ELEMENTS

A. All rail elements shall be galvanized in accordance with AASHTO M180, Type 2.

715.03.03 HARDWARE

A. Bolts, nut, washers, and fastenings shall be galvanized in accordance with ASTM A153.

SECTION 716

SIGN MATERIALS

SCOPE

716.01.01 MATERIALS COVERED

A. This specification covers the kind and quality of materials used in the construction and fabrication of traffic control devices used in temporary event zones and for permanent installations.

REQUIREMENTS

716.02.01 GENERAL

A. The following materials shall conform to the requirements as noted:

Material	Section
Portland Cement Concrete	501
Reinforcing Steel	505

716.02.02 CERTIFICATES

A. The Contractor shall ascertain that all required tests have been made by qualified testing laboratories as approved by the Contracting Agency.

B. 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.

716.02.03 SUBMITTALS

A. Before fabrication is started, 5 sets of shop drawings for each overhead sign structure shall be submitted to the Engineer for approval.

PHYSICAL PROPERTIES AND TESTS

716.03.01 REFLECTIVE SHEETING

A. Sheeting shall be of the following class sets, as specified in the plans or the proposal, and, unless otherwise specified or approved by the Engineer, shall be Class 6.

B. The sheeting shall be a material approved by the Engineer, applied to approved sign substrate in accordance with manufacturer's instructions, and conform to the applicable requirements below.

C. **Class 1 - Non-Retroreflective Plastic Film (ScotchCal or equal):**

1. Pressure sensitive adhesive coated plastic film for sign copy and borders shall be a material recommended by the retroreflective sheeting manufacturer as compatible with the background retroreflective sheeting.

2. Film shall meet the requirements for Type I, Class 1 of MIL-M-43719B, "Marking Materials and Markers, Adhesive, Elastomeric, Pigmented."

3. **Life:** Shall be the same as material applied upon.

D. **Class 2 - Enclosed Lens Retroreflective Sheeting (Engineer grade or equal):**

1. Class 2 sheeting shall meet the requirements of ASTM D4956, Type I.
2. **Life:** 7 years.

E. **Class 3 - Enclosed Lens Retroreflective Sheeting (Super Engineering grade or equal):**

1. Class 3 sheeting shall meet the requirements of ASTM D4956, Type II.
2. **Life:** 10 years.

F. **Class 4 - Encapsulated Lens Retroreflective Sheeting (High Intensity grade or equal):**

1. Class 4 sheeting shall meet the requirements of ASTM D4956, Type III and/or Type IV.
2. **Life:**
   a. 10 years.
   b. 3 years for Work Zone retroreflective sheeting.
3. Retroreflective sheeting for work/special event zone reboundable devices (cones and delineators) shall be Class 4 sheeting.

G. **Class 5 - Wide-Angle Prismatic Retroreflective Sheeting:**

1. Class 5 sheeting shall meet the requirements of ASTM D4956, Type VII sheeting and shall have minimum coefficients of retroreflection, in units of candelas per footcandle per square foot, not less than the values shown below:
2. **Life:**
   a. 10 years for fluorescent sheeting.
   b. 12 years for non-fluorescent sheeting.
   c. 3 years for fluorescent orange sheeting.
3. Class 5 fluorescent orange sheeting shall be used on all construction warning signs and devices except Type I, Type II, and Type III barricades.
   a. Type I, Type II, and Type III barricades shall use non-fluorescent Class 5 sheeting.
   b. Legends and borders for signs using Class 5 fluorescent orange retroreflective sheeting shall be in accordance with manufacturer's recommendations.
   c. Retroreflective sheeting for work/special event zone reboundable devices (traffic barrels/drums) shall be Class 5 sheeting.

H. **Class 6 - Wide-Angle Prismatic Retroreflective Sheeting.**

1. Class 6 sheeting is a wide-angle retroreflective sheeting with optimized performance over a broad range of observation angles and shall meet the requirements of ASTM D4956, Type IX sheeting.
2. **Life:**
   a. 10 years for fluorescent sheeting.
   b. 12 years for non-fluorescent sheeting.
   c. 3 years for fluorescent orange sheeting.

I. Fluorescent yellow-green reflective sheeting shall be used on the following signs only:

1. School Advance (S1-1).
2. School Bus Stop Ahead (S3-1).
3. School Speed Limit (S5-1).
4. Advance Pedestrian Crossing (W11-2).
5. Bicycle Crossing (W11-1).
6. Related supplemental plates.

J. Inks and films for legends and borders on retroreflective sheeting shall be in accordance with manufacturer's specification.

K. **Field Performance Life Requirement:**

1. The supplier shall warranty that signs supplied shall have an effective retroreflective life of not less than that specified above.
2. The retroreflective sheeting shall be considered unsatisfactory and failing this life requirement if it has deteriorated due to natural causes to the extent that 1 or more of the following is true:
   a. The sign is ineffective for its intended purpose when viewed from a moving vehicle under normal day and night conditions.
   b. The values for the coefficients of retroreflection for Class 2 through Class 6 are less than 50 percent of the required values for the same sign when new.
   c. The sign material's integrity or adhesion to the sign substrate has substantially failed.
3. Sheeting which fails the life requirement within the specified required lifetime shall be replaced at no charge.
4. Replaced sheeting lifetime shall begin at time of replacement and lifetime shall be to the life requirement per sheeting type.
5. All finished signs shall be dated with the month and year of delivery in order to ascertain compliance with the life requirements.

716.03.02 BLANK

716.03.03 ALUMINUM SIGN PANELS (FOR REFLECTIVE SHEETING)

A. Sheet aluminum for sign panels shall be of 0.100-inch aluminum alloy Alclad 5052-H38 or 6061-T6 and shall conform to ASTM B209.

B. Sign panels for street name signs shall be as required in the Standard Drawings.

C. Sign panel sections shall be fabricated of standard width aluminum sheets not less than 4 feet wide, except that not more than 2 sheets for any 1 sign may be cut not less than 18 inches in width to provide sign widths to nearest 6-inch increments. Panel sections shall run from the top edge to the bottom edge of the sign without horizontal joints.

D. The aluminum shall be free of all corrosion, white rust, and dirt.

1. All sign dimensions, metal gauge, and bolt holes shall conform to the plans and these specifications.

2. Blanks shall be cleaned, degreased, and chromated or otherwise properly prepared according to methods recommended by the sheeting manufacturer.

E. Metal shall not be handled, except by device or clean canvas gloves, between all cleaning operations and the applications 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 application of the background material.

F. All fabrication, including cutting, shall be completed prior to the cleaning process.

1. Metal panels shall be cut to size and shape and shall be free of defects resulting from fabrication.

2. The surface of all sign panels shall be a plane surface.

716.03.04 BLANK

716.03.05 OVERHEAD SIGN STRUCTURES AND SIGN FRAMES

A. The materials used in the fabrication of overhead sign structures and footings shall conform to the requirements specified below.

B. **Sign Frames:** Bars, plates, and shapes shall be structural steel conforming to ASTM A36.

C. **Sign Pipe Posts:**

1. Pipe posts shall be welded or seamless steel pipe conforming to ASTM A53, Grade B.

2. At the option of the Contractor, posts may be fabricated from structural steel conforming to ASTM A36 or ASTM A283, Grade D, except that plates more than 1 inch in thickness shall be structural steel conforming to ASTM A373.

