$16.00

UNIFORM STANDARD SPECIFICATIONS
CLARK COUNTY AREA

SPECIFICATION - YEAR 2007 REVISIONS

Section	Title	Nature of Change	Page Number	Effective Date
106	"Control of Materials"	Revision to Section 106, "Control of Materials," to adopt consistent quality control, testing of materials and minimum quality standards.	106 (1-7)	1/1/07
203	"Excavation and Embankment"	Revision to Section 203, "Excavation and Embankment," to adopt consistent excavation; fill specifications, and minimum quality standards.	203 (1-13)	1/1/07
206	"Structure Excavation"	Revision to Section 206, "Structure Excavation," to adopt consistent excavation, fills specifications, and minimum quality standards.	206 (1-2)	1/1/07
207	"Structure Backfill"	Revision to Section 207, "Structure Backfill," to adopt consistent excavation; fill specifications, and minimum quality standards.	207 (1-4)	1/1/07
208	"Trench Excavation and Backfill"	Revision to Section 208, "Trench Excavation and Backfill," to adopt consistent excavation; fill specifications, and minimum quality standards.	208 (1-11)	1/1/07
301	"Selected Material Subbase"	Revision to Section 301, "Selected Material Subbase," to adopt consistent quality control, testing of materials and minimum quality standards.	301 (1-3)	1/1/07
302	"Aggregate Base Courses"	Revision to Section 302, "Aggregate Base Courses," to adopt consistent quality control, testing of materials and minimum quality standards.	302 (1-3)	1/1/07
400	"Asphalt Rubber Pavement Surface"	Addition of Section 400, "Asphalt Rubber Pavement Surface," to have alternative asphaltic materials for bituminous pavement.	400 (1-10)	1/1/07
403-2	"Plantmix Bituminous Gap-Graded Surface"	Addition of Section 403-2, "Plantmix Bituminous Gap-Graded Surface," for the placement of Ultra-thin Asphalt Concrete Surface (UTACS) to seal the road from air and water and increase the life of the pavement.	403-2 (1-7)	1/1/07
501	"Portland Cement Concrete"	Revision to Section 501, "Portland Cement Concrete," to adopt consistent mix design, quality control and testing of materials.	501 (1-15)	1/1/07
501	"Portland Cement Concrete"	Revision to Subsection 501.03.04, "Classification and Proportions" to delete the grading limits table and insert a reference to the same table which is in Subsection 706.02.01.	501 (6-7)	1/1/07
601	"Pipe Culverts – General"	Revision to Section 601, "Pipe Culverts – General," to adopt consistent quality control, testing of materials and minimum quality standards.	601 (1-4)	1/1/07

UNIFORM STANDARD SPECIFICATIONS
CLARK COUNTY AREA

SPECIFICATION - YEAR 2007 REVISIONS

603	"Reinforced Concrete Pipe"	Revision to Section 603, "Reinforced Concrete Pipe," to adopt consistent quality control, testing of materials and minimum quality standards.	603 (1-5)	1/1/07
604	"Corrugated Metal Pipe and Metal Arch Pipe"	Revision to Section 604, "Corrugated Metal Pipe and Metal Arch Pipe," to adopt consistent quality control, testing of materials and minimum quality standards.	604 (1-4)	1/1/07
605	"Thermoplastic Pipe Culverts"	Revision to Section 605, "Thermoplastic Pipe Culverts," to adopt consistent quality control, testing of materials and minimum quality standards.	605 (1-5)	1/1/07
613	"Concrete Curb, Walk, Gutters, Driveways, and Alley Intersections"	Revision to Subsection 613.03.06, "Slip Forms," to replace reference to California State Specification with proposed Subsection 728.03.11.	613 (3-4)	1/1/07
623	"Traffic Signals and Street Lighting"	Revision to Section 623, "Traffic Signals and Street Lighting," to allow the use of multi-sided traffic signal poles.	623 (1-63)	1/1/07
628	"Painting Traffic Stripping, Pavement Markings, and Curb Markings"	Revision to Section 628, "Painting Traffic Stripping, Pavement Markings, and Curb Markings," to incorporate the results of the pavement marking test deck and address other issues.	628 (1-6)	1/1/07
633	"Pavement Markers"	Revision to Section 633, "Pavement Markers," to incorporate the results of the pavement marking test deck and address other issues.	633 (1-4)	1/1/07
680	"Fiber Optic Cable"	Addition of Section 680 "Fiber Optic Cable," to Accommodate the Requirements of the Freeway and Arterial System of Transportation (FAST).	680 (1-5)	7/1/07
681	"Fiber Optic Splice & Distribution Equipment"	Addition of Section 681 "Fiber Optic Splice & Distribution Equipment," to Accommodate the Requirements of the Freeway and Arterial System of Transportation (FAST).	681 (1-4)	7/1/07
682	"Fiber Optic Transceiver"	Addition of Section 682 "Fiber Optic Transceiver," to Accommodate the Requirements of the Freeway and Arterial System of Transportation (FAST).	682 (1-4)	7/1/07
683	"Video Optical Transceiver with Bi-Directional Data Channel"	Addition of Section 683 "Video Optical Transceiver with Bi-Directional Data Channel," to Accommodate the Requirements of the Freeway and Arterial System of Transportation (FAST).	683 (1-4)	7/1/07

UNIFORM STANDARD SPECIFICATIONS
CLARK COUNTY AREA

SPECIFICATION - YEAR 2007 REVISIONS

684	"Field-Hardened Ethernet Switch"	Addition of Section 683 "Field-Hardened Ethernet Switch," to Accommodate the Requirements of the Freeway and Arterial System of Transportation (FAST).	684 (1-4)	7/1/07
685	"Video Encoder"	Addition of Section 685 "Video Encoder," to Accommodate the Requirements of the Freeway and Arterial System of Transportation (FAST).	685 (1-6)	7/1/07
687	"Video Decoder"	Addition of Section 687 "Video Decoder," to Accommodate the Requirements of the Freeway and Arterial System of Transportation (FAST).	687 (1-5)	7/1/07
688	"Remote Data Radio Communication System"	Addition of Section 688 "Remote Data Radio Communication System," to Accommodate the Requirements of the Freeway and Arterial System of Transportation (FAST).	688 (1-4)	7/1/07
703	"Bituminous Materials"	Revision to Section 703, "Bituminous Materials," to add performance graded bitumen and polymer modified membrane.	703 (1-13)	1/1/07
703	"Bituminous Materials"	Revision to Section 703 "Bituminous Materials," Tables 1, 2A and 2B to upgrade the requirement of viscosity grades as it applies to asphaltic concrete.	703 (2,5-6)	7/1/07
704	"Base Aggregates"	Revision to Section 704, "Base Aggregates," to adopt consistent quality control, testing of materials and minimum quality standards.	704 (1-11)	1/1/07
705	"Aggregates for Bituminous Courses"	Revision to Subsection 705.03.08 "Plantmix and Roadmix Asphalt Concrete Surface Course Ultra-Thin Asphalt Concrete Surface (UTACS) Type S1 Through S3," to seal the road from air and water and increase the life of the pavement.	705 (6-7)	1/1/07
708	"Concrete and Clay Pipe Drains"	Revision to Section 708, "Concrete and Clay Pipe Drains," to adopt consistent quality control, testing of materials and minimum quality standards.	708 (1-4)	1/1/07
709	"Metal and Thermo-plastic Pipe"	Revision to Section 709, "Metal and Thermoplastic Pipe," to adopt consistent quality control, testing of materials and minimum quality standards.	709 (1-12)	1/1/07
714	"Paint and Pavement Markings"	Revision to Section 714, "Paint and Pavement Markings," to incorporate the results of the pavement marking test deck and address other issues.	714 (1-9)	1/1/07

PLEASE NOTE PAGE 714-11 IS AN ERRONEOUS PAGE PLEASE DISREGARD

SECTION 106

CONTROL OF MATERIALS

106.01 SOURCE OF SUPPLY AND QUALITY REQUIREMENTS: The Contractor shall furnish all materials required to complete the work, except materials that are designated in the Special Provisions to be furnished by the Contracting Agency as specified in Subsection 106.11, "Contracting Agency Furnished Materials."

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 successful bidder warrants that he has good title to all materials and supplies used by him in the work, free from all liens, claims or encumbrances.

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".

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

The Contractor shall furnish the Engineer a list of his sources of materials. The list shall be submitted 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.

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 designated the RTCSN specifications. Uniform Standard Specifications for Public Works' Construction Off-site improvements, Clark County Area, Nevada, subsequently referred to as the Uniform Standard Specifications. The address for the IQAC webpage is:

http://www.accessclarkcounty.com/pubworks/iqac/IQAC.htm

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.

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 his 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.

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.

Contractor reports and records of inspections made and tests performed shall be submitted to the Engineer as required in the Uniform Standard Specifications. The Engineer inspection and testing records, when available at the site of the work, may be examined by the Contractor.

106.02 LOCAL MATERIALS: 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.

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

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

The furnishing of local materials from any source is subject to the provisions of Subsection 102.05, "Examination of Plans, Specifications, Contract Documents, and Site of Work," and 106.03, "Possible Local Material Sources." Material deposits shall not be excavated at locations where their resulting scars will present an unsightly appearance from any street or highway, unless such excavation is approved in writing by the Engineer. Generally deposits other than those indicated in the "Materials Information" packet as referred to in Subsection 102.05, "Examination of Plans, Specifications, Contract Documents, and Site of Work," will not be approved if located within one thousand (1,000) feet of right-of-way line. In any case the Contractor's pit operations shall not encroach within twenty-five (25) feet of the right-of-way. Payment will not be made on material obtained in violation of these provisions.

The Contractor shall, at his own expense, make any and all arrangements necessary for hauling over local, public or private roads or property from any source. Full compensation for furnishing all labor, materials, tools, equipment and incidentals, for doing all the work involved in conforming to the provisions in this Subsection and for furnishing and producing materials from any source shall be considered as included in the price paid for the contract item of work involving such material and no additional compensation will be allowed.

The Contractor or their 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: If the Contractor desires to use materials from sources other than those described in the Section 102.05, "Examination of Plans, Specifications, Contract Documents, and Site of Work," "Materials Information," the Contractor shall, at their own expense, acquire the necessary right to take material and shall obtain all other necessary permits and approvals and shall comply with all the requirements and stipulations in effect by other governing agencies having jurisdiction over the area, and pay all costs involved, including any which may result from an increase in length of haul. All costs of exploring and developing, 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.

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

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 he so elects, exercise any rights that have been obtained, which may be exercised by a Contractor under such arrangements, subject to and upon the conditions hereinafter set forth.

Such arrangements are not a part of the contract and it is expressly understood and agreed that the 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 there from 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.

In those instances in which the Contracting Agency has compiled "Materials Information" as referred to in Subsection 102.05, "Examination of Plans, Specifications, Contract Documents and Site of Work," said compilation may include the documents setting forth the 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.

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

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

(a) Executed a document that will guarantee to hold such owner harmless from all claims for injury to persons or damage to property resulting from the Contractor's operations on the property owner's premises and also 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

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

If the Contractor elects to obtain material under (a), the use of such site shall be subject to the terms, conditions and limitations of the arrangement made between the property owner and the 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.

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

Unless otherwise provided and before 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.

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 in the "Materials Information" for the project, the successful bidder on the project may enter and remove materials for use on subject project only

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

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 his responsibility to determine the rights of others in the area. The Contractor shall not encroach on easements of others without their written permission and shall assume the responsibility for any damages due to his entering said area. In addition, the Contractor shall be bound by the terms, conditions, and reservations contained in the approved application for withdrawal.

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

106.04 SAMPLES AND TESTS: Sampling for final acceptance of materials will be as required in the appropriate Uniform Standard Specifications sections and in general must comply with the AASHTO requirements, where applicable and with the following exception:

(a) 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.

(b) 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.

(c) 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.

(d) 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.

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

Two samples shall be taken from each railroad tank car or truck transport of material by the Contractor or his designated representative under the observation of and per 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 two samples shall be taken to represent a maximum of ten thousand (10,000) gallons (38,000 liters). 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.

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

One of the two samples, taken from each load, shall be submitted to the 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.

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

(f) 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: 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 must be furnished with each lot of material delivered to the work and the lot so certified must be clearly identified in the certificate with attached applicable test results for that lot in accordance with the specification section.

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

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

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

106.06 CITED SPECIFICATIONS: The Nevada Department of Highways has developed test methods for testing the quality of materials and work. These test methods are identified by the prefix Nev. followed by the serial number. Copies of individual test methods are available at the Materials and Research Division, Department of Highways, Carson City, Nevada.

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.

Whenever a reference is made in the specifications to a specification or test designation either of the American Society of Testing and Materials, the 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.

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: 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 his authorized representative shall have free entry at all times to such parts of the plant as concerns the manufacture or production of the materials. Adequate facilities shall be furnished free of charge to make the necessary inspection.

It is understood that the 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: Materials shall be so stored as to assure the preservation of their quality and fitness for the work. When considered necessary by the Engineer, they shall be stored in waterproof buildings, placed on wooden platforms or other hard, clean surfaces, and not on the ground, and shall be covered when directed. Stored materials, even though approved for use before storage, may be inspected prior to their use in the work, and they shall meet the requirements of the specifications at the time of this proposed use. Stored materials shall be located so as to facilitate their prompt inspection. Upon 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 must be provided by the Contractor at his expense. Private or public property shall not be used for storage purposes without written permission of the owner or lessee. All storage sites shall be restored to their original condition by the Contractor at his expense. This shall not apply to the stripping and storing of top soil or to other material salvaged from the work or specifically prescribed under the specifications. Construction materials may not be stored in streets, roads, or highways for more than five (5) days after unloading. All materials or equipment not installed or used in the construction within five (5) days after unloading shall be stored elsewhere by the Contractor at his expense unless he is authorized additional storage time.

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

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: All materials shall be handled in such manner as to preserve their quality and fitness for the work. Aggregates shall be transported from the storage site to the work in tight vehicles so constructed as to prevent loss or segregation of materials after loading and measuring in order that there may be no inconsistencies in the quantities of materials intended for incorporation in the work as loaded, and the quantities as actually received at the place of operation.

106.10 GUIDANCE ANALYSIS OF NONCOMPLYING MATERIALS: In the event of a non-compliance of a produced or placed material, the Source and/or Contractor is responsible for the submitting of 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 must be performed by a Nevada Professional Engineer. The receiving of the report by the Agency

Engineer does not imply acceptance of the report recommendations.

The policy of the Engineer is that a project must 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.

Unless stipulated in other specification sections or contract special provisions, there are no exact rules which can be applied to the acceptance at full pay or the acceptance at some reduced pay for any specific construction product since the final analysis should be based on equitable payment for the value of the product. However, as a general guidance, if more than ten (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.

For more detailed information on this subject, refer to Federal Highway Administration report number FHWA-RD-02-095 "Optimal Procedures for Quality Assurance Specifications"

106.11 CONTRACTING AGENCY FURNISHED MATERIAL: 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.

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

The Contractor will be held responsible for all material delivered to him, and deductions will be made from any money due to him to make good any shortages and deficiencies, from any cause whatsoever, and for any damage which may occur after such delivery and for any demurrage charges. The responsibility by the Contractor includes any project inspection and testing that is required per the Uniform Standard Specifications

SECTION 107

LEGAL RELATIONS AND RESPONSIBILITY TO THE PUBLIC

107.01 LAWS TO BE OBSERVED: The Contractor shall keep fully informed of all federal and state laws, all local bylaws, ordinances, and regulations, and all orders and decrees of bodies or tribunals having jurisdiction or authority, which in any manner affect those engaged or employed on the work, or which in any way affect the conduct of the work. He shall at all times observe and comply with all such laws, bylaws, ordinances, regulations, orders, and decrees, and shall protect and indemnify the 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 himself or his employees, or agents.

107.02 PERMITS, LICENSES, AND TAXES: 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: If the Contractor employs any design, device, material, or process covered by letters of patent or copyright, he shall provide for such use by suitable legal agreement with the patentee or owner. The Contractor and the surety shall indemnify and save harmless the 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 it 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: 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.

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.

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

The Contractor shall absorb in his bid all costs involved in his part as a result of coordinating his 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 his work force to other parts of the work.

Should the Contractor be delayed by the Contracting Agency, and such delay could not reasonably have been

Payment will be made under:

PAY ITEM	PAY UNIT
Removal of Structures and Obstructions	Lump Sum
Removal of	Each, Linear Feet (Meters), Stations (30 Meters), Miles (Kilometers), Square Yards (Square Meters)

SECTION 203

EXCAVATION AND EMBANKMENT

DESCRIPTION

203.01.01 GENERAL: This work shall consist of grading and excavating the roadway, excavating borrow pits, removing slide material, and excavating ditches and stream channels and satisfactorily disposing of all excavated material and all work necessary for the construction and completion of cuts, embankments, slopes, ditches, dikes, stream channels, approaches, parking areas, intersecting driveways and highways, and subsidiary work. Exceptions are 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

203.01.02 REFERENCE CODES AND STANDARDS:

(a) Uniform Standard Specifications for Public Works' Construction Off-Site Improvements, Clark County Area, Nevada that will henceforth be referred to as "USS"

(b) Contract Special Provisions and Drawings

(c) Nevada Revised Statutes (NRS) 338.176, Nevada Administrative Code (NAC) 625.550

(d) Most current ASTM, AASHTO, or Nevada Department of Transportation (NDOT) test and inspection procedures

(e) IQAC procedures at:

www.accessclarkcounty.com/pubworks/iqac/IQAC.htm

MATERIALS

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

203.02.02 DRAINAGE EXCAVATION: Drainage excavation shall include all excavation in the construction of open ditches less than twelve (12) feet (3.7 meters) in bottom width, excepting ditches that are part of the roadway prism as shown in the plans. The nature or type of material encountered shall have no bearing on the classification of material.

203.02.03 CHANNEL EXCAVATION: Channel excavation shall include all excavation in the construction of open ditches or stream channels with a bottom width of twelve (12) feet (3.7 meters) or more with the exception of ditches that are part of the roadway prism as shown in the plans. The nature or type of material encountered shall have no bearing on the classification of material.

203.02.04 BORROW: Borrow shall consist of approved material excavated and used in the construction of fills, or for other construction purposes. Borrow shall be material, which 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.

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

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

CONSTRUCTION

203.03.01 ROADWAY: All excavation shall be made true to lines and grades staked by 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.

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.

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

All suitable material removed from the excavation shall be used as far as practicable in the formation of embankments, subgrade, shoulders, slopes, dikes, and backfill for structures, unless otherwise indicated on the plans or 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: Immediately prior to placing subsequent layers of material thereon, the grading layer shall conform to one of the following:

(a) The subgrade shall not vary more than one-tenth (0.10) foot (30 millimeters) above or below the grade established by the Engineer or Contractor.

(b) The final subgrade layer prior to application of the structural base shall not vary more than zero (0.0) foot (0 millimeters) above or one-tenth (0.10) foot (30 millimeters) below the grade.

203.03.03 UNSUITABLE MATERIAL: 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.

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

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

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

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

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

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

In solid rock excavation, slopes shall be constructed to the approximate neat lines staked by the Engineer. No rock shall project or overhang more than twelve (12) inches (300 millimeters) from the true slope.

203.03.06 OVERBREAK: 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 hereinafter set forth, shall not be considered overbreak. All side slope overbreak as so defined shall be removed by the Contractor and shall be disposed of in the same manner as provided for the surplus under the heading of "Surplus Material," but at his expense and without any allowance for overhaul.

Rock removed to a maximum depth of six (6) inches (150 millimeters) below subgrade will be measured for payment as described in Subsection 203.04.01(b), "Overbreak."

203.03.07 SLOPES: All excavation and embankment slopes, except in solid rock, shall be trimmed to the lines staked by the Engineer. The degree of smoothness shall be that normally obtained by hand shovel operations, or blade grader operations.

203.03.08 WIDENING CUTS: If the Engineer directs the Contractor to excavate beyond the limits of the typical cross section originally proposed and within the limits of the right-of-way, the Contractor shall do so and compensation therefore will be as set forth in Subsection 203.04.01(c), "Widening Cuts."

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

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

203.03.10 SELECTED MATERIAL: When specified in the contract documents, or when selected by the Engineer, suitable selected material encountered in excavating or widening the roadway prism or any other excavation within the highway right-of-way, or in the excavation or borrow, shall be used for finishing the top portion of the subgrade. The top portion of the subgrade that is used for a pavement section structural number, shall be two (2) feet (.6 meters) in depth, or as determined by the Engineer.
Selected material shall be defined as material, which is excavated, from one or more of the above sources and is used for selective purposes.

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

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

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

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

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

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

V-type ditches shall be formed to the cross section and dimensions on the plans by means of suitable equipment, which will deposit all loose material on the downhill side. The reason is that the bottom of the finished ditches shall not be less than two (2) feet six (6) inches (.8 meters) below the crest of the loose material piled on the downhill side.

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

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

203.03.13 CHANNELS: 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 or dikes are nearly parallel to the roadway, turn-around shall not be located closer than two hundred (200) feet (60 meters) apart. Attention is directed to Subsection 107.12, "Protection and Restoration of Property and Landscape."

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

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

The 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.

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

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, therefore, shall be considered as incidental and subsidiary to the borrow material.

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

The Contractor shall notify the Engineer thirty (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.

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 Clean Up." Unless otherwise permitted, borrow pits shall be excavated so that they will drain to the nearest natural outlet.

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

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

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

203.03.15 FOUNDATION: When embankment is to be placed and compacted on hillsides, or when new embankment is to be compacted against existing embankments, or when embankment is to be built one half width at a time, the slopes that are steeper than four-to-one (4:1), when measured at right angles to the roadway, shall be continuously benched as the work is brought up in layers. Benching shall be of sufficient width to permit operations of placing and compacting equipment. Each horizontal cut shall begin at the intersection of the original ground and the vertical sides of the previous cuts. Material thus cut out shall be re-compacted along with the new embankment material at the Contractor's expense, unless the width of excavation required by the Engineer exceeds six (6) feet (1.8 meters), in which case the excavated material excess of six (6) feet (1.8 meters) will be measured and paid for as roadway excavation.

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

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

Where twelve (12) inches (.3 meters) or less of embankment is placed over existing bituminous surface, such surface shall be removed and incorporated in the embankment or otherwise disposed of as approved by the Engineer. Where more than twelve (12) inches (.3 meters) of embankment is placed over existing bituminous surface, such surface shall be left undisturbed. Measurement for removal of existing bituminous material will be as prescribed in Subsection 203.04.10, "Measurement," and paid for as roadway excavation unless the contract documents specifically called for payment under Section 202, "Removal of Structures and Obstructions."

203.03.16 EMBANKMENT MATERIALS: Embankments shall be constructed with suitable materials, excavated as prescribed and with any excess materials from other operations which are acceptable and suitable for use.

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

When there is a choice of material, the excavation shall be made so the best material will be placed on top of the embankment for at least one (1) foot (.3 meters) in depth. This paragraph shall not be interpreted as to require the Contractor to stockpile and subsequently re-handle embankment materials except as provided in Subsection 203.03.10, "Selected Material."

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

Where embankments are to be made of material from rock cuts or other material, which is unsuitable for finishing the roadbed, the upper six (6) inches (.15 meters) of the roadbed, shall be formed of approved material.

203.03.17 PLACING EMBANKMENT: For embankment or backfill deposited against structures, attention is directed to Subsection 207.03.02, "Placing and Compacting at Abutments, Piers, Wingwalls, and Retaining Walls."

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

Where a structure is to be covered by a rockfill, it shall be covered with not less than two (2) feet (.60 meters) of satisfactory soil or granular materials before the rock embankment is placed over the structure.

Embankments shall, except as hereinafter specified, 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 twelve (12) inch (.3 meters) maximum thickness after compaction. Excepted provisions are hereinafter outlined for placing in marsh and placement of rock. Hauling equipment shall be routed to obtain uniform compaction and channelization of haul routes and rutting of the fill shall be avoided.

When embankments are constructed across wet or swampy ground which will not support the weight of heavy hauling and spreading equipment, the Contractor will be expected to choose such methods of embankment construction and to use such hauling and spreading equipment as will least disturb the soft foundation. When soft foundations are encountered, and when approved by the Engineer, the lower part of the fill may be constructed by dumping and spreading successive vehicle loads. This must 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.

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 he had originally contemplated in order to comply with the foregoing, such shall not be the basis for a claim for extra compensation against the 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.

Embankment which, in the opinion of the Engineer, contains enough rock larger than four (4) inches (.10 meters) to make it impractical to place and compact in twelve (1) inch (.3 meters) 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 one and one-third (1-1/3) times the vertical dimension of maximum size material larger than eight (8) inches (.20 meters). The largest size rock allowed in the embankment will be three (3) feet (1 meter) measured in vertical direction and rocks larger than this shall be broken up before being placed in the embankment. Rock to be wasted may exceed three (3) feet (1 meter) and be disposed of in an inconspicuous manner approved by the Engineer.

In rock fills where end dumping is employed, direct end dumping upon the previously constructed layer of embankment will not be permitted. Rock shall be dumped on the layer of embankment being constructed and dozed ahead into place. Care shall be exercised 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."

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

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

(a) on the side slope or slopes of a new embankment being placed; or

(b) on the side slope or slopes of an embankment already in place requiring widening; or where excess rock may be wasted; or

(c) on the side slopes and top of rolled embankment made of embankment materials other than rock.

The Contractor shall not place large rock in embankments where piles will be driven. The Contractor shall be responsible for penetrating the embankment with specified piles.

When rock and other embankment materials are excavated at approximately the same time, the rock shall be distributed throughout the fill and not nested in one location.

When there is insufficient material other than rock in the excavation to permit properly compacted layers, the rock shall be placed for the full cross section width with the larger rocks well distributed and the void spaces filled with the smaller rocks and fragments.

When shown on the plans or considered necessary by the Engineer, embankments shall be built to such elevation above required grade to allow for settlement, or sufficient surcharge shall be placed above the required elevation of earth grade over deposits of unstable material to secure displacement or settlement. Surcharge shall be removed only after the fill has reached stability or the required settlement time has been reached.

203.03.18 COMPACTION, DIRT EMBANKMENT: Optimum moisture content and material density of the various soils will be determined by the Geotechnical Engineer and approved by the Engineer. At the time of compaction, the moisture content of the various soils shall be within the geotechnical engineering report ranges.

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

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 therefore.

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. Said compaction equipment shall work continuously with the grading equipment.

The top eight (8) inches (20 meters) of the base of cuts and natural ground having less than five (5) feet (1.5 meters) of embankment, measured from the sub-grade, and all embankment material, shall be compacted as recommended by the geotechnical engineer report or not less than ninety (90) percent relative compaction. When natural ground material is encountered that cannot be compacted to the required density, compaction requirements shall be determined by the Engineer.

All selected borrow and structure backfill placed within the limits of embankment shown on the plans for approaches to bridges shall be compacted as recommended by the geotechnical engineer report or not less than ninety-five (95) percent relative compaction.

It is to be expected that a loss of density in the upper portion of earth sub-grade 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: Field density tests will not be required on rock embankments. In lieu thereof, the required compaction shall be tested by proof rolling. If a geotechnical report is not available, use the following procedure. Compaction shall be attained and tested by using construction methods and equipment as follows:

(a) **Methods:** The material for the embankment shall be deposited, spread and leveled the full width of the embankment, and the layer of thickness may be one and one-third (1-1/3) times the vertical dimension of maximum size material. The maximum size rock shall not exceed three (3) feet (1 meter.

1) 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 three (3) complete passes for each layer of embankment. The compacting equipment shall not exceed a speed of five (5) miles (8 kilometers) per hour and shall work continuously with the grading equipment.

2) 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.

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

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

The proof roller shall be a pneumatic-tired roller or pneumatic-tired compactor weighing not less than fifty (50) tons (45. metric tons), and capable of applying to the ground loads of not less than twenty-five thousand (25,000) pounds (11,300 kilograms) per wheel. All tires shall be of equal size and diameter and shall be capable of operating at an air pressure of at least ninety (90) pounds per square inch (620 kPa). They shall be kept uniformly inflated so that the difference in pressure in any two (2) tires shall never exceed five (5) pounds per square inch (0.35 kPa) and means shall be provided by the Contractor for checking the tire pressure on the job at anytime.

(c) **Tests:** Subsequent layers shall not be placed until the previous layer of the embankment is compacted to the degree that no further appreciable deflection is evidenced under the action of proof rolling equipment, as determined by the Contractor with approval of the Engineer.

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

2) Payment for rolling and proof rolling or for the correction of any sub-grade weakness or deficiencies disclosed by the proof rolling operation shall be considered subsidiary to the price bid for the "Excavation" item

(d) The Contractor shall submit an inspection report to the Agency Engineer that has been reviewed and stamped by a Nevada Professional Engineer.

203.03.20 MAINTENANCE: Embankment material which may be lost or displaced as a result of natural settlement of the ground or foundation upon which the embankment is constructed shall be replaced by the Contractor with acceptable material from excavation or borrow, etc. The quantity of material required will be paid for at the regular contract price for the type of material used, also overhaul, applicable and no additional compensation will be allowed.

The Contractor shall, at his expense, remove and replace with acceptable material any embankment or portion thereof which has been constructed with unapproved material as well as remove and replace portions of the embankment which may become unstable or displaced as the result of carelessness or negligence on his part.

203.03.21 SUBGRADE TOLERANCE: Subgrade shall comply with Subsection 203.03.02, "Grade Tolerance."

METHOD OF MEASUREMENT

203.04.01 MEASUREMENT: Unless otherwise specified, excavation will be measured on a volume basis by cross sectioning the area to be excavated and computing neat lines for an end area. The average end area method will be used with no allowance made for curvature. If for any reason it is impossible or impractical to measure quantities by average end areas, the Engineer will compute the quantities by a method which, in his opinion, is best suited to obtain an accurate determination.

The quantity of excavation to be measured for payment shall be the number of cubic yards (cubic meters) 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 his 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 there from 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.

When changes are made during construction such as widening cuts, changing grades, disposing of unsuitable material, stockpiling selected material, and other changes resulting in increases or decreases in quantities, then additional measurements for payment will be made by the Engineer as hereinafter outlined:

(a) **Unsuitable Material:** When the removal and disposal of unsuitable material is shown in the contract documents, such material will be measured for payment as excavation for the related item. Removal and disposal of unsuitable material, not shown on the plans, will be measured and paid for as "Roadway Excavation." 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."

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

(b) **Overbreak:** All sideslope overbreaks as defined in Subsection 203.03.06, "Overbreak," shall not be paid for. Rock removed to a maximum depth of six (6) inches (150 millimeters) 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 approved by the Engineer and will be measured and paid for at the contract unit price for the material used.

Rock loosened or removed in excess of six (6) inches (150 millimeters) 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.

c) **Widening Cuts:** If the Engineer directs the Contractor to excavate beyond the limits of the typical cross section and before the excavation is substantially completed, the material shall be classified as "Roadway Excavation" and shall be paid for at the contract bid price. However, if widening cuts requires special equipment, or unusual and extra expense, it may be paid for as extra work according to the provisions of Subsection 104.03, "Extra Work."

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

e) **Surplus Material:** Surplus excavated material will be measured for payment as roadway excavation and no further compensation will be allowed by virtue of the method of disposing, placing, or widening embankments caused from such surplus material.

f) **Slides and Slipouts:** In the event of slides and slipouts, the Engineer and Contractor shall negotiate in each case and decide the relative difficulty of performing the work, and payment will be made either as "Roadway Excavation" or as "Extra Work" as provided in Subsection 104.03, "Extra Work."

Where slopes have been previously completed by the Contractor, the cost of re-sloping required in areas where unstable material is removed will be paid for as extra work as provided in Subsection 104.03, "Extra Work."

The cost of pioneering work necessary to make slide or slipout areas accessible to normal excavation equipment and the cost of necessary clearing and grubbing will be paid for as extra work as provided in Subsection 104.03, "Extra Work."

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

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

Material used for surcharge, whether shown on the plans or called for by the Engineer, will be measured for payment as roadway excavation both in its original position and when removed from the surcharge position.

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

V-type ditches will be measured parallel to the ground and each one hundred (100) linear feet (30.48 meters) shall constitute a unit of measure. The volume of excavation for such ditches will not be measured for payment.

The quantity of "Selected Borrow" or "Selected Borrow Excavation" to be measured for payment will be the number of cubic yards or tons (cubic meters or metric tons) measured as set forth in the Special Provisions.