D. **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 ASTM 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 free from warps, twists, and other defects affecting their appearance or serviceability.

a. The tops of the bearing bars and cross members shall be in the same plane.

b. Gratings distorted by the galvanizing process shall be straightened.

E. **Bolts and Nuts:**

1. Bolts and nuts shall conform to ASTM A307.

2. Bolted connections shall conform to Subsection 506.03.10, "Bolts and Bolted Connections."

F. Bearing plates and gusset or stiffener plates shall be of the sizes and dimensions shown on the plans and shall be galvanized after fabrication.

1. Steel shall conform to ASTM A36.

2. Galvanizing shall conform to ASTM A123.

3. All welding shall conform to Subsection 506.03.20, "Welding."

G. 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 A153 or cadmium plated in accordance with ASTM A165, Type TS.

1. The top portion of anchor bolts shall be galvanized or cadmium plated so that the galvanized or cadmium plated portion will extend at least 2 inches into concrete.

2. Anchor bolts shall be of the size, shape, and length shown on the plans.

H. All bolts, nuts, clamps, and metal washers not otherwise noted shall be galvanized or cadmium plated.

1. Cadmium plating shall conform to ASTM A165, minimum thickness as prescribed for grade Type TS.

2. Galvanizing shall conform to ASTM A153.

I. Supporting frame shall be manufactured in accordance with the plans and requirements herein specified.

1. All metal parts shall be galvanized after fabrication, in accordance with Section 715, "Galvanizing."

2. 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.

3. Metalizing shall be performed in accordance with 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.

1. Splice locations shall be submitted to the Engineer for approval.

2. Contractor shall not commence fabrication until such splice locations are approved.

K. All welding on the fabrication of the structure shall be done by welders qualified in accordance with AWS requirements using the inert-gas shielded-arc method.

1. Welds shall be free from cracks, blow holes, and other irregularities.

2. Welds shall be wire brushed or otherwise cleaned.

3. No field welding on any part of the structural assembly will be permitted.

716.03.06 SIGN HARDWARE, POST, AND RELATED MATERIALS

A. Bearing plates and gusset or stiffener plates shall be of the sizes and dimensions shown on the plans and shall be galvanized after fabrication.

1. Steel shall conform to ASTM A36.

2. Galvanizing shall conform to ASTM A123.

3. All welding shall conform to Subsection 506.03.20, "Welding."

B. Structural I-beam steel shall be galvanized in accordance with ASTM A153 or cadmium plated in accordance with ASTM A165, Type TS.

C. Anchor bolts, nuts, and washers shall be of structural carbon steel conforming to Section 710, "Structural and Eyebar Steel."

1. The top portion of anchor bolts shall be galvanized or cadmium plated so that the galvanized or cadmium plated portion will extend at least 2 inches into the concrete.

2. Anchor bolts shall be of the size, shape, and length shown on the plans.

D. Steel pipe for posts shall conform to ASTM A53, Grade B, and shall be galvanized.

1. Galvanized steel pipe posts shall be of the diameter and length shown on the plans.

2. The top of the posts shall be fitted with a cover.

3. Posts showing damage shall be repaired or rejected.

E. Wood posts shall be constructed of Douglas Fir, West Coast Hemlock, or any other equivalent stress-rated wood material, at the option of the Contractor.

1. The wood material shall be construction grade, free of heart center, minimum stress rating of 1200f, and graded in accordance with the provisions contained in Section 718, "Timber."

2. Sweep shall not exceed 0.08 feet in 10 feet.

F. Aluminum stiffeners, braces, and stringers used as horizontal supporting structural members shall be of aluminum alloy 6061-T6.

1. These extrusions shall have a continuous, inverted "T" slot.

2. The inverted "T" shall accommodate positionable stainless steel clamping devices.

3. The clamping devices shall provide complete freedom of alignment within the slot, forming an interlocking clamp system for fastening the sign to the post.

4. The sign support system described herein shall conform to AASHTO *Standard Specifications for Highway Signs, Luminaires and Traffic Signals*, latest revision, and be rated for minimum wind velocities of 80 mph.

5. All bolts, nuts, clamps, and metal washers in contact with this aluminum channel shall be Stainless Steel Type 304.

6. The system shall be compatible with all I-beam, steel post, and wood post systems.

G. All other bolts, nuts, clamps, and metal washers in contact with other aluminum components shall be galvanized or cadmium plated.

1. Cadmium plating shall conform to ASTM A165, minimum thickness as prescribed for grade Type TS.

2. Galvanizing shall conform to ASTM A153.

H. Cantilever arm brackets shall be used when it is desired to offset the entire length of a sign to 1 side of a post or pole.

1. Cantilever arm brackets shall consist of a stainless steel or aluminum head mounted to an extruded aluminum "TEE" section.

2. The "TEE" section shall have a continuous slot that will accept signs up to 1/8 inch thick.

3. If sign thickness, including aluminum sign panel and reflective sheeting, exceeds the width of the "TEE" section slot, sign panel thickness may be reduced to not less than 0.080 inch, or reflective sheeting may be eliminated in the bracket area, as directed by the Engineer.
4. The heads shall be designed to accept 3/4-inch stainless steel banding.
5. The "TEE"-shaped extrusions shall be made from 6061-T6 aluminum alloy.
6. The cantilever arm brackets shall be used to support the entire length of the sign on both the top and the bottom.
7. The sign shall be attached to the brackets using 1/8-inch rivets spaced according to the hole pattern pre-drilled on the extruded "TEE" section.
8. The cantilever arm brackets shall be compatible with any size and shape of post or pole.
9. The system shall be designed for use on signs up to 72 inches in length with a maximum surface area of 9.5 square feet.
10. Signs with surface area greater than 2 square feet shall be fastened to round posts or poles using 3/4-inch by 0.030-inch stainless steel banding.
11. When mounting to square posts or flat surfaces, compatible stainless steel threaded studs or bolts can be used as well as 3/4-inch by 0.030-inch stainless steel banding.
12. For signs less than 2 square feet in surface area, 5/8-inch banding is acceptable.

SECTION 717

TIMBER PILES

SCOPE

717.01.01 MATERIALS COVERED

A. This specification covers the quality of round timber piles.

REQUIREMENTS

717.02.01 CERTIFICATES

A. Inspection certificates shall be furnished without extra charge with each shipment of timber piles.

B. These certificates shall be issued by the inspection agency under whose rules the material was manufactured and graded.

C. Timber piles to be treated shall be inspected prior to treatment by an inspector designated by the Engineer.

1. The inspector shall stamp each pile on the butt end with a stamp that shall make an impression that is readily legible after treatment.
2. The stamp shall be copyrighted and a true impression filed with the Contracting Agency.

PHYSICAL PROPERTIES AND TESTS

717.03.01 GENERAL

A. Timber piles shall conform to ASTM D25.

SECTION 718

TIMBER

SCOPE

718.01.01 MATERIALS COVERED

A. This specification covers the quality requirements for structural timber, lumber, guardrail posts, markers, and miscellaneous items.