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

BASIS OF PAYMENT

203.05.01 PAYMENT: The accepted quantities of excavation measured as specified in Subsection 203.04.01, "Measurement," will be paid for at the contract unit price bid for each of the pay items listed in the bid schedule. 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 sub-base, 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.
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 therefore.

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 (cubic meter or metric ton) for "Selected Borrow" or "Selected Borrow Excavation" which price shall be full compensation for furnishing all materials, loading, hauling, depositing, spreading, watering, compacting and maintaining the material complete and in place.

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.

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

Payment will be made under:

PAY ITEM	PAY UNIT
Roadway Excavation	Cubic Yard (Cubic Meter)
Drainage Excavation	Cubic Yard (Cubic Meter)
Channel Excavation	Cubic Yard (Cubic Meter)
Borrow Excavation	Cubic Yard (Cubic Meter)
V-type Ditches	Stations (30. Meters)
Selected Borrow	Cubic Yard or Ton (Cubic Meter-Metric Ton)
Selected Borrow Excavation	Cubic Yard or Ton (Cubic Meter-Metric Ton)

TESTING

203.06.01 TESTING:

SECTION	DESCRIPTION	TEST	REFERENCE SPECIFICATION AND/OR TEST PROCEDURE	RECOMMENED FREQUENCY
203.02.01	Roadway Excavation (Subgrade)	Field Density	AASHTO T 310	
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 twelve (12) inch (30 centimeter) layer of compacted material.
[2] This is in reference to benched slope construction of embankment only.

Payment will be made under:

PAYMENT ITEM	PAY UNIT
Slope Rounding	Stations (30 Meters)

SECTION 205 – BLANK

SECTION 206

STRUCTURE EXCAVATION

DESCRIPTION

206.01.01 GENERAL: 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.

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: 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.

206.01.03 REFERENCE CODES AND STANDARDS:

a) Uniform Standard Specifications for Public Works' Construction Off-site Improvements, Clark County Area, Nevada that will henceforth be referred to as "USS"

b) Contract Special Provisions and Drawings

c) NRS 338.176, NAC 625.550

d) Most current ASTM, AASHTO, or NDOT test and inspection procedures

e) Related Interagency Quality Assurance Committee (IQAC) procedures at
www.accessclarkcounty.com/pubworks/iqac/IQAC.htm

206.02.01 BLANK:

CONSTRUCTION

206.03.01 GENERAL: 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.

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 approximately only, and the Engineer may order, in writing, such changes in dimensions or elevation of footings as may be necessary to secure a satisfactory foundation.

Unless otherwise permitted by the Engineer, foundations shall be compacted to not less than ninety (90) percent relative compaction for culvert pipe and not less than ninety-five (95) percent relative compaction for structures. For fine-grained soils, which are classified by having fifty (50) percent or more passing the # 200 sieve, the relative compaction may not be less than ninety (90) percent for structures if approved by the entity engineer.

All rock or other hard foundation material shall be freed from all loose material, cleaned and cut to a firm surface, either level, stepped or serrated, as may be permitted by the Engineer. All seams and crevices shall be cleaned out and filled with concrete mortar or grout.

Where masonry is to rest on material other than rock or boulders, special care must be given not to destroy it's bearing value.

Should the Contractor remove structure excavation below grade, he shall backfill to the required elevation at his own expense with backfill in a manner satisfactory to the Engineer.

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

Excavated material, which is suitable for backfilling, shall be so utilized or used in embankments, in a manner satisfactory to the Engineer. Surplus or unsuitable material shall be disposed of 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.

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: 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."

206.04.01 BLANK:

BASIS OF PAYMENT

206.05.01 PAYMENT: 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 only when the Special Provisions or Proposal so provides.

SECTION 207

STRUCTURE BACKFILL

DESCRIPTION

207.01.01 GENERAL: This work shall consist of placing and compacting, to the lines designated on the plans or as established by the Engineer, backfill 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.

207.01.02 REFERENCE CODES AND STANDARDS:

(a) Uniform Standard Specifications for Public Works' Construction Off-site Improvements, Clark County Area, Nevada that will henceforth be referred to as "USS" Specifications and Drawings
(b) Contract Special Provisions and Drawings
(c) NRS 338.176, NAC 625.550
(d) Most current ASTM, AASHTO, or NDOT test & inspection procedures
(e) Related Interagency Quality Assurance Committee (IQAC) procedures at
www.accessclarkcounty.com/pubworks/iqac/IQAC.htm

MATERIALS

207.02.01 SELECTED BACKFILL: 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 if recommended by the geotechnical engineer report and approved by the Agency Engineer.

Table 1 – Select Backfill Gradation

Sieve Sizes	Percentage of Weight Passing
6"	100
3"	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

When the completed select backfill test results from the sample indicate a Plasticity Index of twelve (12) or greater, a swell potential test may be required. Contact the agency for further procedure requirements or the contract special provisions.

The liquid limit of the material shall not exceed fifty (50) percent maximum.

Stones or lumps exceeding three (3) inches (75 millimeters) shall not be used within the zones twelve (12) inches (300 millimeters) or less from the structure, twelve (12) inches (300 millimeters) or less from the finish subgrade in unpaved areas, or sixteen (16) inches (400 millimeters) or less below the pavement in paved areas.

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

207.02.02 GRANULAR BACKFILL: 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.

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

Table 3 – Granular Gradation

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

The plasticity index of the material shall be as specified in Subsection 704.02.03, "Plastic Limits."

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: Compaction of backfill or embankment around all structures shall be as per 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.

The compaction requirement shall be as stated by the geotechnical engineer and approved by the Agency Engineer or a minimum of ninety (90) percent.

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 twelve (12) inches (300 millimeters) and a maximum loose lift of sixteen (16) inches (400 millimeters) and shall be brought up uniformly on all sides of the structure or improvement.

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.

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.

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 eighty (80) percent on the required compressive strength and approved by the Engineer.

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

Where backfill is placed against waterproofed surfaces, care shall be taken that no damage is done to the waterproofing material.

207.03.02 PLACING AND COMPACTING AT ABUTMENTS, PIERS, WINGWALLS AND RETAINING WALLS: With the approval of the Engineer, all spaces excavated and not occupied by abutments, piers, or other permanent work shall be refilled with earth up to the surface of the surrounding ground or to the limits designated on the plans or as described herein. All backfill shall be thoroughly compacted in accordance with the provisions set forth in Subsection 207.03.01, "General."

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

Existing slopes, which 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: 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 six (6) inches (150 millimeters). 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 twelve (12) inches (300 millimeters) in depth after compaction nor a loose lift of sixteen (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."

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

Unless otherwise directed, the backfilling shall continue as directed to the level of the ground or to an elevation six (6) inches (150 millimeters) 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.

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.

Special care shall be taken in backfilling arches, particularly half-circle arches. The arch shall be covered in layers, each layer conforming to the shape of the arch and tamped thoroughly.

207.03.04 PLACING AND COMPACTING OF BIN-TYPE RETAINING WALLS: Placing and compacting backfill material for bin-type retaining walls shall progress concurrently with the assembly of the bins, and backfilling around the outer sides thereof shall be kept approximately level with the inside fills. The materials shall be thoroughly tamped and meet the density requirements as set forth in Subsection 207.03.01, "General." Care shall be exercised to completely fill the depressions of stringers and spacers without displacing them from established line and batter.

207.04.01 BLANK:

BASIS OF PAYMENT

207.05.01 PAYMENT: 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

Table 4 - Testing

Spec. Section	Description	Test	Reference Specification And/Or Test Procedure	Recommended Frequency[1]
207.02	Selected Backfill	Sieve Analysis	AASHTO T11 & T27 RTC 301 & Special Provisions	1/1000 CY
		Plasticity Index	AASHTO T89 & T90 RTC 301 & Special Provisions	1/1000 CY
207.02.	Granular Backfill	Sieve Analysis	AASHTO T11 & T27 RTC 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

NOTE: A maximum test table lift is defined as a twelve (12) inch (300 millimeter) layer of compacted material.

[1] A maximum testable lift is defined as a twelve (12) inch (300 millimeter) layer of compacted material.

SECTION 208

TRENCH EXCAVATION AND BACKFILL

DESCRIPTION

208.01.01 GENERAL: 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).

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." The trench section installation configuration as demonstrated in Figure 1 shall only be permitted when approved by the Engineer.

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.

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.

208.01.02 REFERENCE CODES AND STANDARDS:

(a) Uniform Standard Specifications for Public Works' Construction Off-site Improvements, Clark County Area, Nevada that will henceforth be referred to as "USS" Specifications and Drawings

(b) Contract Special Provisions and Drawings

(c) NRS 338.176, NAC 625.550

(d) Most current ASTM, AASHTO, or NDOT test procedures

(e) Related Interagency Quality Assurance Committee (IQAC) procedures at

www.accessclarkcounty.com/pubworks/iqac/IQAC.htm

(f) Figure 1 - Trench Section Terms

(g) Figure 2 - Terminology for Embankment Installation

208.01.03 DEFINITIONS:

(a) **Foundation:** A 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) **Haunching:** The backfill under the lower half of the pipe (haunches) distributes the superimposed loadings.

(d) **Initial Backfill:** This zone of backfill provides the primary support against lateral pipe deformation for flexible pipe.

(e) **Final Backfill:** Backfill above the pipe zone.

Figure 3 - Compaction area terms

MATERIALS

208.02.01 GENERAL: The material placement in the pipe zone area must first comply with Table 1, when applicable.

Table 1 - Pipe Zone Maximum Particle Size for Backfill

Nominal Pipe Size (in/mm)	Maximum Particle Size (in/mm)
2 to 4	½
6 to 8	¾
10 to 16	1
18 and larger	1-1/2

One of two methods of compaction of the trench shall be used and shall be recommended by the designing engineer and approved by the Agency Engineer prior to construction:

Method A: The use of CLSM as defined in this Section
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.

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

208.02.02 SELECTED BACKFILL: This material shall be similar to that removed from the trench excavation as per the Geotechnical Engineer recommendation or may be imported material as specified in Subsection 207.02.01, "Selected Backfill."

208.02.03 GRANULAR BACKFILL: Granular backfill shall be as specified in Subsection 207.02.02, "Granular Backfill."

208.02.04 SAND BACKFILL: 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"	100
No. 4	80-100
No. 200	5-20

The plasticity index of the material shall be as specified in Subsection 704.02.03, "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: 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: 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): Backfill shall be as specified in Subsection 704.03.07, "Controlled Low Strength Material".

208.02.08 CRUSHED ROCK: The materials properties shall conform to Subsection 704.03.03, "Crushed Rock".

208.02.09 TYPE III AGGREGATE: 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: Excavation including the manner of supporting excavation and provisions for access to trenches, shall comply with the current regulations ads 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 PE 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 therefore.

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

208.03.02 MINIMUM TRENCH WIDTH: Excavation 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 native material that meets or exceeds the pipe zone material as indicated for each zone in Subsection 208.04, "Measurements" which meets the classification class A1 or A3 installation as defined in AASHTO M 145 table. In all cases, the trench width shall be wide enough to allow for the compaction equipment.

Table 3- MinimumTrench 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

For pipe backfill using CLSM, the minimum trench width may be reduced to the pipe diameter plus twelve (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.

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 shall not be less than the minimum stated in this section.

208.03.03 MAXIMUM TRENCH WIDTH: The maximum width of the trench shall be determined by the contractor based on the method and means for the installation. However, it shall not exceed the width of a ride-along compactor plus two feet when working along side the pipe or culvert. If the maximum trench width is exceeded as noted above, the Contractor shall provide additional backfill materials and bedding or if the design is based on the trench configuration in figure 1, a higher strength of pipe may be required as determined by the Engineer of record, with no additional payment to the Contractor. Any engineer design check is at the expense of the Contractor.

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 five hundred (500) feet (152 meters), 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 across streets shall be completely backfilled as soon as possible after pipe, wire, or conduit installation.

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: 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 bedding material as specified in Subsection 208.03.03, "Maximum Trench Width".

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

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

208.03.05 DISPOSAL OF UNSUITABLE AND EXCESS EXCAVATED MATERIALS: 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: In the event that changes in elevation of the trench of less than six (6) inches (150 millimeters) are ordered by the Engineer no changes in the contract amount will be allowed. When such changes in elevation are more than six (6) inches (150 millimeters) 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: 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, embedment material shall be placed in lifts and the shield shall be lifted to allow for the embedment material to be placed for each lift, trench wall to trench wall.

208.03.08 MINIMUM PIPE SPACING: Minimum Spacing requirement of Parallel Pipes in a Single Trench shall be recommended by a Nevada Professional Engineer and approved by the Agency Engineer during the plan review. If the pipe space is not conducive to mechanical backfill, then CLSM shall be used.

208.03.09 TRENCH BACKFILL: The backfilling of the trench differs in each zone due to the complexity of providing a secure support for the pipe as well as assure 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 3.

208.03.10 USE OF CLSM: 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.

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.

The Contractor shall cast one set of six each four-inch diameter by eight-inch high (600 millimeter by 1200 millimeter) specimens in split cylinders. No rodding method shall be used for the placement of the CLSM into the cylinders. All field curing and environmental protection shall conform to the AASHTO T23 Test Methods for Making and Curing Concrete Test Specimens in the Field. The cast specimens shall then be laboratory-cured in one hundred (100) percent humidity, temperature-controlled concrete cure room (cure tanks shall not be used). Samples from each set shall be tested at the ages of seven (7), twenty-eight (28), and ninety (90) days. A report of the results shall be submitted to the Engineer.

The use of Bonded Aggregate Fill (BAF) as described in Section 704.03.07, "Controlled Low Strength Material (CLSM)" shall be tested each day. Two (2) each split concrete cylinders are to be made from the material placed from the concrete truck. The cylinders shall cure twenty four (24) hours then be opened in order to visually check. If the material is self-supporting with a vertical face, it is acceptable

Placement of backfill or pavement materials on top of the CLSM shall not be allowed until the CLSM passed the ball drop test as per ASTM D6024.

208.03.11 FOUNDATION: Trench floor shall be stable.

208.03.12 PIPE BEDDING: 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 six (6) inches (150 millimeters) below the bottom of the pipe barrel and to a depth which will be sufficient to provide at least two (2) inches (50 millimeters) clearance under the pipe bell (where applicable).

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 one-third the pipe outside diameter shall be loosely placed. The compaction shall be:

Compaction density minimum = ninety (90) percent with exception of the middle uncompacted area.

The material for use as bedding shall be Type II/III Aggregate Base, Sand Backfill, or CLSM as per this section. Crushed Rock may be used for pipe bedding only if material use has been specifically approved by the governing agency.

Bedding shall be backfilled to the required grade of the bottom of the pipe. When Crushed Rock is used for pipe bedding the Contractor shall follow the same procedures described later in this Subsection 208.03.06 "Drain Backfill".

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 approved may be required by the Engineer.

208.03.13 HAUNCH ZONE BACKFILL: Except as otherwise provided by utility agency specifications or approved by the Engineer, after the pipe or conduit is laid, the haunch areas are to be backfilled with Type II, Type III, Aggregate Base Backfill, Sand Backfill or CLSM. Crushed Rock may be used for the haunch zone only if material use has been specifically approved by the governing agency. If crushed or drain rock is used, comply with Subsection 208.04.02, "Pipe Bedding".

Compaction of the haunching material can best be accomplished by hand with tampers or suitable power compactors for maximum compacted lift thickness of six (6) inches (150 mm). The Contractor shall take care to not disturb the pipe from its line and grade and shall compact to:

Compaction minimum = ninety (90) percent.

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

208.03.14 INITIAL ZONE BACKFILL: Except as otherwise provided by utility agency specifications or approved by the Engineer, after the pipe or conduit is laid, the initial backfill areas are to use Type II, Type III, Aggregate Base, Sand 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 may be used for the only if material use has been specifically approved by the governing agency. If crushed or drain rock is used, comply with Subsection 208.04.02, "Pipe Bedding". 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 (50 millimeters) or less diameter	6 inches (150 millimeters) above the top of pipe
Greater than 2 inch (50 millimeters) diameter	12 inches (300 millimeters) above top of the pipe

208.03.15 FINAL BACKFILL: The remaining backfill shall consist of one of the following types as determined by the Engineer.

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

(1) **The material shall be compacted to:**

Compaction minimum = ninety (90) percent

If "Selected Backfill" is used in trenches two (2) feet (600 millimeters) or less in width, no stones or lumps greater than three (3) inches will be permitted.

(2) **CLSM:** CLSM shall be placed from the top of the initial backfill zone to the bottom of the pavement section (top of subgrade).

208.03.16 DRAIN BACKFILL: In the event that Drain Backfill is used to control groundwater, the Contractor shall, at his expense, construct dams conforming to the requirements of Section 501 Portland Cement Concrete, Class II CLSM, or compacted Type II. Construct the dams within the drain rock bedding material at each manhole, or six hundred (600) feet, whichever is less. However, only for the longitudinal length of the manhole and shall be the full width of the trench:

Compaction minimum = ninety five (95) percent

208.03.17 COMPACTION: 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 In (mm)	Maximum Loose Lift Thickness In (mm)
Bedding, Haunch and Initial Zones	6 (150)	8 (200)
Final Backfill Zone	12 (300)	16 (400)

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

208.03.18 TRANSITION INSTALLATIONS: 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: 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 twenty four (24) in (600 mm). The initial zone must use equipment that will allow compaction to the lift requirements of this specification without damage to the pipe.

208.03.20 TESTING: The testing methods and frequency shall be referenced to Subsection 208.01.02, "Reference Codes and Standards". 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: 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.

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

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.

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.

Pavement in the area of the trench excavation may be wheel cut or spade cut. Trench excavation and backfill shall be per the applicable sections of the Uniform Standard Specifications and Standard Drawings. "CLSM" shall be used for all cases of backfill.

Whenever permanent pavement patches are not constructed immediately following trench backfilling operations, temporary pavement patches consisting of a minimum of two (2) inches (50 millimeters) of hot or cold plantmix or plates must be utilized to provide the required number of paved travel lanes. Plates may be left in place for a maximum of fourteen (14) days or unless otherwise approved by the Engineer. Temporary pavement patches may be left in place for a maximum of thirty (30) working days following completion of backfilling operations unless otherwise approved by the Engineer.

The following surface tolerance for temporary patches shall be observed. When a twelve (12) foot (4 meter) 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 one-half (1/2) inch (12.5 millimeters) 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.

Prior to placing the permanent patch, the existing pavement shall be sawcut to a neat line and to a minimum width as follows:

(a) For transverse trenches, sufficient width of a four (4) feet (1.2 meters) minimum to accommodate mechanical placement using Agency approved paving machine, rolling and compaction in compliance with Subsection 401.03.11, "Rolling and Compaction."

(b) For longitudinal trenches on streets with rights-of-way greater than 60 feet, one lane width in its entirety. Sawcut lines shall be made at the edge of the travel lane and shall not fall within the travel lane. Pavement patches for longitudinal trenches on streets with rights-of-way 60 feet or less shall be sufficient width four (4) feet (1.2 meters) minimum to accommodate mechanical placement using Agency approved paving machine, rolling and compaction in compliance with Subsection

401.03.11, "Rolling and Compaction" and sawcut shall not be placed in wheel path area of travel lane.

(c) For narrow trenches six (6) inches (150 millimeters) or less in width for conduit placement within two (2) feet (600 millimeters) of the curb and gutter, a minimum of four (4) feet (1.2 meters) from the lip of gutter and removed to the curb and gutter. Pavement patch width shall be sufficient to accommodate mechanical placement using Agency approved paving machine, rolling and compaction in compliance with Subsection 401.03.11, "Rolling and Compaction" and sawcut shall not be placed in wheel path area of travel lane.

Existing aggregate base, if disturbed, shall be recompacted to meet the requirements of Section 302 of the Uniform Standard Specifications. Compaction by rolling with vehicle tires will not be permitted. Aggregate base courses, which were constructed with geosynthetics shall be repaired in conformance with the manufacturer's recommendations.

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 four (4) inches (100 millimeters) 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 three (3) inches (75 millimeters); for existing depth of four (4) inches (100 millimeters) or more, pavement shall be replaced in multiple lifts of equal thickness within the parameters established in Section 401, "Plantmix Bituminous Pavements". The pavement material must be similar to the original. If not known, request from the Engineer the current mix type used on Agency Capital Improvement Projects (CIP).

Completion of the permanent patch in areas where an open graded surface course exists, which is less than ten (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.

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.

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 twelve (12) feet (4 meters) 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 one-quarter (1\4) inch from the lower edge of the straightedge. Patches exhibiting deviations greater than one-quarter (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.

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

All traffic control devices removed or disturbed during construction must 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: The quantity of Permanent Patch to be measured for payment will be the number of square feet complete, in place, and conforming to all requirements herein.

BASIS OF PAYMENT

208.05.01 BASIS OF PAYMENT: Unless otherwise provided in the Special Provisions or Proposal, 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.

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.

The contract unit price paid for permanent patch as measured in Subsection 208.04, "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), 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.

Payment for such excavation or backfill will be made only when the Special Provisions or Proposal provides.

SECTION 215

QUICKLIME TREATED SUB-BASE

This section has been deleted.
Refer to new Section 306, "Lime Stabilized Subgrade."

SECTION 301

SELECTED MATERIAL SUBBASE

DESCRIPTION

301.01.01 GENERAL: 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 place 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) Uniform Standard Specifications for Public Works' Construction Off-site Improvements, Clark County Area, Nevada that will henceforth be referred to as "USS" Specifications and Drawings

(b) Contract Special Provisions and Drawings

(c) NRS 338.176, NAC 625.550

(d) Most current ASTM, AASHTO, or NDOT test procedures

(e) Related Interagency Quality Assurance Committee (IQAC) procedures at www.accessclarkcounty.com/pubworks/iqac/IQAC.htm

MATERIALS

301.02.01 GENERAL: Material shall be as set forth in the Special Provisions.

Table 1- Subbase Material

Type I Aggregate Base	Subsection 704.03.04

Acceptance sampling shall conform to the tests requirements as set forth in Subsection 301.06- Inspection and Testing.

CONSTRUCTION

301.03.01 SUBGRADE PREPARATION: The surface of the subgrade upon which the selected material is to be placed shall conform to the established lines and grade, shall be smooth and uniform and shall be compacted to the required density. The tolerance to the plan elevation grade shall be plus zero (+0) inches (millimeter) and minus one-half (-1/2) inch (17 millimeters).

301.03.02 PLACING: In producing, handling, and placing selected materials, care shall be taken to prevent segregation of the fine particles from the coarse. When the required compacted thickness is more than six (6) inches (15 centimeters), the material shall be placed in layers, none of which shall exceed six (6) inches (15 centimeters) in depth after compaction, except as provided in Subsection 301.03.04, "Compaction."

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. It shall then be spread and finished to the required cross section. At the option of the Contractor, selected material may be spread with equipment meeting the requirements of Subsection 303.03.03, "Spreading and Finishing."

Binder material, if required, shall be incorporated either in the surfacing aggregate at the plant where the aggregate is produced, or shall be incorporated uniformly on the roadbed in amounts designated by the Engineer.

301.03.03 WATERING: Water shall be applied prior to and during all blading operations, to moisten the material sufficiently to prevent segregation of the fine and coarse particles. Water shall also be applied during the compaction and maintenance stages in sufficient amounts to attain compaction and prevent raveling.

301.03.04 COMPACTION: Compaction shall immediately follow the spreading operation. Where the required thickness is six (6) inches (15 centimeters) or less, the base course may be spread and compacted in one layer. However, if vibratory compaction equipment approved by the Engineer is used, and the requirement for density is complied with, the compacted thickness of any one layer must be increased to eight (8) inches (20 centimeters). Aggregate bases, placed on road approaches and connections, street intersection areas, median strip areas, shoulder areas, and at locations which are inaccessible to the spreading equipment, may be spread in one or more layers by any means to obtain the specified results.

Each layer of material shall be compacted to not less than ninety-five (95) percent relative compaction. Except for under sidewalk areas, in which case the material shall be compacted to not less than ninety (90) percent compaction.

It is to be expected that a loss of density in the upper portions of the material may occur due to the elements, or for other reasons. Recompaction to the specified density will be required prior to placement of any subsequent course and no additional compensation will be allowed for such recompaction.

METHOD OF MEASUREMENT

301.04.01 MEASUREMENT: The quantity of selected material base or surface to be measured for payment will be in the number of cubic yards or tons (cubic meters or metric tons) complete and in place.

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

BASIS OF PAYMENT

301.05.01 PAYMENT: The accepted quantity of selected material base or surfacing, measuring as provided above, will be paid for at the contract unit price bid per cubic yard or ton (cubic meter or metric ton) for selected material base or surface, which price shall be full compensation for stripping the pit, crushing, screening, loading, hauling, placing, compacting, and maintaining the base or surface as shown on the plans and as directed by the Engineer.

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

Partial payments may be made in accordance with Subsection 109.06, "Partial Payment."

Payment will be made under:

PAY ITEM	PAY UNIT
Selected Material Subbase	Cubic Yard or Ton (Cubic Meter or Metric Ton)

SECTION 302

AGGREGATE BASE COURSES

DESCRIPTION

302.01.01 GENERAL: This work shall consist of furnishing, placing, and compacting aggregate base courses constructed in accordance with the requirements hereinafter set forth and in 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) Uniform Standard Specifications for Public Works' Construction Off-site Improvements, Clark County Area, Nevada that will henceforth be referred to as "USS"
(b) Contract Special Provisions and Drawings
(c) NRS 338.176, NAC 625.550
(d) Most current ASTM, AASHTO, or NDOT test procedures
(e) Related Interagency Quality Assurance Committee (IQAC) procedures at
www.accessclarkcounty.com/pubworks/iqac/IQAC.htm

MATERIALS

302.02.01 GENERAL: All materials shall conform to the requirements as set forth in the following subsections:

Type I Aggregate Base ..... Subsection 704.03.02

CONSTRUCTION

302.03.01 SUBGRADE PREPARATION: Any ruts, holes, defects, or soft yielding places which occur in the subgrade or sub-base for any cause whatsoever shall be corrected and compacted to required density and stability before an aggregate base course is placed thereon. The above mentioned repairs are to be made at the expense of the Contractor, except as provided for in Subsection 203.03.02, "Unsuitable Material." The tolerance to the plan elevation grade shall be plus zero (+0) foot (millimeter) and minus 0.1 foot (30 millimeters).

The top six (6) inches of subgrade shall be compacted as per the Geotechnical Engineer recommendation or not less than ninety (90) percent compaction.

302.03.02 SPREADING AGGREGATES: The aggregate shall be uniformly deposited on the approved subgrade by means of the hauling vehicle with or without spreading devices. Aggregate will be distributed over the surface to the depth specified on the plans or established by the Engineer.

After base course material has been deposited, it shall be thoroughly blade-mixed to full depth of the layer by alternately blading the entire layer to the center and back to the edges of the road. It shall then be spread and finished to the required cross section by means of a self-propelled pneumatic-tired motor grader.

At the option of the Contractor, the aggregate may be spread with 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."

Reference points will be established on one side of the roadway at intervals approved by the Engineer.

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: The base course material and water may be mixed at the plant in a mixer approved by the Engineer. Water shall be added during the mixing operation by means of spray bars in the amount necessary to provide the optimum moisture content for compacting. 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. 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: 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. Water shall be applied during the compaction and maintenance stages in sufficient amounts to assist in compaction and prevent raveling. Reference is made to Section 210, "Watering."

302.03.05 COMPACTION: Compaction shall immediately follow the spreading operation. Where the required thickness is six (6) inches (150 millimeters) or less, the base course may be spread and compacted in one layer. However, if vibratory compaction equipment of a type approved by the Engineer is used, and the requirement for density is complied with, the compacted thickness of any one layer may be increased to eight (8) inches (200 millimeters). Aggregate bases, placed on road approaches and connections, street intersection areas, median strip areas, shoulder areas, and at locations which are inaccessible to the spreading equipment, may be spread in one or more layers by any means to obtain the specified results. Each layer of material shall be compacted to not less than ninety-five (95) percent compaction, except for under sidewalk areas, in which case the material shall be compacted to not less than ninety (90) percent compaction.

It is to be expected that a loss of density in the upper portions of the material may occur due to the elements, or for 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: When a ten (10) foot (3 meters) straightedge is laid in any direction, the finished surface shall not deviate at any point more than one-half inch (12 millimeters) from the bottom thereof. The tolerance to the plan elevation grade shall be plus zero (+0) foot (millimeter) and minus one-half (-0.05) foot (13 millimeter).

METHOD OF MEASUREMENT

302.04.01 MEASUREMENT: The quantity of aggregate base to be measured for payment will be the number of cubic yards or tons (cubic meters or metric tons) complete and in place. The weight of material will be determined by deducting from the weight of material delivered to the work, the weight of water in excess of optimum plus one percentage point. Optimum moisture will be determined by AASHTO T 180 by the Contractor with the moisture content determined by AASHTO T 255 and confirmed by the Engineer. The weight of water thus deducted will not be measured for payment.

Due to possible variations in the specific gravity and voids of the aggregates, the tonnage used may vary from proposal quantities and no adjustment in contract unit price will be made because of such variation.

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

BASIS OF PAYMENT

302.05.01 PAYMENT: The accepted quantity of aggregate base material, measured as provided in Subsection 302.04.01, "Measurement," will be paid for at the contract unit price bid per cubic yard or ton (cubic meters or metric ton) for the type specified, which price 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.

It is to be expected that deviations in thickness will occur in placing aggregate base courses. It shall be the inherent responsibility of the Contractor to bring the various base courses to the required grade line. Payment will be limited to the number of tons or cubic yards (metric tons or cubic meters) complete and in place and no additional payment will be made for any labor or equipment used in bringing the course to grade.

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

Partial payments may be made in accordance with Subsection 109.06, "Partial Payment."

Payment will be made under:

PAY ITEM	PAY UNIT
Type II Aggregate Base	Subsection 704.03.04

SECTION 303

PLANTMIX BITUMINOUS BASE

DESCRIPTION

303.01.01 GENERAL: This work shall consist of aggregate and bituminous material mixed in a central plant and spread and compacted on a prepared surface in accordance with these specifications and in conformance with the lines, grades, thickness, and typical cross sections shown on the plans or established by the Engineer.

The requirements of Section 401, "Plantmix Bituminous Pavements - General" shall be applicable to this work, except as hereinafter specified.

MATERIALS

303.02.01 GENERAL: The materials shall conform to the requirements as specified in Subsections 401.02.01 through 401.02.04 inclusive, of Section 401, "Plantmix Bituminous Pavements - General."

CONSTRUCTION

303.03.01 GENERAL: The construction requirements shall conform to the requirements as specified in Subsections 401.03.01 through 401.03.15 inclusive, of Section 401, "Plantmix Bituminous Pavements - General," with the exceptions contained in the following two subsections.

303.03.02 SPREADING AND FINISHING: Unless otherwise specified, bituminous plantmix base shall not be placed in courses exceeding four (4) inches (100 millimeters) in compacted thickness. When more than one course is placed, the courses shall be of approximately equal thickness.

303.03.03 SURFACE TOLERANCES: The completed surfacing shall be thoroughly compacted, smooth, and free from ruts, humps, depressions, or irregularities. When a straightedge ten (10) feet (3 meters) long is laid on the finished surface and parallel with the centerline of the highway, the surface shall not vary more than one-half inch (12 millimeters) from the lower edge of the straightedge. The transverse slope of the finished surface shall be uniform to a degree such that no depressions greater than one-half inch (12 millimeters) are present when tested with a straightedge ten (10) feet (3 meters) long laid in a direction transverse to the centerline and extending from edge to edge of a twelve (12) foot (3.7 meters) traffic lane.

Any ridges, indentations, or other objectionable marks left in the surface of the bituminous mixture by blading or other equipment shall be eliminated by rolling or other means. The use of any equipment that leaves ridges, indentations, or other objectionable marks in the bituminous mixture shall be discontinued and other acceptable equipment shall be furnished by the Contractor.

METHOD OF MEASUREMENT

303.04.01 MEASUREMENT: Plantmix bituminous base will be measured as specified in Subsection 401.04.01, "Measurement."

SECTION 400

ASPHALT RUBBER PAVEMENT SURFACE

DESCRIPTION

400.01.01 GENERAL: 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. The asphalt rubber pavement mix shall consist of a surface course composed of mineral aggregate along with a reacted asphalt rubber binder. The reacted asphalt rubber binder shall consist of asphalt cement, crumb rubber modifier, and other additives if required. The asphalt rubber pavement mixture shall be prepared in a central mixing plant and placed in accordance with these specifications. The following table references the components of the rubberized asphalt concrete to their respective sections of these specifications.