REQUIREMENTS

718.02.01 GRADES

A. Grades furnished shall be as noted on the plans or in the Special Provisions.

718.02.02 CERTIFICATES OF INSPECTION

A. Inspection certificates shall be furnished without extra charge with each shipment of timber.

B. 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

A. 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)	Pseudosuga taxifolia (coast type)
Fir, Douglas (inland)	Pseudosuga taxifolia (inter-mountain type)
Hemlock, West Coast	Tsuga Heterophylla
Larch	Larix Occidantalis
Redwood, California	Sequoia sempervirens

718.03.02 GRADES

A. 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.

B. Any commercial grading rules, including grading rules of The West Coast Lumber Inspection Bureau and the Western Wood Products Association, that will provide material of an equal or greater stress value may be used.

C. Grading rules in effect on the date of advertisement of bids shall govern.

D. Guardrail posts and blocks shall meet the following requirements:

1. Douglas Fir and Western Larch shall conform to the West Coast Lumber Inspection Bureau grading rules, paragraph 131-b, No. 1 Structural grade, or with the Western Wood Products Association grading rules, paragraph 80.11.
2. West Coast Hemlock shall conform to the West Coast Lumber Inspection Bureau grading rules, paragraph 131-a, Select Structural grade, or with the Western Wood Products Association grading rules, paragraph 80.10.

SECTION 719

TIMBER PRESERVATIVES

SCOPE

719.01.01 MATERIALS COVERED

A. This specification covers the type and quality of materials used in the preservative treatment of timber.

REQUIREMENTS

719.02.01 BLANK

PHYSICAL PROPERTIES AND TESTS

719.03.01 PRESERVATIVES

A. Timber preservatives shall conform to AASHTO M133.

SECTION 720

GUARDRAIL MATERIALS

SCOPE

720.01.01 MATERIALS COVERED

A. This specification covers the quality and kind of material used in the construction of guardrail.

REQUIREMENTS

720.02.01 CERTIFICATES

A. Contractor shall furnish 2 certified copies of mill test reports showing the chemical and physical characteristics from each heat from which metal is used.

B. Certificates for wood posts shall be furnished in accordance with Subsection 718.02.02, "Certificates of Inspection."

C. 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

A. Rail members shall conform to AASHTO M180 for Class A, Type 2 guardrail.

720.03.02 FITTINGS

A. 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 5,000-pound side pull in either direction.

B. All bolts, nuts, and washers shall be 5/8 inch in size.

1. Bolts shall be buttonhead style and nuts shall be hexagonal.
2. Bolts and nuts tapped oversize shall not exceed 1/32 inch.
3. Outside dimensions of bolt heads, nuts, and washers shall have the following minimums:
   a. Bolt Heads: 1-1/4 inches.
   b. Nuts: 15/16 inch.
   c. Washers: 1-1/2 inches.
4. Splice bolts shall be 1-1/4 inches in length.
5. Post connection bolts shall be of lengths required to fit the post dimensions and extend beyond the tightened nuts thereon within limits of 1/4 inch to 1/2 inch.
6. Washers 1/8 inch thick shall be provided for use under nuts on all post bolts and under any nut that has a width of less than 1-1/16 inches.

C. All fittings shall be galvanized in accordance with Section 715, "Galvanizing."

720.03.03 REFLECTOR PLATES

A. Reflector plates shall be fabricated from 11 gauge steel sheet or 0.148-inch thick aluminum sheet alloy 6061-T6.

B. Nails for fastening reflector plates to the guardrail post shall be either galvanized metal or aluminum.

C. Steel reflector plates shall be galvanized.

D. Reflectorized material for reflector plates shall conform to Subsection 721.03.03, "Reflectors."

720.03.04 CABLE END ANCHOR ASSEMBLIES

A. Cable end anchor assemblies for metal beam guard railing shall conform to the provisions specified below.

B. The anchor plate shall be fabricated of steel conforming to ASTM A36.

C. The anchor rod shall be fabricated of steel conforming to ASTM A575 or ASTM A576, Grade 1020.

   1. The eye may be drop forged or formed with a full penetration weld.

   2. The eye shall develop 100 percent of the rod strength.

D. All bolts and nuts shall conform to ASTM A307 and be galvanized in accordance with Section 715, "Galvanizing."

E. Anchor cable shall be 3/4-inch preformed, 6 x 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.

F. Thimbles shall be commercial quality, galvanized steel.

G. Cable clips shall be commercial quality drop forged galvanized steel.

H. The swaged fitting and stud assembly shall be of AISI C1035 steel and shall be annealed, galvanized, suitable for cold swaging. The swaged fitting and stud assembly shall develop 100 percent of the breaking strength of the cable.

I. Contractor shall furnish to the Engineer for testing 1 sample of cable as specified above, properly fitted with swaged fitting, right-hand thread stud at both ends, and 3 feet in total length.

SECTION 721

OBJECT MARKERS AND GUIDE POSTS

SCOPE

721.01.01 MATERIALS COVERED

A. This specification covers the quality and kind of material used in the construction of object markers and guide posts.

REQUIREMENTS

721.02.01 CERTIFICATES

A. At no additional cost to the Contracting Agency, 2 certificates covering each order of material (plates, reflectors, and posts) shall be furnished by the manufacturer, certifying that the product complies with the specifications.

B. Certificates shall be delivered to the Engineer at the time of, or prior to, delivery of the order.

C. For steel used in posts, the Contractor shall furnish 2 certified copies of mill test reports showing the chemical and physical characteristics from each heat.

PHYSICAL PROPERTIES AND TESTS

721.03.01 METAL POSTS

A. Posts shall be steel conforming to ASTM A570, Grade C.

B. 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.

B. Zinc-Coated Steel Sheet:

1. 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 180-degree bend on itself at room temperature without flaking the coating.

2. The zinc-coated surface shall be prepared for painting by the application of phosphate coating.

3. Surface preparation shall conform to the following requirements:

   a. The phosphatizing process shall be accomplished without damaging or removing the galvanized coating from the steel base metal.

   b. Any evidence of damage or removal of the zinc coating shall be cause for rejection of the entire lot.

C. Aluminum Sheet:

1. The aluminum shall be prepared for painting with a chemical conversion coating conforming to Federal Specification MIL-C-5541.

2. The coating shall be applied in accordance with the manufacturer's specifications and recommended sequence of operation.

3. Contractor shall furnish 2 copies of certified mill tests of the aluminum sheets to the Engineer.

D. Target plates shall be fabricated from 20 gauge steel sheet or 0.050-inch thick aluminum sheet, alloy 3005-H14.

E. Fabrication of all metal parts shall be accomplished in a uniform and workmanlike manner.

1. 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.

2. Surfaces and edges of the plates shall be free from defects resulting from fabrication.

F. **Paint:**

1. Target plates shall have satisfactory paint adherence.

2. The plates shall be coated with baked enamel conforming to the following provisions:

a. The enamel finish coat for plates shall comply in all respects with 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.

b. 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.

c. 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.

d. The dry film thickness on both front and back surfaces of the aluminum plates shall be:

1) Not less than 1.5 mils on each side if enamel is applied by spray or dip method.

2) Not less than 1.0 mil if enamel is applied by continuous roller coat method.

e. The coating shall be uniform throughout and shall be smooth and free from flow lines, streaks, blisters, and other surface imperfections.

G. 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:**

1. Each reflective delineator shall have the following minimum brightness values at 2 degrees divergence expressed as candlepower per foot candle.