Table 1 – Specification Reference Sections

Item	Specification Section
Asphalt Rubber Pavement	400.02.01
1) Mineral Aggregate	400.02.02
2) Asphalt Rubber Binder	400.02.03
a) Asphalt Cement	400.02.04
b) Crumb Rubber Modifier	400.02.05
c) Admixture	400.02.06
Quality Control and Liquidated Damages	400.03.16

Rubberized asphalt concrete shall conform to these specifications and to the lines, grades, thickness, and typical cross-sections shown on the plans. All mix designs shall be performed by the Contractor.

MATERIAL

400.02.01 ASPHALT RUBBER PAVEMENT MIX REQUIREMENTS: Asphalt rubber pavement shall conform to the following requirements:

Table 2 – Asphalt Rubber Pavement Mix Requirements

Parameter	Requirement
Marshall Stability, 75 blows, lbs, min.	1200
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

For bidding purposes, the percent of asphalt rubber binder in the mix shall be eight (8) percent. The exact amount of asphalt rubber binder in the mix shall be determined by the Contractor's mix design.

The Contractor shall submit five (5) copies of an asphalt rubber pavement mix design fifteen (15) days prior to production of the asphalt rubber hot mix. The mix design shall conform to the mix design requirements as shown in the table above. Asphalt rubber pavement mix design will be performed in accordance with AASHTO T-245 (modified), test specimens compacted at 295 ± 5°F (75 blows) and the Asphalt Institute MS-2, May 1984 Edition procedure, Marshall Method.

The mix design must 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

The entity Engineer will review the mix design proposal to assure that it contains all required information. If it does not, it will be returned for further action and re-submission by the Contractor.

400.02.02 MINERAL AGGREGATE: The aggregate for the asphalt rubber pavement mixture shall meet the following requirements:

1) Minimum sand equivalent value shall be sixty five (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 three (3) percent. Water absorption is to be determined separately for each aggregate material proposed for use. For fine fractions (minus No. 4) water absorption shall not exceed three (3) percent. For course fractions, water absorption shall not exceed three (3) percent.
4) L.A. abrasion limits for each aggregate proposed for use shall be as follows:

   Maximum: Nine (9) percent abrasion at one hundred (100) revolutions

   Maximum: Thirty five (35) percent abrasion at five hundred (500) revolutions
5) Recycled aggregates will not be permitted
6) The gradation shall be as follows:

Table 3 – Aggregate Gradation

Sieve Size	Percent Passing
1" (24 mm)	100
3/4" (18 mm)	90-100
1/2" (12 mm)	65-85
3/8" (9 mm)	60-70
#4 (4.75 mm)	22-42
#8 (2.36 mm)	15-25
#30 (600 um)	5-15
#200 (75 um)	3-7

400.02.03 ASPHALT RUBBER BINDER: 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.

The asphalt-rubber binder shall meet the following physical parameters when reacted with the asphalt cement at 375°F, (± 25°F.) for a minimum of thirty (30) minutes:

Table 4 – Asphalt Rubber Binder Requirements

Parameter	Requirement
Rotational Viscosity; 350 °F; Pascal seconds, Haake type viscometer[1],	1.5-4.0
Penetration, 39.2 °F, 200g, 60 sec. (ASTM D-5);1/10 mm	10 Minimum
Penetration, 77 °F, 100g, 5 sec. (ASTM D-5);1/10 mm	25-75
Softening Point, °F (ASTM D-36)	135° Minimum
Resilience, 77 °F (ASTM D-3407)	20% Minimum
Ductility, 39.2 °F (ASTM D-113), 1 CPM	5 Minimum

[1]The viscometer used must be correlated to a Haake Viscometer, Model VT-04, Rotor No. 1.

The Contractor shall provide documentation that the Haake Viscometer has been correlated (2 point minimum) within six (6) months prior to use on the project.

The percentage of crumb rubber modifier shall be twenty (20) percent plus or minus three (3) percent by weight of total asphalt rubber mixture, the exact crumb rubber content shall be determined by the asphalt rubber binder mix design prepared by the Contractor.

400.02.04 ASPHALTIC CEMENT: Asphalt cement shall be grade AC-20. The exact amount shall be determined by the Contractor's mix design and shall be approved by the entity Engineer.

400.02.05 CRUMB RUBBER MODIFIER: Rubber shall be a recycled vulcanized rubber produced primarily from the processing of scrap tires. Gradation of the rubber shall be in accordance with ASTM C-136 (dry sieve only) using fifty (50) grams ± one (1) gram.

Samples shall meet the following requirements:

Table 5- Crumb Rubber Modifier Gradation

Sieve Size	Percent Passing
#10	100
#16	75-100
#30	25-60
#50	0-20
#200	0-5

The use of rubber of multiple types from multiple sources is acceptable provided that the overall blend of rubber meets the above gradation requirements.

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. However, up to four (4) percent (by weight of rubber) calcium carbonate may be included to prevent rubber particles from sticking together. The rubber shall be dry so as to be free flowing and not produce foaming when blended with hot asphalt cement. The length of the individual rubber particles shall not exceed 3/16 inch.

Fiber content in the rubber shall be less then 0.1 percent by weight. The moisture content in the rubber shall be less than 0.75 percent by weight. Mineral contaminant in the rubber shall not be greater than 0.25 percent by weight, as determined after separating a fifty (50) gram rubber sample in a one liter glass beaker of water. The rubber shall contain no visible metal particles, as indicated by a thorough stirring of a fifty (50) gram sample with a magnet and shall conform to the chemical analysis in the table below.

Table 6 – Crumb Rubber Modifier Chemical Analysis Requirements

Test	Requirement
Acetone Extract (ASTM D-297)	6%-16%
Ash Content (ASTM D-297)	0%-8%
Carbon Black Content (ASTM D-297)	28%-38%
Rubber Hydrocarbon (ASTM D-297)	42%-65%
Natural Rubber Content (ASTM D-297)	22%-39%

Certification that the ground rubber meets or exceeds the requirements as set forth in these specifications shall be provided by the rubber supplier.

400.02.06 ADMIXTURE: If required by the job mix formula to produce appropriate water resistance and assure proper adhesion and/or coating of aggregate, an anti-stripping agent shall be incorporated into the mineral aggregate.

The admixture shall be either hydrated lime (ASTM C-1097) or Portland Cement II (ASTM C-150). The amount needed for the admixture shall be as determined by the Contractor's mix design.

400.02.07 MIX DESIGN REQUIREMENTS: The mix designs must be performed by a Nevada registered professional engineer knowledgeable in asphalt mix design. The laboratory used to prepare the mix design can be the Contractor's laboratory or an independent geotechnical-materials laboratory provided they comply with the following:

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). A copy of the certification will be required with each submittal as described above.

The asphalt rubber binder mix design shall be a twenty four (24) hour design.

CONSTRUCTION

400.03.01 ASPHALT-RUBBER BINDER MIXING AND PRODUCTION EQUIPMENT: All equipment utilized in production and proportioning of the asphalt-rubber binder shall be described as follows:

1) 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 three thousand (3,000) gallons of asphalt cement.

2) An asphalt-rubber binder mechanical blender with a two 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 entity Engineer. 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. A separate asphalt cement feed pump and finished product pump are required. This unit shall have both an asphalt cement totalizing meter in gallons and a flow rate meter in gallons per minute.

3) 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.

4) 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. The temperature and viscosity of the asphalt rubber binder shall be within the range specified in the approved rubberized asphalt concrete formula. 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

Asphalt Cement Temperature: The temperature of the asphalt cement shall be between 375°F and 450°F at the time of addition of the granulated rubber.

Blending and Reacting: 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 forty five (45) minutes from the time the granulated rubber is added to the asphalt cement. Temperature of the asphalt-rubber mixture shall be maintained at or above 350°F during the reaction period, but shall not exceed 450°F at any time. Exceeding 450°F will be grounds for rejection of the affected material. The asphalt rubber binder may be allowed to cool to between 300°F and 350°F only after the reaction time is complete and the viscosity is within the specified range.

Transfer: After the material has reacted for at least forty five (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.

Delays: When a delay occurs in binder use after its full reaction, the asphalt-rubber binder shall be allowed to cool. The asphalt-rubber binder shall be reheated slowly just prior to use to a temperature between 300°F and 335°F, and shall also be thoroughly mixed before pumping and metering into the hot plant for combination with the aggregate. The entity Engineer shall be notified of any material that is held over and allowed to cool. 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. The entity Engineer or his representative shall be present at the time of testing.

400.03.03 ASPHALT-RUBBER BINDER /AGGREGATE MIXING EQUIPMENT: 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:

Batch Mixing: 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. Also, the plant may be equipped with hot-mix surge or storage bins for short-term holding of the mixture until spreading.

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.

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.

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: The Contractor will not be allowed to feed the hot plant from stockpiles containing less than two (2) full days of production, unless only two days' production remains to be done. Mineral aggregate shall be separated and stockpiled so that segregation is minimized. An approved divider of sufficient size to prevent intermingling of stockpiles shall be provided.

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.

A positive signal system and a limit switch device shall be installed in the plant, at the point of introduction of the mineral admixture. The positive signal system shall be placed between the metering device and the drum dryer, and utilized during production, whereby the mixing shall automatically be stopped if the admixture is not being introduced into the asphalt rubber concrete mixture. Failure to provide electronic integration of the feed controls at all times will be grounds for immediate suspension of production.

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. The entire plant operating shall not exceed two percent for any setting, nor one and one-half percent for any batch. Bituminous material shall be weighed in an insulated bucket suspended from a spring-less dial scale system. All scales must be certified.

No fine material, which has been collected in the dust collection system, shall be returned to the mixture, unless the entity Engineer, on the basis of tests, determines that all or a portion of the collected fines can be utilized.

If the entity Engineer so determines, it 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.

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.

The continuous feeder will supply the correct amount of mineral aggregate in proportion to the bituminous material, and so arranged that the proportion of each mineral aggregate size can be separately adjusted. The continuous feeder for the mineral aggregate shall be electrically actuated. Failure to provide electronic integration of the feed controls at all times will be grounds for immediate suspension of production.

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.

A positive signal system shall be provided to indicate the low level of mineral aggregate in the bins. The plant will not be permitted to operate unless this signal system is in good working condition. Each bin shall have an overflow chute or a divider to prevent material from spilling into adjacent bins.

The mixing operation shall be sufficient to achieve a satisfactory mixture with one hundred (100) percent coated particles as determined by AASHTO T195 or ASTM D 2489.

The aggregate shall be dried and heated to provide a rubberized asphalt concrete mixture immediately after mixing, having a temperature of 290°F to 335°F and a moisture content not exceeding one (1) percent by weight of mixture.

400.03.05 ASPHALT RUBBER BINDER CONTROL: The asphalt-rubber binder shall be a minimum of 300°F when pumped and metered into the mixing plant.

The crumb rubber modifier content shall not fluctuate more than one (1) percent by weight of total rubberized asphalt concrete mixture.

400.03.06 ASPHALT RUBBER PAVEMENT CONTROL: The asphalt rubber pavement mixture shall have a temperature not exceeding 335°F and a moisture content not exceeding one (1) percent by weight of mixture immediately upon discharge from the mixer.

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.

The moisture content of the asphalt rubber concrete immediately behind paver shall not exceed one 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: Trucks used for hauling the paving mixture shall be capable of discharging directly into the spreading equipment. Discharge onto the surface being paved shall not be permitted. The truck beds shall be clean of materials such as dirt, mud and aggregates. 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.

If required by the entity Engineer or his representative, the load shall be covered with a tarpaulin to prevent loss of heat.

Mixtures which have cooled in transport shall be rejected. The temperature of the mixture, in the mat behind the paver, shall be at least 275°F but shall not exceed 325°F.

Hauling over freshly laid asphalt concrete pavement will not be permitted.

400.03.08 SPREADING ASPHALT RUBBER PAVMENT MIXTURE: Paving shall be accomplished with self-propelled mechanical spreading and finishing equipment. Equipment should have a tampering bar or 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. 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. The spreading temperatures shall be in accordance with the approved job mix formula.

The mixture shall not be placed on any wet surface or when weather conditions will otherwise prevent its proper handling or finishing.

Mixtures shall be placed only when the surface temperature is 60°F and rising.

A ski not less than thirty (30) feet must be used at all times on the through lane paving. A longer ski is preferred, if available. Paving will be halted immediately if the auto screed controls fail and may not proceed without approval of the entity Engineer.

Asphalt Rubber Pavement shall be placed in two (2) inch maximum lifts.

400.03.09 COMPACTING ASPAHLT RUBBER PAVEMENT MIXTURE: A minimum of two self-propelled two-axle steel-wheel rollers shall be furnished for each spreader and finisher. Rollers shall have a minimum roller weight of eight (8) tons and maximum roller weight of twelve (12) tons.

All rollers shall be equipped with pads and a watering system to prevent sticking of the paving mixture to the steel wheeled drums. Vibratory rollers may not be used on one (1) inch or less A.C. Pavement thickness. Pneumatic tire rollers shall not be used due to the increased adhesiveness of the asphalt-rubber binder.

Initial or break down compaction shall commence immediately after mixture spreading and shall consist of three (3) full coverage before the pavement temperature reaches 200°F unless otherwise directed by the entity Engineer or his representative. A coverage shall be as many passes as are necessary to cover the entire width being paved with a pass being one movement of a roller in either direction. Each coverage shall be complete before subsequent coverage is started. Final rolling, consisting of not less than one complete coverage, shall be used to smooth the surface of the mat. All rolling shall be accomplished without excessive aggregate fracturing or mixture shoving.

The asphalt shall be compacted to a minimum of ninety five (95) percent of the seventy five (75) blow design density, as specified in the approved job mix formula.

400.03.10 JOINTS: Longitudinal joints of each course shall be staggered a minimum of twelve (12) inches with relation to the longitudinal joint of the immediate underlying course.

The Contractor shall schedule his paving operations to minimize exposed longitudinal edges. Unless otherwise approved by the entity Engineer, the Contractor shall limit the placement of asphalt rubber concrete courses, in advance of adjacent courses, to one shift of asphalt rubber concrete production. The Contractor shall schedule his paving operations in such a manner as to eliminate exposed longitudinal edges over weekends or holidays.

Longitudinal joints shall be located within twelve (12) inches of the center of a lane, or within twelve (12) inches of the centerline between two adjacent lanes.

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. After placement and finishing of the new asphalt concrete, both sides of the joint shall be dense, and the joint shall be well sealed. The surface in the area of the joint shall conform to the requirements hereinafter specified

for surface tolerances when tested with the straightedge placed across the joint.

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 fifteen (15) degrees from a lie perpendicular to the centerline of the road.

400.03.11 PRODUCTION START-UP PROCEDURE: On the first day of construction, the Contractor shall produce five hundred (500) tons of asphalt rubber pavement mix and then stop production for the day. The five hundred (500) tons of asphalt rubber pavement mix shall be placed within the project limits as a test strip. The entity Engineer or his 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. Mix production and construction will not proceed until the test strip has been accepted by the entity.

400.03.12 WEATHER LIMITATIONS: The asphalt rubber pavement shall be placed when temperature of the existing pavement surface is 60°F and rising before placement.

400.03.13 TACK COAT: A SS-1h tack coat shall be applied, as directed by the entity Engineer, at a rate of 0.05 to 0.10 gallons per square yard. Immediately before applying the bituminous material, the area to be surfaced shall be cleaned of dirt and other objectionable material. In urban areas, the surface shall be cleaned with a self-propelled pick-up sweeper. In rural areas, power brooms may be used. When necessary, cleaning shall be supplemented by hand brooms.

400.03.14 MILLING: The milling process shall not proceed more than seven (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.

The Contractor shall be required to protect all milled surfaces from deterioration and repair subsequent damage prior to seal coating.

Utility companies are not required to lower their appurtenances to facilitate edge milling or cul-de-sac milling.

The Contractor through the Inspector 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: The pavement shall not be used for vehicular traffic of any kind until the pavement has cooled to 180°F, or less, after final rolling.

Traffic shall be prohibited from using the new pavement by utilization of flagging or ribbons placed between barricades. The Contractor, at his own expense, shall be responsible for repairing the new asphalt if damaged by vehicular traffic prior to cooling and curing. 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/5000 gallon) followed by a water rinse to remove hydrated lime residue. The entity Engineer or his 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: 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".

The Contractor shall furnish daily documentation to the entity Engineer that the required amount of mineral admixture has been incorporated into the asphalt rubber concrete.

The asphalt rubber supplier shall maintain records indicating for each batch of asphalt rubber binder produced, the quantity of asphalt cement in gallons and tons, the temperature of the asphalt cement, the amount of anti-stripping agent or other additives, if used, in gallons and/or tons, and the quantity of crumb rubber modifier in pounds, and shall

provide the records to the entity on a daily basis.

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°F per minute, shall be placed at the discharge chute of the dryer 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 entity Engineer at the end of each shift.

The entity Engineer shall be provided 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 entity.

METHOD OF MEASUREMENT

400.04.01 MEASUREMENT: Asphalt Rubber Pavement will be paid for per square yard.

BASIS OF PAYMENT

400.05.01 PAYMENT: The accepted quantity of asphalt rubber pavement will be paid for at the contract unit price bid per square yard, which price shall be considered full compensation for furnishing all the materials including tack coating, hydrated lime, Portland Cement, aggregate, asphalt rubber binder, asphalt cement, crumb rubber modifier, 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.

Payment will be made under:

Pay Item	Pay Unit
Two (2) Inch Asphalt Rubber Pavement Overlay	Square Yard

SECTION 403-2

PLANTMIX BITUMINOUS GAP-GRADED SURFACE

DESCRIPTION

403-2.01 GENERAL: 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. 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). 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.

The requirements of Section 401, "Plantmix Bituminous – General," shall be applicable to this work, except as hereinafter specified.

403-2.01.01 REFERENCE CODES AND STANDARDS:

(a) Uniform Standard Specifications for Public Works' Construction Off-site Improvements, Clark County Area, Nevada that will henceforth be referred to as "US" Specifications and Drawings

(b) Contract Special Provisions and Drawings

(c) NRS 338.176, NAC 625.550

(d) Most current ASTM, AASHTO, or NDOT test procedures

(e) Related Interagency Quality Assurance Committee (IQAC) procedures at www.accessclarkcounty.com/pubworks/iqac/IQAC.htm

403-2.01.02 REQUIREMENTS: Persons involved with the placement of UTACS shall be trained by the manufacturer and or the Nevada T2 Program.

MATERIALS

403-2.02 GENERAL MATERIALS: The materials shall conform to the requirements as specified in Subsections 401.02.01 "Plantmix Bituminous–General" with the following exceptions detailed in Subsections 403-2.02.01 "Certification".

Prior to starting work, the Contractor shall submit a proposed job-mix formula in writing for review and approval by the Engineer. The proposed job-mix formula shall be determined by an AASHTO Certified testing laboratory using NAQTC certified technicians based on the tests required to determine the gradation and surface capacity for coarse aggregate. The gradation shall be type "S1", "S2", or "S3" as per Subsection 705.03.02, "Plantmix and Roadmix Asphalt Concrete Surface Course Types 'S1 through S3' " and the contract special provisions. The bituminous materials shall be "PG76-22CC" as per Section 703.03.02, "Asphalt Cements".

403-2.02.01 COMPOSITION OF GAP-GRADED (UTACS) MIXTURE: 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 403-2.02 and the following:

(a) Film Thickness, (µm) - 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. The minimum film thickness shall be 10µm.

(b) Specimens for T-283 testing are to be compacted using the Superpave gyratory compactor applying one hundred (100) gyrations or using the Marshall compactor applying fifty (50) blows on each side of the four (4)" diameter sample. Use mix quantity necessary to obtain compacted samples 2.5 ± 0.05 inch in height. Further test compacted samples regardless of air void levels achieved after one hundred (100) gyrations or fifty (50) blows on each side. Apply vacuum to samples to be conditioned for twenty (20) seconds and proceed without calculating percent saturation. Mixing and compaction temperatures are to be recommended by the binder supplier. The minimum Moisture Susceptibility shall be eighty (80) percent retained strength.

(c) The minimum air voids shall be four (4) percent and the maximum aggregate surface shall be twenty six (26) square feet per lb.

(d) Marshall Stabilities are not required.

(e) Gradation per Subsection 705.03.08 "Ultra Thin Asphalt Concrete Surface" (UTACS) of Section 705 "Aggregates for Bituminous Courses."

(f) The binder type shall be PG76-22CC as described in Section 703 "Bituminous Materials".

403-2.02.02 POLYMER MODIFIED MEMBRANE 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.

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 shall come in contact with the PMM before the surface course is applied. The process of applying the PMM, placement of the surface course, and screed compacting shall be performed in under five (5) seconds during normal paving speeds resulting in a homogeneous surface that can be opened to traffic immediately upon sufficient cooling (160ºF).

The PMM target design application rate shall be as per Table 1. The PMM application rates shall be adjusted in the field to account for the texture of the existing pavement, and 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

403-2.03.01 GENERAL CONSTRUCTION: The construction requirements shall conform to the requirements as specified in Subsections 401.03.01 through 401.03.15, inclusive of Section 401, "Plantmix Bituminous Pavements – General," with the exceptions contained in the following subsections.

403-2.03.02 GAP-GRADED UTACS PAVING EQUIPMENT: The Contractor shall use a self-priming paver, designed and built for the purpose of applying the PMM bond and the UTACS pavement. All other equipment and tools shall be approved by the Engineer. All equipment and tools shall be maintained in satisfactory working condition at all times.

The self-priming machine shall be capable of spraying the PMM emulsion, applying the surface coarse overlay and providing a smooth surface to the mat in one pass at the rate of ten (10) to thirty (30) m/minutes (35.5 to 92 ft/min). The self-priming paving machine 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. 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.

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.

The PMM shall be applied by a mechanical pressure spray bar. The application rate shall be applied within a tolerance of 0.018 gal per square yard (0.08 liter/square meter). The PMM shall be applied at a uniform rate for the full paving width.

a) **Rollers:** Rolling of the wearing course shall consist of a minimum of two passes with a steel double drum asphalt roller of minimum weight of ten (10) metric tons, before the material temperature has fallen below 185ºF. At no time shall the roller or rollers be allowed to remain stationary on the freshly placed asphalt concrete. Rolling shall immediately follow the placement of the UTACS with an approved asphalt roller(s). Rollers shall be monitored to ensure the rollers are not picking up material and that setting process is completed while the mat is above 185ºF. Roller(s) 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. Adequate roller units shall be supplied so the rolling will be accomplished promptly following the placement of the material. A release agent (added to the water system) may be required to prevent adhesion of the fresh mix to the roller drum and wheels. Rolling shall normally be done in the static mode.

b) **Sweepers:** The Contractor shall have a minimum of one (1) approved sweeper available at all times during the construction of the surface course to pick up lose material.

c) **Material Transfer Vehicle:** A Material Transfer Vehicle (MTV) shall be used when placing UTACS. The MTV shall have the ability to remix the UTACS mixture to eliminate truck end segregation, minimize material temperature loss and deliver a uniform mixture to the paver. The MTV shall be a self-propelled machine totally independent of the paver. The MTV shall have a high capacity truck unloading system to receive UTACS mix from the haul units. The MTV shall have a minimum twenty five (25) ton surge capacity to minimize paver start/stops and maximize trucking efficiency. The MTV shall be equipped with a pivoting paver loading conveyor. The paver-loading conveyor must have the ability to swing fifty five (55) degrees to either side to allow off-lane paving.

403-2.03.03 APPLICATION OF GAP-GRADED UTACS SURFACE: The performance of the UTACS pavement is directly dependent on the two key components: the proper application of the PMM and the use of a self-priming paver, designed and built for the purpose of applying the UTACS pavement.

The UTACS pavement shall not be placed on a wet pavement. The pavement surface temperature shall not be less than 50ºF (10ºC) and the ambient temperature shall not be less than 50ºF (10ºC) and rising.

The PMM shall be sprayed by a metered mechanical pressure spray bar at a temperature of 140º – 180ºF (60º – 80ºC). The sprayer shall accurately and continuously monitor the rate of spray and provide a uniform application across the entire width to be overlaid. 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. The PMM shall be applied manually where the screed extension or handwork is required outside the range of the machine mounted spray bar. Over application or double application of emulsion on the existing base shall not be permitted. 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. The PMM field adjusted shot rate shall be reduced by 0.03 gal/square yard within one hundred and fifty (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. The Contractor and Engineer shall establish an acceptable range for the spray rate. The PMM shall have a minimum of two daily yield verifications to be reported to the engineer, one at midway production and one at the end of production. These reports shall be the sum of the rates documented each one hundred (100) lineal foot by the Contractor QC Inspector.

The PMM application rate can be adjusted based on the texture depth of the existing pavement measured according to ASTM E965:"Measuring Surface Macro texture Depth Using a “Volumetric Technique". Suggestions to adjust the PMM application rate as a function of texture depth of the existing pavement are shown Table 2.

No wheel or other part of the paving machine shall come in contact with the PMM before the Surface Course is applied. Placement operations or equipment which do not keep surfaces clean and free of contamination or debris prior to placement of the polymer modified asphalt emulsion membrane, or do not prevent tracking through the polymer modified asphalt emulsion membrane prior to placement of the gap graded polymer modified asphalt concrete shall not be used.

The surface course shall be applied at a temperature of 302º – 330º F (150 – 165º C) and shall be spread over the PMM in less than five (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

When filling the emulsion tank, no emulsion shall overflow into the paver hopper. Should emulsion be spilled into the paver hopper, paving shall stop and all contaminated material shall be removed from the paver hopper. Under no circumstances shall the contaminated material be placed on the roadway.

Overlapping or hot lapping of the bonded wearing course shall not be permitted when paving miscellaneous areas in order to achieve project layout requirements, 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.

UTACS shall be applied at a thickness such that no aggregate is fractured. The S3 mix shall be applied at a minimum 3/4" thickness. The S2 mix shall be applied at a minimum 5/8" thickness. The S1 mix shall be applied at a minimum of 9/16" thickness.

403-2.03.04 SURFACE PREPARATION FOR UTACS: The following items will be performed prior to the commencement of paving operations and paid for under the appropriate bid item numbers.

Manhole covers, drains, grates, catch basins, and other such utility structures shall be protected and covered with building felt prior to paving and also shall be clearly referenced for location and adjustment after paving.

Thermoplastic traffic markings shall be removed.

Pavement cracks and joints greater than 0.25 inches wide shall be cleaned and filled using an approved material and method. There shall be no over banding of cracks which will be covered by UTACS. Crack sealing will be completed at least seven days prior to paving.

Surface irregularities greater than one (1) inch deep shall be milled and/or filled with a material approved by the Engineer. All repairs shall be completed one week prior to paving or as recommended by the sealant manufacturer or the Engineer.

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 insure a clean surface.

Cold planning shall be completed as specified herein.

403-2.03.05 JOINTS: Longitudinal joints shall be constructed only on the shoulders, or at the edge of the travel lanes.

403-2.03.06 QUALITY CONTROL ASPECTS: PMM application rate shall be checked twice per day using random sample location techniques.

Determination of the application rate of the PMM shall be as follows:

At the location to be sampled, immediately adjacent to the paving area, use two pads approximately 3.3 feet (1 m) wide by 3.3 feet (1 m) long to determine the PMM application rate based on the average of two application rate measurements. Capture the tare weight of each pad to be used prior to capturing the PMM sample. Place the first pad five feet in front of spray bar on the spray paver. Place the second pad in front of the first pad further away in the travel direction. Set the machine in automatic mode, do not use manual mode when calibrating emulsion application rate. Circulate the emulsion through the spray bars for approximately five (5) minutes before spray calibration in order to purge the system. Select the machine ground speed/production rate to be no less then thirty (30) ft per minute. Select the desired emulsion application rate and take a sample at this setting. Weigh each pad that has been sprayed with the PMM. Calculate the net weight of emulsion and convert it into gallons using the PMM weight per gallon information provided by the emulsion manufacturer. Divide the gallons of PMM by the pad area and compare with the target application rate in gallon per square yard.

A minimum of three (3) daily samples of the bituminous wearing course shall be tested for asphalt content and gradation. If the average of the daily test results vary from the job mix formula (JMF) by more

than the tolerance as indicated in Subsection 705.03.08, "Plantmix and Roadmix Asphalt Concrete Surface Course UTACS Type S1 through Type S3"production will stop. The contractor shall identify the cause and document what corrective action will be taken. The JMF may be adjusted only as approved by the Engineer.

A minimum of two daily UTACS mixture yield checks shall be completed, one at mid day during production and one at the end of the day's production to ensure that mixture application rate requirements defined in Subsection 403.03.03 "Joints" are met.

a) **Placement Limitations:** The UTACS and/or PMM shall not be placed on pavement that has any visible surface moisture.

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 Owner.

Place UTACS and/or PMM only when the pavement surface temperature is 50ºF and rising and the ambient temperature is 50ºF and rising.

The UTACS shall not be placed if the forecast low from the national weather service is 32ºF or lower for the night following any single day's paving operation.

Because of the minimal depth of the surface course being placed it 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 160ºF).

No more than fifteen (15) minutes shall be allowed to elapse between the delivery trucks carrying the UTACS mix to the paver or three (3) cold joints per one-half mile. Cold joints are defined as when the last delivery truck leaves the paver, the paver has stopped more than fifteen (15) minutes before the next delivery truck is brought to the paver.

403-2.03.07 SURFACE TOLERANCES FOR UTACS: The completed surfacing shall be thoroughly compacted, smooth, and free from ruts, humps, depressions, or irregularities. 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. 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.

The Contractor shall produce completed surfacing which meets the requirements of Subsections 402.03.03.02 "Spreading and Finishing" of the Uniform Standard Specifications when required buy the agency with the following additions and exceptions to the profilograph measurement.

The Contractor shall furnish and operate a profilograph, as specified in Subsection 402.03.04, "Profilpgraph Equipment" at the time and date ordered.

Any requirement for grinding shall have a depth selected so that at least eighty (80) percent of the original UTACS thickness is preserved in order to minimize the risk of localized bleeding. Liquidated damages may be assessed, as required by the agency, for each such high point that is allowed to remain in place.

The profile index requirements herein will not apply to the pavement within thirty (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.

403-2.03.08 UTACS PAVEMENT REPAIRS: The Contactor shall pay all costs of UTACS pavement repair activities and their implementation, except as otherwise provided herein. 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 403-2.03.07 "Surface Tolerances for UTACS".

METHOD OF MEASUREMENT

403-2.04.01 MEASUREMENT: 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 (square meters), including the asphalt cement, used in the accepted work.

BASIS OF PAYMENT

403-2.05.01 PAYMENT: The Ultra-Thin Asphalt Concrete Surface (UTACS) bonded with a polymer modified membrane (PMM) will be paid at the contact price bid per square yard, which price 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.

All payments will be made in accordance with Subsection 109.01, "Scope of Payment." Partial payments for UTACS may be made as set forth under Subsection 109.06, "Partial Payments."

Payment will be made under:

Pay Item	**Pay Unit**
Construct UTACS bonded with a PMM, S1 gradation	Square Yard
Construct UTACS bonded with a PMM, S2 gradation	Square Yard
Construct UTACS bonded with a PMM, S3 gradation	Square Yard

Payment will be made under:

PAY ITEM	PAY UNIT
Prestressing Cast-In-Place Concrete	Lump Sum

SECTION 501

PORTLAND CEMENT CONCRETE

DESCRIPTION

501.01.01 GENERAL: This work shall consist of Portland cement, fine aggregate, coarse aggregate, water and when specified, an air entraining admixture, proportioned, mixed, placed, and cured as herein specified.