2. 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			
	0.2	0.5	0.2	0.5
	Brightness (cd/ftcd)			
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

3. The brightness of the reflective sheeting, totally wet by rain, shall not be less than 90 percent of the above values.

4. Wet performance measurements shall be conducted in conformance with standard rainfall tests specified in MIL-R-13689A.

B. **Durability.** The delineator surface shall readily be refurbished by cleaning and clear overcoating in accordance with the manufacturer's recommendations.

SECTION 722

WATER

SCOPE

722.01.01 MATERIAL COVERED

A. This specification covers the quality of water from non-potable sources 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

A. 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

722.02.02 CONCRETE USE

A. Samples submitted for tests shall consist of 2 quarts of water, obtained and shipped in clean glass containers carefully packed and labeled.

B. Tests shall be made in accordance with AASHTO T26.

C. Any indication of unsoundness, marked change in time of setting, or a reduction of more than 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

A. This specification covers the quality of bolts, nuts, washers, drift pins, dowels, nails, spikes, and other metal fastenings.

REQUIREMENTS

723.02.01 BLANK

PHYSICAL PROPERTIES AND TESTS

723.03.01 GALVANIZING

A. Galvanizing, when required, shall comply with ASTM A153.

723.03.02 BOLTS, NUTS, DOWELS, AND DRIFT BOLTS

A. Bolts, nuts, dowels, and drift bolts shall conform to ASTM A307, Grade A, unless otherwise specified.

723.03.03 WASHERS

A. Cast washers shall be of cast iron of the 0-gee type.

1. The diameter shall be not less than 3-1/2 times the diameter of the bolts for which it is used.
2. The diameter of the hole shall be 1/8 inch larger than the diameter of the bolt.

B. 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, shall comply with the following:

1. The diameter shall be not less than 3-1/2 times the diameter of the bolt for which it is used.
2. The thickness shall be equal to 1/2 the diameter of the bolts.
3. The diameter of the hole shall be 1/8 inch larger than the diameter of the bolt.

SECTION 724

FENCE MATERIALS

SCOPE

724.01.01 MATERIALS COVERED

A. 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

A. The Contractor shall supply the Engineer with 3 line posts for testing purposes, the posts to be selected at random by the Engineer.

B. At no additional cost to the Contracting Agency, 2 certificates covering each order of material shall be furnished from the manufacturer, certifying that the various metal components comply with the requirements herein.

C. The certificates shall be delivered to the Engineer at the time, or prior to, delivery of the order.

PHYSICAL PROPERTIES AND TESTS

724.03.01 WOOD POSTS

A. Intermediate braced posts and braces shall be of the same type as line posts.

B. End, gate, and corner post assemblies, including bracing timber, shall be sawed, shall conform to the grading requirements of Section 718, "Timber," and shall be of Douglas Fir, Larch, or Southern Pine.

C. 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 that will impair their strength or durability.

   1. 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 1/2 inch wide or 3 inches long.

   2. All knots shall be trimmed flush with the side, spurs and splinters removed, and ends cut square.

D. Line posts and intermediate braced posts and braces shall not be less than 7 feet long and all other posts and braces shall be not less than 8 feet long.

E. The small end of round line posts and braces shall be between 3-1/2 inches and 4-1/2 inches in diameter; the small end of intermediate braced posts shall be between 5-1/2 inches and 6-1/2 inches in diameter. The allowable taper from end to end of round posts and braces shall not exceed 1-1/2 inches.

F. All posts and braces shall be pressure-treated with creosote, creosote-coal tar solution, or pentachlorophenol solution in accordance with Section 719, "Timber Preservatives."

1. The minimum weight of pentachlorophenol solution retained per cubic foot of post shall be 0.6 pound.
2. Pentachlorophenol solution shall consist of 5 percent pure pentachlorophenol in light petroleum.
3. All posts and braces shall be treated with the same type of preservative.

G. When pressure-treated materials have been damaged or when it has been absolutely necessary to cut or bore into them, after delivery to the job site, 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

A. Tubular posts shall be galvanized standard-weight steel pipe conforming to ASTM F1083, except that the hydrostatic test will not be required.

B. At the Contractor's option, tubular pipe and posts conforming to AASHTO M181, Grade 2 may be used, except that Grade 2 posts shall be only zinc plus organic coated.

C. C-section posts and braces shall be roll formed steel conforming to ASTM A570, Grade 45 and zinc coated in accordance with ASTM F1083 or zinc plus organic coated in accordance with AASHTO M181, Grade 2.

1. The required exterior coating shall be applied to both the interior and exterior of C-section posts.
2. Pre-galvanized C-section posts may be used provided the edges are coated in conformance with ASTM A780.

D. Pipe and posts shall meet the following performance criteria when subjected to salt spray testing in accordance with ASTM B117:

1. Exterior surface - 1,000 hours with maximum 5 percent red rust.
2. Interior surface - 650 hours with maximum 5 percent red rust.

E. The base metal for the manufacturer of other steel sections used for post and braces shall be good commercial quality weldable steels.

POST SIZES FOR CHAIN-LINK FENCE
6-Foot or Less Fabric Height and Type A Fencing

Post Location	Post Type	Minimum Post Size	
Terminal	Pipe	2.375-inch O.D. X 0.130	X 3.12 lbs/ft
		2.375-inch O.D. Schedule 40	X 3.65 lbs/ft
Line	Pipe	1.900-inch O.D. X 0.120	X 2.28 lbs/ft
		1.900-inch O.D. Schedule 40	X 2.72 lbs/ft
	C-Section	1.875-inch X 1.625-inch	X 1.85 lbs/ft
Temporary Line	T-Post		X 1.13 lbs/ft
Braces	Pipe	1.660-inch O.D. X 0.110	X 1.82 lbs/ft
		1.660-inch O.D. Schedule 40	X 2.27 lbs/ft
	C-Section	1.625-inch X 1.250-inch	X 1.35 lbs/ft

Gate	Gate Leaf Width Up to 6 feet	2.875-inch O.D. X 0.160 X 4.64 lbs/ft
		2.875-inch O.D Schedule 40 X 5.79 lbs/ft
	Greater than 6 feet through 13 feet	4.000-inch O.D. X 0.160 X 6.56 lbs/ft
		4.000-inch O.D. Schedule 40 X 9.11 lbs/ft
	Greater than13 feet through 18 feet	6.625-inch O.D. Schedule 40 X 18.97 lbs/ft
	Greater than18 feet through 23 feet	8.625-inch O.D. Schedule 40 X 28.55 lbs/ft

POST SIZES FOR CHAIN-LINK FENCE Greater than 6-Foot to 8-Foot Fabric Height		
Post Location	**Post Type**	**Minimum Post Size**
Terminal	Pipe	2.875-inch O.D. X 0.160 X 4.64 lbs/ft
		2.875-inch O.D. Schedule 40 X 5.79 lbs/ft
Line	Pipe	2.375-inch O.D. X 0.130 X 3.12 lbs/ft
		2.375-inch O.D. Schedule 40 X 3.65 lbs/ft
	C-Section	1.875-inch X 1.625-inch X 2.28 lbs/ft
Braces	Pipe	1.660-inch O.D. X 0.110 X 1.82 lbs/ft
		1.660-inch O.D. Schedule 40 X 2.27 lbs/ft
	C-Section	1.625-inch X 1.250-inch X 1.35 lbs/ft