501.01.02 REFERENCE CODES AND STANDARDS:

(a) Uniform Standard Specifications for Public Works' Construction Off-site Improvements, Clark County Area, Nevada that will henceforth be referred to as "USS" Specifications and Drawings
(b) Contract Special Provisions and Drawings
(c) NRS 338.176, NAC 625.550
(d) Most current ASTM, AASHTO, ACI, or NDOT test procedures
(e) Related Interagency Quality Assurance Committee (IQAC) procedures at www.accessclarkcounty.com/pubworks/iqac/IQAC.htm

MATERIALS

501.02.01 GENERAL: Materials shall meet the requirements of the following sections and subsections:

Table 1- Material Requirements

Materials	Section
Aggregate for Portland Cement Products	706
Concrete Curing Materials and Admixtures	702
Portland Cement	701
Water	722

501.02.02 GRADATION REQUIREMENTS: The gradation requirements represent the extreme limits in determining the suitability of material. The gradation from any one source shall maintain a uniformity such that variations in the fineness modulus will not exceed 0.2 from the fineness modulus of samples of the material offered for use. Fine aggregate from any one source having a variation in fineness modulus of more than 0.2 as prescribed above shall be rejected, or at the discretion of the Engineer, may be accepted subject to such approved changes. The fineness modulus of fine aggregate shall be determined by adding the cumulative percentages, by weight, of material retained on each of U.S. Standard sieves No. 4, No. 8, No. 16, No. 30, No. 50, and No. 100, and dividing by one hundred (100).

If the fine aggregate for a job-mix is to be a composite material from two or more sources, material from respective sources shall be blended by methods which will maintain the degree of uniformity of gradation required by these specifications.

Adequate supplies of aggregate shall be produced and stockpiled sufficiently in advance of construction operations to permit sampling and testing before use.

Coarse aggregates secured from sources which vary widely in gradation shall be placed in separate stockpiles or bins and combined in proportions approved by the Engineer. Different sizes of aggregates shall be stored in stockpiles sufficiently removed from each other to prevent intermixing.

If the Contractor changes the source of any size of aggregate, opportunity shall be given in advance of use to permit the Engineer to determine the concrete-making properties as provided in Subsection 501.02.04, "Concrete Making Properties."

501.02.03 ADMIXTURES: Air-entraining admixtures and water reducers and retarders shall conform to the requirements of Subsection 702.03.03, "Air-Entraining Admixtures" and 702.03.04, "Water Reducers and Retarders."

No admixtures shall be used without written permission from the Engineer, except as otherwise provided in these specifications or in the Special Provisions.

Admixtures shall not be used to replace cement. Admixtures containing chlorides as Cl^- in excess of one (1) percent by weight shall not be used in prestressed concrete. If admixtures are used to entrain air, to reduce the water-cement ratio, to retard or accelerate setting time, or to accelerate the development of strength, they shall be used at the dosage specified in the contract document or as provided by the Engineer.

When the use of an air-entraining agent is specified, it shall be added in a quantity conforming to Table I of Subsection 501.03.04, "Classifications and Proportions." It shall be measured 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 (cubic meter) of concrete remain constant. Such adjustments shall be made by decreasing the weight of fine aggregate without changing the weight of coarse aggregate unless otherwise approved by the Engineer.

Admixtures shall be measured accurately into each batch by methods approved by the Engineer.

Except as otherwise provided for air-entraining agents, samples of admixtures proposed for use shall be submitted by the Contractor to the Engineer in advance of intended use to permit tests to be made to determine compliance with claimed properties.

Any type of admixture shall be uniform in properties throughout its use in the work. Should it be found that the admixture as furnished is not uniform in properties: its use shall be discontinued.

Admixtures shall be dispensed in liquid form. Dispensers for 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 approved by the Engineer by more than five (5) percent. Equipment for measurement shall be designed for convenient confirmation of the accuracy of measurement. If more than one admixture is used, each shall be dispensed by separate equipment unless otherwise permitted in writing by the Engineer.

When water-reducing agents or water-reducing retarders are used, the permitted dosage of the admixture shall not exceed that which will result in an increase in the drying shrinkage of the concrete of twenty (20) percent when used in precast, prestressed concrete; ten (10) percent when used in cast-in-place prestressed concrete; ten (10) percent when used in cast-in-place reinforced concrete; or three (3) percent when used in non-reinforced concrete pavements.

Water reducers shall reduce the water demand of concrete for a given slump at least seven (7) percent when used at the maximum dosage recommended by the manufacturer. Set retarders shall not be used in greater dosages than those recommended by the manufacturer, nor more than that needed to obtain the desired retardation. The strength of the concrete containing the admixture in the amount approved by the Engineer, shall at the age of forty-eight (48) hours and longer, be not less than that of similar concrete without the admixture.

When the Contractor proposes to use an air-entraining admixture which has been previously approved, he shall submit a certification stating that the admixture is the same as that previously approved.

If an admixture offered for use is essentially the same (with only minor differences in concentration) as another previously approved material, a certification will be required stating that the product is essentially the same as the approved admixture and that no other admixture or chemical agent is present.

501.02.04 CONCRETE MAKING PROPERTIES: Portland cement concrete shall be subject to the AASHTO related American Concrete Institute (ACI) standards:

A test, as defined above, shall be required for each one hundred (100) cubic yards (76.5 cubic meters), or portion thereof, placed each day. Cylinders shall be required to be taken each day regardless of the volume of concrete placed.

501.02.05 ZERO SLUMP CONCRETE FOR THE MANUFACTURING OF PRECAST CONCRETE: Concrete products manufactured by the zero slump method shall comply with material requirements contained in Subsection 701.01.01, "Materials Covered", design, and performance requirements meeting relevant ASTM specifications. For zero slump concrete, all other parts of Section 501 do not apply.

CONSTRUCTION

501.03.01 EQUIPMENT: Methods employed in performing the work, and all equipment, tools, and machinery used for handling materials and executing any part of the work, shall be subject to the approval of the Engineer. All equipment necessary shall be on hand and approved before concrete operations are begun by the Contractor.

The Contractor shall maintain the equipment in good condition and adjustment. Concrete mixers and other equipment which are not adequate or suitable for the work shall be removed and suitable equipment shall be provided by the Contractor.

CONCRETE STRENGTH P.S.I.
4,000
39
38
37
36
3,500
34
33
32
31
3,000
29
28
27
26
2,500
28
30
35
40
45
50
55
60
65
70
75
AGE, DAYS
CHART NO. 1

501.03.02 PROTECTING AND SAMPLING CEMENT: Suitable means of storing and protecting the cement against moisture or other injurious effects shall be provided by the Contractor. Sacked or bulk cement which, for any reason, has become partially set or which contains lumps of caked cement shall be rejected and shall be immediately removed from the worksite.

Different brands of cement shall not be mixed during use or in storage, nor shall they be used alternately in any one structure. The same brand and kind of cement shall be used in a given structure above the ground line.

The sacked cement shall be so piled as to permit access for tally, inspection, and identification of each shipment.

The Contractor shall obtain from the cement company from which the cement is purchased, a certificate stating that the cement delivered to the work complies with the specifications for the type of cement specified for use. The certificate shall be dated, signed, and indicate the quantity of shipment. Two copies shall be delivered directly to the Engineer in charge of the work.

Upon receipt of the certificate of compliance, the Engineer may permit the use of the cement. When a certificate of compliance is not furnished by the Engineer, the cement shall not be used in the work until a release of its use has been received by him from the Contracting Agency's Materials and Research Division.

When a certificate of compliance is not furnished, the Contracting Agency shall be afforded sufficient time to make a seven (7) day test on approved brands of cement in common use, and a twenty-eight (28) day test of new and unapproved brands of cement.

Whenever it is determined by subsequent laboratory test of mill or field samples that the cement does not comply with the specifications, subsequent use of cement from the same cement company will be delayed, if required by the laboratory, until tests can be made on each lot of cement delivered.

All cement not conforming to the specifications and all cement damaged by exposure to moisture shall be removed immediately and permanently from the work.

501.03.03 STORAGE OF AGGREGATES: The handling and storage of aggregates shall be such as to prevent segregation or contamination by foreign materials.

In placing materials in storage or in moving them from storage to the mixer, any method which may cause the segregation, degradation, or the combining of material of different gradings which will result in any stockpile or bunker material failing to meet specified requirements shall be discontinued and the materials shall be reprocessed or wasted.

501.03.04 CLASSIFICATION AND PROPORTIONS: The Contractor shall notify the Engineer not less than thirty-two (32) calendar days in advance of use of the proposed sources of materials and shall make arrangements for the Engineer to obtain samples as required for testing purposes. 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. If permission to change sources of material is granted, a new job-mix formula will be required.

When requested by the Contractor, exceptions to the above requirement may be granted in writing by the Engineer under either of the following conditions:

(a) The concrete structures on the project are minor in nature, such as culvert headwalls, manholes, small boxes, sidewalks, etc., generally, when less than one hundred (100) cubic yards (76 cubic meters) of concrete are called for on the project.

(b) When the aggregate source has been previously tested within the past one (1) year and accepted by the Contracting Agency.

Table 2 Concrete Mix Designations

Class of Concrete	Cement Range Sacks Per Cubic Yard	Kg Per Cubic Meter	Coarse Min Agg. Size No.	Compressive Strength (28 Day)		Slump Range[1]		Air Range %	Unit Weight Variation		Use
				PSI	Mpa	In.	Cmr		lbs	Kg	
A	6.0 - 7.5	334 - 419	467	3000	20.7	1 - 4	2.5 - 10	--	± 3	± 1.4	General
AA	6.0 - 7.5	334 - 419	467	3000	20.7	1 - 4	2.5 - 10	4 - 7	± 3	± 1.4	General
D	6.0 - 7.5	334 - 419	67	3000	20.7	1 - 4	2.5 - 10	--	± 3	± 1.4	General
DA	6.0 - 8.0	334 - 446	67	3000	20.7	1 - 4	2.5 - 10	4 - 7	± 3	± 1.4	General
E	6.0 - 7.5	334 - 419	57	3000	20.7	1 - 4	2.5 - 10	--	± 3	± 1.4	Reinforced Sections
EA	6.0 - 8.0	334 - 446	57	3000	20.7	1 - 4	2.5 - 10	4 - 7	± 3	± 1.4	Curbs, etc.
PAA	6.0 - 8.0	334 - 446	57	Specified on Plans	--	0 - 4	0 - 10	Specified on Plans	± 3	± 1.4	Prestressed Members

[1] When the deck of a structure is used as a riding surface, the slump shall conform to that specified in Subsection 409.03.01, "Classification and Proportions." The difference in slump, determined by comparing slump tests on two samples of mixed concrete for each individual batch tested, shall not exceed two (2) inches (5) centimeters). When the difference in slump does exceed two (2) inches (5 centimeters), procedure and equipment used in producing the concrete shall be adjusted to reduce the difference in slump to not more than two (2) inches (5 centimeters).

Samples will not exceed five hundred (500) pounds (200 kilograms) for each separate grading.

Before beginning concrete work, the Contractor shall submit in writing to the Engineer the proposed concrete mix design giving the cement factor in sacks per cubic yard (cubic meter) indicating the proportions of cement, water, admixtures and the gradation of the primary aggregate nominal sizes which he proposes to furnish. When the primary coarse aggregate is separated into two sizes, the gradation shall consist of the gradation for each individual size, and the proposed proportions of each individual size, combined mathematically with the fine aggregate to indicate one proposed gradation. Such gradation shall meet the grading requirements shown in the following table. (Not applicable to light-weight concrete). If the Contractor proposes to use an admixture other than an air-entraining agent, he shall state its complete brand name and the quantity proposed to be used per sack of cement.

Portland cement concrete shall be proportioned using the aggregates tested such that the compressive strength requirements in Table 1 of this subsection will be satisfied. The Contractor shall give the Engineer advance notice in writing when any changes are to be made in the batch proportions.

Batches of concrete shall not vary more than ± three (3) pounds per cubic foot (± 48 kilograms per cubic meter) in unit weight from design mix. The cement factor of any individual batch placed in the work shall not be more than 0.15 sack per cubic yard less, nor more than 0.25 sack per cubic yard (8.4 kilograms per cubic meter less or 14.0 kilograms per cubic meter more) greater than the designated factor (sacks of cement per cubic yard) (kilograms of cement per cubic meter). The weights used may be varied as necessary to comply with the above tolerances in cement factor and unit weight.

501.03.05 PROPORTIONING METHODS: Except as hereinafter noted, aggregate bins shall conform to either (a) or (b) as follows:

(a) Each specified size of 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.

(b) Each size aggregate shall be weighed individually in a single bin, providing there is a satisfactory method employed to eliminate any excess material resulting from over-charging of the bin before the material reaches the surge hopper.

(a) and (b) above will not be required when batching for culvert headwalls, manholes, small boxes, sidewalks, etc., and the total quantity of concrete called for on the project does not exceed three hundred (300) cubic yards (229 cubic meters).

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.

Batches requiring fractional sacks of cement will not be permitted, unless the Contractor elects to weigh the cement in each batch.

Bulk cement shall be weighed separately when the batch is one (1) cubic yard (cubic meter) or more. 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 one (1) percent of the amount specified. An interlock system will not be required on projects having less than three hundred (300) cubic yards (229 cubic meters) in the bid schedule.

Scales utilized in the proportioning device may be of the springless dial type or of the multiple beam type.

If of the dial type, the dial shall be of such size and so arranged that it may be read easily from the operating platform.

If of the multiple beam type, the scales shall be provided with an indicator operated by the main beam which will give positive visible evidence of over or under weight. The indicator shall be so designed that it will operate during the addition of the last four hundred (400) pounds (180 kilograms) of any weighing. The over travel of the indicator hand shall be at least one-third of the loading travel. The indicator shall be enclosed against moisture and dust.

Weighing equipment shall be insulated against vibration or movement of other operating equipment in the plant. When the entire plant is running, the scale reading and cutoff shall not vary from the weight designated by more than one (1) percent for cement and one and one-half (1-1/2) percent for any size aggregate, nor one and one-half (1-1/2) percent for the total aggregate in any batch.

Scales shall be approved with a certificate of inspection as required by Subsection 109.01, "Measurement of Quantities."

Should separate supplies of aggregate and material of the same size group, but of different moisture content or specific gravity be available at the proportioning plant, withdrawals shall be made from one supply exclusively and the material therein completely exhausted before starting upon another.

Stockpiled aggregates shall be in a saturated surface dry condition just prior to batching. The moisture content of the aggregate shall be such that no visible separation of moisture and aggregate will take place during transportation from the proportioning plant to the point of mixing. Aggregate containing excess moisture shall be stockpiled prior to use until sufficiently dried to meet the above requirements.

Batches with cement in contact with damp aggregates shall be mixed within thirty (30) minutes after being proportioned. Batch trucks hauling more than one (1) batch of cement and aggregate shall be so constructed that materials do not flow from one compartment to another during haul or discharge.

Coarse and fine aggregate shall be handled and measured separately. Each bag of cement shall contain ninety-four (94) pounds (42.5 kilograms) net and shall be emptied directly into the charging skip of the mixer. Water shall be measured either by volume or by weight.

The equipment for measuring and supplying the water to the mixer shall be so constructed and arranged that the amount of water added to the mixture can be measured in one operation into the mixing drum without dribbling. The equipment shall be so designed that water from the source of supply cannot enter the measuring tank while the water is being discharged from the measuring tank into the mixer. Tanks or other equipment for measuring and discharging water into the mixer shall be sufficiently accurate that the amount of water delivered to the mixer for any batch shall not vary more than one (1) percent from the required quantity of water for any position of the mixer with respect to a level plane. The tanks or other equipment shall be so arranged as to permit the checking of the amount of water delivered by discharging into measured containers.

501.03.06 MACHINE MIXING: Concrete manufactured by any procedure which results in any unmixed lumps of cement in the mixed product shall be rejected.

The Engineer shall be provided with a legible ticket with each load of concrete delivered to the contract which shall contain the following information:

Name of Vendor
Name of Contractor
Number of Cubic Yards in the Load
Actual Weights of Cement and of each Size of Aggregate
Amount of Water Added at the Plant
Amount of Water in the Aggregate
Brand and Type of Cement
Brand and Amount of Admixture
Time and Date of Batching

When mix proportions have been designated for a project and are identified by number, the Engineer may waive the foregoing and accept a legible ticket which shall contain the following information:

Name of Vendor
Name of Contractor
Number of Cubic Yards in the Load
Mix Designation Number
Amount of Water Added at the Plant (including Water in Aggregates)
Time and Date of Batching

Space shall be provided on the ticket so the amount of water added on the job may be indicated.

(a) **General.** All concrete shall be mixed in mechanical mixers, except that when permitted by the Engineer, batches not exceeding one-third (1/3) cubic yard (1/3 cubic meter) may be mixed by hand methods in accordance with the provisions of Subsection 501.03.07, "Hand Mixing." Mixers shall have legible permanently attached plates showing manufacturer's rated capacity, mixing speeds, and serial number.