POSTS SIZES FOR CHAIN-LINK FENCE Greater than 8-Foot to 12-Foot Fabric Height		
Post Location	**Post Type**	**Minimum Post Size**
Terminal	Pipe	4.00-inch O.D. X 0.160 X 6.56 lbs/ft
		4.00-inch O.D. Schedule 40 X 9.11 lbs/ft
Line	Pipe	2.875-inch O.D. X 0.160 X 4.64 lbs/ft
		2.875-inch O.D. Schedule 40 X 5.79 lbs/ft
Braces	Pipe	1.660-inch O.D. X 0.110 X 1.82 lbs/ft
		1.660-inch O.D. Schedule 40 X 2.27 lbs/ft
	C-Section	1.625-inch X 1.250-inch X 1.35 lbs/ft

F. Gate posts for standard Type A fencing shall be as specified herein for chain-link fence except that for single gates over 13 feet and up to 18 feet, the posts shall be pipe, 4.000 inch O.D. by 0.160 (minimum) weighing not less than 6.56 pounds per linear foot.

G. T-Section Posts:

1. T-section posts shall be manufactured of steel conforming to ASTM A238, ASTM A663, or ASTM A675, or shall be manufactured to comply with ASTM A702, T-section type.

2. T-section posts shall be manufactured to tolerances and workmanship as provided in ASTM A702.

3. T-section posts shall be provided with tapered anchor plates attached securely thereto.

   a. The anchor plates shall weigh not less than 0.67 pound and have a minimum area of 15 square inches.

b. The top edge of the anchor plate shall be from 16 inches to 24 inches above the bottom end of the line post for Type A and Type C fence.

c. The anchor plate may be omitted provided the post is set in concrete.

d. Each post shall be furnished with galvanized wire clamps as follows: 1 clamp for each strand of barbed wire; and clamp for the top, bottom, and at not more than 14-inch intervals between top and bottom for mesh fencing.

4. T-section posts shall be galvanized or painted with anti-corrosive paint. The posts shall be drilled, notched, or stubbed to facilitate fastening the fencing.

724.03.03 BARBED WIRE

A. Barbed wire may be either steel or aluminum alloy.

B. Steel barbed wire shall conform to ASTM A121. The coating weight shall be Class I unless otherwise specified.

C. Barbed wire shall be composed of 2 strands of No. 12-1/2 gauge wire with 4-point barbs of 14 gauge spaced not more than 5 inches apart.

D. Aluminum alloy barbed wire shall be manufactured of aluminum alloy conforming to ASTM B211, alloy 5052-0 for the line wire and alloy 5052-H38 for the barbs.

724.03.04 WOVEN WIRE

A. Woven wire shall conform to ASTM A116, No. 12-1/2 Farm.

724.03.05 CHAIN-LINK FABRIC

A. Chain-link fabric and required fittings and hardware shall conform to AASHTO M181. The coating weight shall be 1.2 ounces of zinc per square foot or Type II aluminum coated unless otherwise specified by the Engineer.

B. The wire used in the manufacture of the fabric shall be 11 gauge for all fence 72 inches or less in height.

724.03.06 STAPLES, BRACE WIRE, AND NAILS

A. Brace wire shall be 8 gauge, medium temper, 55,000 psi to 75,000 psi tensile strength, and shall be galvanized as specified for barbed wire.

B. Staples shall be made from No. 9 U.S. gauge galvanized and shall be of the L-shaped (Strong-Hold) type. The long shank shall be threaded 1-3/4 inches.

724.03.07 METAL GATES

A. **Drive Gates for Standard Fencing.**

1. The gate frames shall be constructed of not less than 1-inch galvanized standard weight pipe conforming to the dimensions, nominal weights, and galvanizing specified in ASTM A53. Hydrostatic test will not be required.

2. 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.

3. The wire mesh shall be rectangular mesh or 2-inch diamond mesh and shall be galvanized as specified for woven wire fabric.

B. **Drive Gates for Chain-Link Fencing:**

1. The gate frame shall be constructed of not less than 1-1/2-inch galvanized standard weight pipe conforming to the dimension, nominal weights, and galvanizing specified under ASTM A53 (hydrostatic test will not be required), or 1-7/8-inch O.D. pipe conforming to AASHTO M181, Grade 2.
2. Gate frames shall be cross-trimmed with galvanized 3/8-inch adjustable truss rods.
3. The corners of the gate frames shall be fastened together and reinforced with malleable iron fittings designed for the purpose of welding.
4. Chain-link fence fabric as specified for the fence shall be attached to the gate frame by stretcher bars and tie wires as specified for fence construction and suitable tension connectors spaced at approximately 1-foot intervals.

C. **Walk Gates:**

1. Unless otherwise specified, walk gates shall be 3-1/2 feet wide and of the height corresponding to the adjacent fence.
2. The gate frame shall be constructed of not less than 3/4-inch galvanized standard weight pipe conforming to the dimension, nominal weights, and galvanizing specified under ASTM A53. Hydrostatic test will not be required.
3. The gate frame shall be filled with fabric as specified herein.
4. 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

A. Elastomeric bearing pads shall be preformed pads formed by casting or extruding natural rubber or neoprene under pressure and heat.

B. The pads shall be cast or extruded in a single, integral layer to the required thickness, unless pads with nonelastic lamination are called for on the plans.

C. All components of a laminated pad shall be molded together into an integral unit and all edges of the laminates shall be covered by a minimum of 1/8 inch of elastomer, except at laminate restraining devices and around holes that will be entirely closed on the finished structure.

D. Laminates shall be of the material and thickness called for on the plans.

REQUIREMENTS

725.02.01 CERTIFICATE OF INSPECTION

A. The material furnished will be evaluated for acceptance on the basis of the manufacturer's Certified Report of Test or Analysis indicating compliance with these special properties, but the Engineer may obtain test specimens on request.

B. Contractor shall furnish to the Engineer 3 copies of the manufacturer's Certified Report of Test or Analysis before use of the material in the work.

C. Test specimens, when required, shall be in accordance with ASTM D15, Part B.

PHYSICAL PROPERTIES AND TESTS

725.03.01 GENERAL

A. The pads shall conform to the following physical properties:

	Natural Rubber	**Neoprene**
Grade (Durometer)	60	60
Physical Properties:		
Hardness, (ASTM D 2240)	60 ±5	60 ±5
Tensile Strength, min. psi, (ASTM D412)	2,500	2,500
Ultimate elongation, min. percent	400	350
Heat Resistance, 70 hours at 158°F (ASTM D573):		
Hardness, max. points change	10	15
Tensile strength, max. percent change	-25	-15
Ultimate elongation, max. percent change	-25	-40
Compression Set (ASTM D395, Method B):		
22 hours at 158°F, max. percent	25	--
22 hours at 212°F, max. percent	--	35

	Natural Rubber	Neoprene
Ozone (ASTM D1149), 20 percent strain 100°F ±2°F, mounting procedure ASTM D518, Procedure A:		
225 pphm ozone in air by volume, 48 hours	No cracks	---
100 pphm ozone in air by volume, 100 hours	--	No cracks
Adhesion (ASTM D429, Method B):		
Bonds made during vulcanization, pounds per inch	40	40

SECTION 726

ROADSIDE MATERIALS

SCOPE

726.01.01 MATERIALS COVERED

A. This specification covers the materials used in erosion control, landscaping, and irrigation systems.

REQUIREMENTS

726.02.01 CERTIFICATES AND SAMPLES

A. **Planting Soil:**

1. Before imported planting soil is brought on the jobsite, a 10-pound sample shall be submitted to the Engineer for approval.
2. 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, electrical conductivity, and analysis of salt concentrate.

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. **Organic Material:**

1. Before bulk organic material is brought to the jobsite, a 10-pound sample shall be submitted to the Engineer for approval.
2. 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 insoluble ash), nitrogen (based on dry weight), pH factor, and the amount of Douglas Fir bark.

D. **Plants:**

1. All plants shall be nursery grown, healthy, vigorous, well-rooted, shall be true to type or name as shown on the plans, and shall conform to ANSI Z60.1, No. 1 grade.
2. Plants shall be tagged in accordance with the most recent standard practice recommended by the American Association of Nurserymen and the latest edition of Standardized Plant Names, American Joint Committee on Horticultural Nomenclature.
3. All plants shall comply with federal and state laws requiring inspection for plant diseases and infestations.
4. Inspection certificates required by law shall accompany each shipment of plants, and all plant shipments shall be inspected and passed by the Nevada Department of Agriculture.
5. All shipments of pine nursery stock shall meet all applicable state and federal quarantine regulations.

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 6 months before the date of delivery on the project.

F. **Irrigation Materials:**

1. The Contractor shall ascertain that all required tests have been made by qualified testing laboratories as approved by the Contracting Agency.

2. 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.

G. All materials shall be approved prior to use.

PHYSICAL PROPERTIES AND TESTS

726.03.01 PLANTING SOIL

A. Planting soil shall consist of friable soil of loamy character.

B. The soil shall be obtained from well-drained arable land and shall be free from subsoil, refuse, roots, heavy or stiff clay, stones larger than 1 inch in largest dimension, coarse sand, sticks, brush, litter, and other deleterious substances.

C. Requirements for planting soil shall be as follows:

Organic Matter	0.1 to 1.0% by dry weight of soil
Particle Size	3/8 inch (0.953 centimeters) maximum
Clay Content	20% maximum (by weight)
pH Factor	6.5 to 8.0
Electrical Conductivity	0.5 to 1.0 mmhos. per centimeter of the saturation paste extract

726.03.02 FERTILIZER

A. Fertilizer and agricultural minerals shall be a standard commercial grade of organic or inorganic fertilizer of the kind and quality specified in the contract documents.

1. Fertilizer may be separate or in a mixture containing the percentage of total nitrogen, available phosphoric acid, and water-soluble potash in the amounts specified.

2. All fertilizers and agricultural minerals 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.

B. Acceptable commercial fertilizer and agricultural minerals will be specified in 1 of the following forms:

1. A dry, free-flowing, granular material suitable for application by agricultural fertilizer spreaders.

2. A soluble fertilizer and agricultural mineral ground to a fineness that will permit complete suspension of insoluble particles in water, suitable for application by power sprayers.

3. A granular or pelleted fertilizer and agricultural mineral suitable for application by blower equipment.

4. A non-volatile liquid fertilizer or agricultural mineral.

726.03.03 ORGANIC MATERIAL

A. Organic matter shall be processed, composted, fine-ground bark of White Fir, Pine, or Redwood, or a mixture of these in any proportion.

B. Organic matter shall be free of lumps and clods and shall be fine enough so that 100 percent of the material will pass a 1/2-inch screen and 85 percent will pass a No. 6 screen.

C. Requirements for organic material shall be as follows:

Moisture Retention Capacity	35 percent minimum
Organic Matter Based on Dry Weight	95 percent minimum
Mineral Matter (Ash)	5 percent maximum
Silica (Acid Insoluble Ash)	3 percent maximum
Nitrogen Based on Dry Weight	0.8 percent minimum
pH Value Based on 1:5 Solution	4.0 to 6.0 maximum
Douglas Fir Bark	0 percent

726.03.04 MULCH

A. **Hay or Straw:**

1. 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.

2. Unless otherwise specified in the contract documents, hay or straw mulch material shall be of approved field grasses or legumes indigenous to the area.

B. 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/ Grams of Fiber)	1,150 minimum

C. **Wood Cellulose Fiber:**

1. Wood cellulose fiber mulch shall be specially processed wood fiber containing no growth or germination inhibiting factors.

2. Mulch shall be dyed a suitable color to facilitate inspection of the placement of the material.

D. **Wood Chips and Shavings:**

1. Wood chips and shavings shall be manufactured from any clean wood free of infestations.

2. Chips from kiln-dried or air-dried material will not be acceptable.

3. Chips shall be produced by machinery equipped with knives or blades which cut rather than shred or break the material.

4. Chips shall be graded so that substantially all chips are from 1/2 inch to 3 inches in length, 1/2 inch to 1-1/2 inches in width, and from 1/8 inch to 1/2 inch in thickness.

E. **Bark:**

1. Bark shall be 100 percent bark derived from the bark of White Fir, Red Fir, or Pine and shall contain no Douglas Fir.
2. The bark shall be granular or chunky in nature with all particles between 1-1/4 inches and 2-1/2 inches in diameter.

726.03.05 JUTE MATTING

A. Jute matting shall be of a uniform, open, plain weave of undyed and unbleached single jute yarn.

B. The yarn shall be of a loosely twisted construction and shall not vary in thickness by more than 1/2 its normal diameter.

C. Jute matting shall be furnished in rolled strips as follows:

1. Length shall be approximately 50 yards.
2. Matting width shall be 48 inches with an average weight of 0.92 pounds per square yard. A tolerance of ±1 inch in width and of 5 percent in weight will be allowed.

726.03.06 PLANTS

A. All plants shall be nursery grown, representative specimens of their species, and shall be true to type or name as shown on the plans.

B. All plants shall be uniform in growth, in healthy condition, and free from insects, pests, diseases, and injuries, and without evidence of being or having been in a wilted condition.

726.03.07 SEEDS

A. Grasses, legumes, or cover crop seed shall be furnished in standard containers on which shall be shown the following information:

1. Date of Test.
2. Seed Name.
3. Lot Number.
4. Net Weight.
5. Percentage of Purity.
6. Percentage of Germination (in the case of legumes, percentage of germination shall include hard seed).
7. Percentage of Weed Seed Content and Inert Material, clearly marked for each kind of seed, in accordance with applicable state and federal laws.
8. No noxious weed seed present.

B. Seed that has become wet, moldy, or otherwise damaged in transit or storage will not be accepted.

C. Seed shall be at least 95 percent pure and shall have a minimum of 85 percent germination.

726.03.08 TREE TIES

A. Tree ties shall be strips of vinyl-coated nylon, durable, non-hardening, long-life material approximately 1 inch wide and approximately 10 mils thick, or other suitable material approved by the Engineer.

B. A 10-gauge galvanized wire encased in at least 1/2-inch rubber hose may be used when permitted by the Engineer.

726.03.09 PIPE AND FITTINGS

A. **Plastic Pipe:**

1. Plastic pipe, shall be PVC 1120 or 1220 pressure pipe as shown in the irrigation system legend on the plans.
2. All PVC pipe shall be extruded from 100 percent virgin material and shall be NSF approved, except plastic pipe for soaker lines shall be flexible PVC conforming to ASTM D2287.
3. Fittings for PVC plastic pipe shall be rigid polyvinyl chloride, standard weight, Schedule 40, and shall be solvent weld type except as shown on the plans.
4. Fittings for PVC pipe shall have higher bursting pressure than the pipe.
5. All plastic pipe shall be continuously and permanently marked with the following information:
   a. Manufacturer's name and trademark.
   b. Pipe size.
   c. Pipe class.
   d. Type of pipe.
   e. Working pressure at 73.4 degrees F.
   f. National Sanitation Foundation (NSF) rating.
6. All PVC plastic pipe shall be homogeneous throughout; smooth inside and outside; and free from cracks, holes, foreign materials, dents, wrinkles, and blisters.

B. **Delivery:** Plastic pipe shall be delivered to the site in unbroken bundles packaged to provide adequate protection for the pipe ends.

726.03.10 CONTROL TUBING

A. Control tubing shall be PVC tubing meeting NSF rating in the size specified on the plans.

726.03.11 GATE VALVES

A. Gate valves, when called for on the plans, shall be heavy-duty bronze conforming to ASTM B62.

726.03.12 QUICK COUPLER VALVES

A. Quick coupler valves shall have a service rating not less than 150 psi for non-shock cold water.

B. Body of the valves shall be a single-piece construction of sand-cast semi-red brass alloy No. 5-A as given in ASTM B584.

726.03.13 MASONRY

A. Hollow load-bearing concrete masonry blocks shall conform to ASTM C90.

B. Hollow non-load-bearing concrete masonry blocks shall conform to ASTM C129.

SECTION 727

CONCRETE SURFACE FINISHING MATERIAL

SCOPE

727.01.01 MATERIAL COVERED

A. This specification covers the types and quality of concrete surface finishing materials.

PHYSICAL PROPERTIES AND TESTS

727.02.01 REQUIREMENTS

A. Bonded grout finishing material shall conform to the provisions specified below.

B. Except as noted herein, tests shall be made in accordance with test method indicated. Federal standard test methods are as contained in FED-STD-141, most current edition.

C. Viscosity: 110-115 K.U., using pin paddle. (Federal Standard. Method No. 4281)

D. Total Solids (Federal Standard Test Method No. 4042):

1. By weight: 65% minimum.
2. By volume: 48% minimum.

E. Flexibility (Federal Standard Test Method No. 6221):

1. Pass 1/8-inch mandrel when spread 12 mils wet on a tin panel and air dried 16 hours at 120 degrees F.
2. Panel shall show no mud cracking and no loss in adhesion to the panel when bent.

F. Water Resistance: No softening when tested as follows (ASTM D1647):

1. Spread a 12-mil film on tin panel and allow to air dry 48 hours.
2. Immerse in water for 16 hours and allow to dry for 8 hours.
3. There shall be no effect on the material.

G. Weatherometer Durability (Federal Standard Test Method No. 6152):

1. Expose a 12-mil film applied to asbestos cement board for 500 hours in an Atlas Twin-Arc weatherometer.
2. There shall be no erosion, cracking, softening, or other visible defects in the coating.

SECTION 728

EPOXY

SCOPE

728.01.01 MATERIALS COVERED

A. These specifications are intended to specify epoxy that will meet service requirements for street and highway construction.

B. Epoxy shall be furnished as 2 components that shall be mixed together at the site of the work.

REQUIREMENTS

728.02.01 SAMPLING AND TESTING

A. 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."

B. All tests will be conducted in accordance with the latest test methods of ASTM International and Federal Test Method Standard No. 141.

728.02.02 CERTIFICATES

A. Without expense to the Contracting Agency, 2 certificates covering each order of material shall be furnished by the manufacturer, certifying that the product complies with the specifications.

B. 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

A. Each component shall be packaged in steel containers not larger than 5 gallons in volume.

B. When the components are to be mixed at a ratio of 2 parts Component A to 1 part Component B, by volume, the container containing Component B shall be 1/2 the volume of the container containing Component A.

C. The containers shall have lug-type crimp lids with ring seals, shall be new, shall be not less than 24 gauge, shall otherwise meet U.S. Department of Transportation Hazardous Materials Shipping Regulations, and shall be well sealed to prevent leakage.

D. If a lining is used in the containers, it shall be of a character to resist any action by the components.

E. Each container shall be clearly labeled with the designation (Component A or Component B), 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 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 10 minutes with water and secure immediate medical attention.

F. Attention is directed to the characteristics of some epoxy components to crystallize or thicken excessively prior to use when stored at temperatures below 35 degrees F. Any material that shows evidence or crystallization or a permanent increase in viscosity or settling of pigments that cannot be readily redispersed with a paddle shall not be used.

728.02.04 DIRECTIONS FOR USE

A. At the time of mixing, Component A and Component B shall be at a temperature between 60 degrees F and 85 degrees F, unless otherwise specified.

B. Any heating of the adhesive components shall be done by application of indirect heat.

C. Immediately prior to mixing, each component shall be thoroughly mixed with a paddle. Separate paddles shall be used to stir each component.

D. Immediately prior to use, the 2 components shall be thoroughly mixed together in the specified ratios.

1. When mixed, all adhesive, except coal tar modified epoxy, shall have a uniform gray color without black or white streaks.

2. No solvent shall be added to any epoxy.

E. After mixing, all epoxies shall be placed in the work and any overlaying or inserted material that is to be bonded to the work by the epoxy shall also be placed before thickening of the epoxy has begun.

F. Surfaces upon which epoxy is to be placed shall be free of rust, paint, grease, asphalt, and loose and deleterious material.

G. When epoxy is used as a binder to make epoxy concrete or mortar, the 2 components of epoxy shall be thoroughly mixed together before the aggregate is added and, unless otherwise specified, the mix proportions shall consist of 1 part binder to approximately 4 parts aggregate, by volume.

H. 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 in accordance with ASTM D2216.

I. 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.

PHYSICAL PROPERTIES AND TESTS

728.03.01 BINDER (ADHESIVE), EPOXY RESIN BASE

A. **Classification:**

1. 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.

2. Thick sections of this epoxy are not suitable for use in freeze-thaw environments.

3. Epoxy Resin Base Binder (Adhesive) shall conform to AASHTO M235 or ASTM C881.

B. **Directions for use:**

1. The ingredients in Component A and Component B shall be thoroughly dispersed such that each component forms a fluid mixture.

2. The mixing ratio is 2 parts by volume of Component A to 1 part by volume of Component B.

3. No more material shall be mixed than can be used within 10 minutes from the time mixing operations are started.

728.03.02 COAL TAR MODIFIED EPOXY RESIN

A. **Classification:**

1. 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.

2. This epoxy is suitable for use in freeze-thaw environments.

3. Coal Tar Modified Epoxy Resin shall conform to ASTM C881.

B. **Directions for use:**

1. Equal parts, by weight or volume, of Component A and Component B shall be mechanically batch mixed, or continuously mixed in automatic paving equipment that provides continuous metering, mixing, and application at a controlled rate.

2. If the components are to be batch mixed, mixing shall be performed with a propeller type stirrer, or other power driven agitator attached to a 1/2 inch heavy duty drill.

3. Care shall be exercised to thoroughly incorporate material at the sides and bottom of the mixing container.

4. When mixed in batches, the mixing time shall be 5 minutes at 60 degrees F to 80 degrees F or 3 minutes at 80 degrees F to 100 degrees F and the batch size shall not exceed 5 gallons.

5. The mixed material will set quickly if allowed to remain in large mass, due to the heat generated as the 2 components react.

6. Pot life in large quantities (1 gallon to 5 gallons) is approximately:

Material Temperature	**Pot Life** (Measured from Beginning of Mixing)
60-70 degrees F	18 minutes
70-80 degrees F	12 minutes
80-90 degrees F	10 minutes
90-100 degrees F	8 minutes

728.03.03 EPOXY RESIN ADHESIVE FOR BONDING NEW CONCRETE TO OLD CONCRETE

A. **Classification:**

1. 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.
2. This epoxy is available in 2 types:
   a. Type I for general use.
   b. Type II for use when cure temperatures are below 60 degrees F, or when a faster cure is required.
3. Thick sections of this epoxy are not suitable for use in freeze-thaw environments.
4. Epoxy Resin Adhesive shall conform to AASHTO M235 or ASTM C881.

B. **Directions for use:**

1. The ingredients in Component A and Component B shall be thoroughly agitated so each component forms a uniform paste.
2. The mixing ratio is 2 parts by volume of Component A to 1 part by volume of Component B.
3. When measuring individual Component A and Component B, stir and tap the measuring containers to remove possible air voids.
4. Do not mix more material than can be spread within 8 minutes from the time mixing operations are started.
5. The spreading rate shall be sufficient to thoroughly coat the surface.
6. Spread the mixed adhesive by brush or roller over thoroughly cleaned concrete at a rate not exceeding 40 square feet per gallon.
7. On very rough surfaces, the spreading rate shall be 25 square feet per gallon.
8. The new concrete shall be placed against the adhesive coating on the old concrete within 15 minutes after spreading at temperatures below 90 degrees F or within 10 minutes at temperatures above 90 degrees F.

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728.03.06 BINDER (ADHESIVE), EPOXY RESIN BASE, ALKYLBENZENE EXTENDED

A. **Classification:**

1. 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.
2. This epoxy is suitable for use in freeze-thaw environments.

3. Alkylbenzene Extended Epoxy Resin Base Binder (Adhesive) shall conform to ASTM C881.

B. **Directions for use:**

1. The mixing ratio is 1 part by volume of Component A to 1 part by volume of Component B.
2. 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

A. **Classification:**

1. 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.
2. This epoxy is not formulated for use in bonding of new Portland cement concrete to old Portland cement concrete.
3. This epoxy is suitable for use in freeze-thaw environments.
4. Fast Setting Epoxy Resin Base Binder (Adhesive) shall conform to ASTM C881.

B. **Directions for use:**

1. The mixing ratio is 2 parts by volume of Component A to 1 part by volume of Component B.
2. Aggregate shall be added immediately after Component A and Component B are thoroughly mixed.
3. The epoxy mortar or concrete shall be placed as soon as possible.
4. The useful work life of the mortar will depend on temperature, but shall be about 10 minutes to 15 minutes at 75 degrees F.
5. All surfaces shall be primed with mixed epoxy.

728.03.08 BINDER (ADHESIVE), EPOXY RESIN BASE, FAST SETTING, ALKYLBENZENE EXTENDED

A. **Classification:**

1. 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.
2. This epoxy is suitable for use in freeze-thaw environments.
3. Fast Setting Epoxy Resin Base Alkylbenzene Extended Binder (Adhesive) shall conform to ASTM C881.

B. **Directions for use:**

1. The mixing ratio is 1 part by volume of Component A to 1 part by volume of Component B.

2. Do not mix more material than can be used within 10 minutes from the time mixing operations are started.

3. When applying resinous seal, the aggregate shall be sprinkled in the epoxy film not later than 5 minutes after epoxy is applied to the road surface.

728.03.09 EPOXY SEALANT FOR INDUCTIVE LOOPS

A. **Classification:**

1. 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.

2. This epoxy is to be used for repair work on existing spalls, cracks, and other deformations in and around saw cuts and housing inductor loops and leads.

3. The rapid cure allows minimum traffic delay.

4. This sealant is suitable for use in freeze-thaw areas and can be used on grades up to 15 percent without excessive flow of material.

5. Epoxy Sealant for Inductive Loops shall conform to ASTM C881.

B. **Directions for use:**

1. Saw cuts shall be blown clean and dry with compressed air to remove all excessive moisture and debris.

2. 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.

3. The mixing ratio is 1 part by volume of Component A to 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.

728.03.10 EPOXY ADHESIVES FOR PAVEMENT MARKERS

A. **Rapid-Set Epoxy Adhesive:**

1. This specification covers a high viscosity, rapid set epoxy formulated primarily for use in bonding pavement markers to Portland cement concrete and asphalt cement.

2. The epoxy used under this specification shall conform to AASHTO M237, Type I.

3. Tests for requirements for AASHTO M237 shall be performed in accordance with AASHTO T237.

B. **Standard-Set Epoxy Adhesive:**

1. This specification covers a high viscosity, rapid set epoxy formulated primarily for use in bonding pavement markers to Portland cement concrete and asphalt cement.

2. The epoxy used under this specification shall conform to AASHTO M237, Type II.

3. Tests for requirements for AASHTO M237 shall be performed in accordance with AASHTO T237.

728.03.11 BINDER (ADHESIVE), STRUCTURAL EPOXY

A. **Classification:**

1. This specification covers a multipurpose, 2-component, moisture tolerant, structural epoxy adhesive, formulated primarily for bonding new concrete to asphalt cement pavement.
2. This epoxy is formulated for hot weather concrete placements requiring a bonding adhesive and is suitable for minimum substrate and ambient temperature of 40 degrees F.
3. Physical properties shall meet the criteria a minimum of 2,200 psi and heat deflection temperature at 14 days shall be a minimum of 108 degrees F.

B. **Directions for use:**

1. The epoxy shall not be mixed with more material than can be used within 60 minutes at 73 degrees F or 30 minutes at 100 degrees F from the time mixing operations begin.
2. Surface shall be clean and sound.
3. Surface may be dry or damp, but shall be free of standing water, dust, curing compound, and other contaminants.

SECTION 729

FLY ASH

SCOPE

729.01.01 MATERIALS COVERED

A. This specification covers the quality of fly ash used in Portland cement products.

REQUIREMENTS

729.02.01 REQUIREMENTS

A. Fly ash shall conform to ASTM C618 for Class F, with the following exceptions:

1. The maximum loss of ignition shall be 6 percent.
2. The sulfate resistance factor, R, shall not exceed 1.5, where

$$R = \frac{(\% \text{ CaO} - 5)}{\% \text{ Fe}_2\text{O}_3}$$

B. Certification that the fly ash used in Portland cement concrete conforms to ASTM C618 shall be provided by the supplier of the fly ash.

C. Copies of the certification shall be provided to the Engineer by the supplier of the fly ash or supplier of the Portland cement concrete fly ash upon request.

D. The certification provided is to be a maximum of 30 days old.

PHYSICAL PROPERTIES AND TESTS

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