Mixers may be stationary mixers or truck mixers. Agitators may be truck mixers operating at agitating speed or truck agitators. Each mixer and agitator shall have attached thereto in a prominent place a metal plate or plates on which is plainly marked the various uses for which the equipment is designed, the manufacturer's guaranteed capacity of the drum or container in terms of the volume of mixed concrete and the speed of rotation of the mixing drum or blades.

The Contractor, at his expense, shall furnish samples of the fresh concrete and provide safe and satisfactory facilities for obtaining the samples.

Concrete mixers may be of the revolving drum or the revolving blade type and the mixing drum or blades shall be operated uniformly at the mixing speed recommended by the manufacturer.

The temperature of materials as charged into the mixer shall be such that the temperature of the mixed concrete at the time it is placed in final position is not less than fifty (50) degrees F. nor more than ninety (90) degrees F. (10 degrees C. nor more than 32 degrees C.) as specified in Subsection 501.03.10(b). Aggregates and water used for mixing shall not exceed one hundred fifty (150) degrees F. (66 degrees C.).

Concrete for structures shall be mixed for a period of not less than sixty (60) seconds nor more than five (5) minutes after all materials, including water, are in the mixer.

Cement shall be batched and charged into the mixer by means that will not result either in loss of cement due to the effect of wind, or 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.

Stationary mixers having a capacity of one (1) cubic yard (1 cubic meter) or more and all paving mixers shall be operated with an automatic timing device that can be locked by the Engineer. The time device and discharge mechanisms shall be so interlocked that during normal operations no part of the batch will be discharged until the specified mixing time has elapsed.

The total elasped time between the intermingling of damp aggregates and cement and the start of mixing shall not exceed thirty (30) minutes.

Mixers and agitators which have an accumulation of hard concrete or mortar or worn blades shall not be used.

When central-mixed concrete is furnished and non-agitating hauling equipment is used for transporting concrete to the delivery point for Portland cement concrete pavement, discharge into the laydown machine shall be completed within forty-five (45) minutes after the addition of the cement to the aggregates.

(b) **On-Site Mixed Concrete.** When mixing at the site of the work, the mixers used shall be of the paving or stationary type. The size of batch shall not exceed the rated capacity as determined by the standard requirements of the Associated General Contractors of America, except that in paving mixers when used for Portland cement concrete pavement, concrete slope protection and curbs and sidewalks, the size of the batch may exceed the rated capacity of the mixer as determined by the standard requirements of the Associated General Contractors of America to a total of 32.4 cubic feet (0.92 cubic meter) in 27 E mixers and 40.8 cubic feet (1.15 cubic meters) in 34 E mixers, provided that all parts of the mixer will hold the overcharge without spillage, that the uniformity and strength of the resulting concrete is not reduced, and provided further that when paving mixers are operating on grades in excess of six (6) percent, the size of batch shall not exceed 29.7 cubic feet (0.84 cubic meter) in 27 E mixers nor 37.4 cubic feet (1.06 cubic meters) in 34 E mixers.

(c) **Ready-Mixed Concrete.** 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.

The size of batch in truck mixers and truck agitators shall not exceed the rated capacity as determined by the current Standard Requirements of Truck Mixer Manufacturers Bureau. The size of batch in stationary mixers shall not exceed the rated capacity of the mixer as determined by the standard requirements of the Associated General Contractors of America. No batches requiring fractional sacks of cement will be permitted unless all of the cement is weighed when added to the batch.

If the use of ready-mixed concrete is approved, the 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.

Ready-mixed concrete for structures shall be transported in truck mixers or truck agitators.

The mixer, when loaded to capacity, shall be capable of combining the ingredients of the concrete within the specified time, into a thoroughly mixed and uniform mass and of discharging the concrete with a satisfactory degree of uniformity. The agitator, when loaded to capacity, shall be capable of

maintaining the mixed concrete in a thoroughly mixed uniform mass and of discharging the concrete with a satisfactory degree of uniformity.

Mixers and agitators shall be examined periodically for changes in condition due to accumulation of hardened concrete or mortar or to wear of the blades. When any such change in condition is found, the concrete should be subjected to the slump tests. If the tests indicate that the concrete is not being properly mixed, the faulty equipment shall be corrected before its further use is allowed.

Truck mixers shall be equipped with electrically or mechanically actuated revolution counters by which the number of revolutions of the drum or blades may be readily verified. The counters shall be of the continuous-registering, 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.

When a truck mixer is used, each batch of concrete shall be mixed for not less than seventy (70) no more than one hundred (100) revolutions of the drum or blades at the rate of rotation designated by the manufacturer of the equipment as mixing speed. If any additional mixing is done, it shall be at the speed designated by the manufacturer of the equipment as agitating speed.

When shrink-mixed concrete is furnished, concrete that has been partially mixed at a central plant shall be transferred to a truck mixer and all requirements for transit-mixed concrete shall apply. No credit in the number of revolutions at mixing speed shall be allowed for partial mixing in a central plant.

No additional mixing water shall be incorporated into the concrete during hauling or after arrival at the delivery point, unless permitted by the Engineer. If the Engineer permits additional water to be incorporated into the concrete, the drum shall be revolved not less than thirty (30) revolutions at mixing speed after the water is added and before discharge is commenced.

The rate of discharge of mixed concrete from truck mixer-agitators shall be controlled by the speed of revolution of the drum in the discharge direction with the discharge gate fully open.

When truck mixer or truck agitator is used for transporting concrete that has been completely mixed in a stationary mixer, mixing during transportation shall be at the speed designated by the manufacturer of the equipment as agitating speed.

When a truck mixer or agitator is used for transporting concrete, the concrete shall be delivered to the site of the work and discharge shall be completed within ninety (90) minutes after the introduction of the mixing water to the cement and aggregates, or the introduction of the cement to the aggregates. In hot weather, or under conditions contributing to quick stiffening of the concrete as determined by the Engineer, a delivery time of less than ninety (90) minutes may be required. When a truck mixer is used for the complete mixing of the concrete the mixing operations shall begin within thirty (30) minutes after the cement has been intermingled with the aggregate.

If the mixing plant is such a distance from the site of the work that 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.

The organization supplying concrete shall have sufficient plant capacity and transporting apparatus to insure continuous delivery at the rate required. The rate of delivery of concrete shall be used as to provide for the proper handling and placing of concrete. An interval of more than forty-five (45) minutes between any two consecutive batches or loads, or a delivery and placing rate of less than eight (8) cubic yards (6 cubic meters) 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 his own expense, a construction joint at the location and of the type directed by the Engineer in the concrete already mixed.

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.

501.03.07 HAND MIXING: Hand mixing shall not be permitted, except in case of an emergency or under written permission of the Engineer. When permitted, it shall be done only on watertight platforms. The sand shall be spread evenly over the platform and the cement spread upon it. The sand and cement shall then be thoroughly mixed while dry by means of shovels until the mixture is of uniform color, after which it shall be formed into a "crater" and water added in the amount necessary to produce mortar of the proper consistency. The material upon the outer portion of the "crater" ring shall then be shoveled to the center and the entire mass turned and sliced until a uniform consistency is produced. The coarse aggregate shall then be thoroughly wetted and added to the mortar and the entire mass turned and returned at least six (6) times and until all of the stone particles are thoroughly covered with mortar and the mixture is of a uniform color and appearance. Hand mixing will not be permitted for concrete to be placed under water.

501.03.08 RETEMPERING: Concrete shall be mixed only in such quantities as are required for immediate use and shall be placed before initial set has taken place. Any concrete in which initial set has begun shall be wasted and not used in the work. No retempering of concrete shall be allowed.

501.03.09 CURING:

(a) **General.** All concrete shall be cured for the length of time hereinafter specified. If Type III cement is used, the curing time may be reduced as directed by the Engineer. In the event of low temperatures, the time will be increased according to the produce specified in Subsection 501.03.10(b), "Cold Weather."

Curing shall commence immediately upon completion of the finish. In the event that the application or placement of the curing medium is delayed, curing will be as described under (b) below.

(b) **Water Method.** The concrete shall be kept continuously wet by the application of water for a minimum period of seven (7) days after the concrete has been placed.

The entire surface of the concrete shall be kept damp by applying water in the form of a fine fog mist, until the surface of the concrete is covered with the curing medium. The moisture from the nozzle shall not be applied under pressure directly upon the concrete and shall not be allowed to accumulate on the concrete in a quantity sufficient to cause a flow or wash the surface.

Cotton mats, rugs, carpets, or earth or sand blankets may be used as a curing medium to retain the moisture during the curing period. The cotton mats, rugs, or carpets shall be of such character that they will retain water.

(c) **Curing Compound Method.** The entire surface of the concrete shall be sprayed uniformly with a curing compound. It shall be applied when just a light film of water is present on the surface. If the surface is dry, water shall be added as specified in (b) above before the curing compound is applied.

On decks or slabs cured by this method, foot traffic must be held to a minimum and these surfaces shall not be used as a work area during the cure period. Should the film of the compound be damaged before the expiration of seven (7) days, the damaged portions shall be repaired immediately with additional compound.

This method shall not be used on surfaces until all finishing is completed.

The curing compound shall be delivered to the work in ready-mixed form. At the time of use, the compound shall be in a thoroughly mixed condition with the pigment uniformly dispersed throughout the vehicle. The compound shall not be diluted or altered in any manner, unless dilution is recommended by the manufacturer.

Curing compound that has become chilled to such an extent that it is too viscous for satisfactory application shall be warmed to a temperature not exceeding one hundred (100) degrees F. (38 degrees C.).

The curing compound shall be applied to the exposed surface at a uniform minimal rate of one (1) gallon per one hundred fifty (150) square feet (1 liter per 3.7 square meters) of area.

(d) **Waterproof Membrane.** The membrane shall be formed into sheets of such width as to provide a complete cover of the entire concrete surface. All joints in the sheets shall be securely cemented together in such a manner as to provide a waterproof joint. Overlap of sheets shall have a minimum lap of eighteen (18) inches (46 centimeters). 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.

The curing membrane shall remain in place for a period of not less than seven (7) days.

Should any portion of the sheets be broken or damaged before the expiration of the curing period, the broken or damaged portion shall be immediately repaired with new sheets properly cemented into place, or water curing as described above shall commence immediately. Sections of the membrane shall not be used which have lost their waterproof qualities or have been damaged to such an extent as to render them unfit for curing.

(e) **Form Method.** If forms are kept on the concrete surfaces, this will be considered adequate cure for these surfaces. However, should the forms be removed within seven (7) days after the concrete has been placed, one of the above methods must be used on the exposed surfaces.

Attention is directed to Subsection 502.03.11, "Removal of Falsework and Forms."

501.03.10 WEATHER LIMITATIONS:

(a) **General.** If impending inclement weather conditions exist, the Contractor shall decide whether or not to begin the pour and he shall have sole responsibility for his decision. Before any concrete is placed, the Contractor shall have adequate provisions readily available as approved by the Engineer, to protect the concrete from any impending weather conditions. In case precipitation should occur after placing operations have started, the Contractor shall provide ample covering to protect the work. The placing of concrete shall be stopped before the quantity of precipitation is sufficient to cause a flow or to wash the surface.

(b) **Cold Weather -- General.** All concrete shall be maintained at a temperature of not less than fifty (50) degrees F. (10 degrees C.) for three (3) days or not less than forty (40) degrees F. (4.4 degrees C.) for seven (7) days. The count of time shall commence immediately upon completion of final placement and vibration. The three (3) fifty (50) degree (10 degree C.) days need not be consecutive.

One twenty-four (24) hour period shall constitute one (1) day.

The temperature of the concrete shall be determined by placement of thermometers on the concrete surfaces and properly insulating said devices to record the surface temperature of the concrete. Temperature shall be monitored continuously throughout the total protection time required by this subsection. In case the surface temperature of the concrete falls below forty (40) degrees F. (4.4 degrees C.) for a duration of three (3) hours or more in any twenty-four (24) hour period during the time of temperature protection, the time shall be increased one (1) day for each day this occurs. An absolute minimum temperature of thirty-five (35) degrees F. (1.7 degrees C.) must be maintained for the total time of protection specified in this subsection. Should the temperature of the concrete fall below thirty-five (35) degrees F. (1.7 degrees C.) at any time, damage may occur. The assessment

of damage will be determined by the Contracting Agency and concrete so damaged may require repair or replacement at the option of the Engineer.

The concrete shall have a temperature of at least fifty (50) degrees F. (10 degrees C.) and not more than ninety (90) degrees F. (32 degrees C.) at the time of placing. (Also see Subsection 501.03.06, "Machine Mixing"). Heating equipment or methods which alter or prevent the entrainment of the required amount of air in the concrete shall not be used. The equipment shall be capable of heating the materials uniformly. Aggregates and water used for mixing shall not be heated to a temperature exceeding one hundred fifty (150) degrees F. (66 degrees C.). Concrete containing frost or lumps at the time of placing shall not be used.

Stockpiled aggregates may be heated by the use of dry heat or steam. Aggregates shall not be heated directly by gas or oil flame or on sheet metal over fire.

Reinforcing steel shall be free of ice, snow or frost during placement of concrete. Concrete shall not be placed on frozen ground.

(c) **Low Temperature Protection.**

(1) **General.** After the concrete has been placed, means shall be taken to protect the concrete from any impending low temperatures. Methods and materials not hereinafter prescribed may be used if approved by the Engineer and the following requirements adhered to:

(a) Materials shall be fire resistant

(b) Materials shall be waterproof

(c) Materials shall not adhere, abrade or damage the surface of the concrete.

Approval of the Engineer shall not relieve the Contractor from obtaining specification results.

(2) **Insulating Blankets.** Insulating blankets used to protect concrete from low temperatures shall be fire resistant and waterproof. The blankets must be secured and overlapped along the edges and joints to insure that no opening will exist in the protection during high winds or other adverse conditions. Provisions shall be made to allow the reading of any thermometers placed inside of the protection. When depositing concrete against previously cast concrete, the blanket insulation shall extend at least fourteen (14) inches (36 centimeters) onto the existing concrete and shall be securely held in place.

(3) **Low Temperatures Protection -- Heating and Housing.** In order to meet the provisions of Articles (a) and (b) of this subsection, the concrete may be protected by applying artificial heat within an enclosure. The enclosure will be constructed with fire resistant material, unless otherwise directed by the Engineer, and shall be subject to his approval. The heating system shall be so arranged as to provide uniform heating, insuring that the concrete farthest from the source of heat is receiving adequate protection without drying the concrete near the source of heat so as to cause shrinkage cracks.

(d) **Hot Weather.** The maximum temperature of cast-in-place concrete shall not exceed ninety (90) degrees F. (32 degrees C.) immediately before placement.

The consistency of the concrete as placed should allow the completion of initial finishing operations without the addition of water to the surface. When conditions are such that additional moisture is needed for initial finishing, the required water shall be applied to the surface fog spray only, and shall be held to a minimum amount. Fog spray for this purpose may be applied with hand-operated fog equipment, as approved by the Engineer.

From the time of initial strike-off until final finish is complete, the 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.

Equipment for fogging, type of evaporation retarder and method of application shall be approved by the Engineer. Equipment shall be portable, adapted for intermittent use and operable in the direction of any prevailing wind.

After all finishing operations are complete a final curing membrane shall be applied.

MORTAR

501.03.11 GENERAL: 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.

(a) Cement mortar shall be designated by class and proportioned by loose volume as follows:

Table 2- 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

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.

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.

(c) **Sand.** Sand shall conform to the requirements of Subsection 706.03.04. 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.

BASIS OF PAYMENT

501.05.01 PAYMENT: Portland cement concrete shall be measured and paid for in accordance with the provisions specified in the various sections of these specifications covering construction requiring concrete.

508.04.01, "Measurement," will be paid for at the contract unit price bid per linear foot, which price shall be full compensation for drilling holes for piling and disposing of material resulting therefrom, and for furnishing and placing all materials including Portland cement concrete and reinforcing steel and for doing all the work necessary to install the piling complete and in place as shown on the plans and as directed by the Engineer.

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

Payment will be made under:

PAY ITEM	PAY UNIT
Furnish and Drive (Type) Piles	Linear Foot (Meter)
Load Test	Each
Splices	Each

SECTION 601

PIPE CULVERTS – GENERAL

DESCRIPTION

601.01.01 GENERAL: These specifications include general requirements that are applicable to all type culvert pipes irrespective to 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.

This work shall consist of furnishing and installing pipe culverts, siphons, end sections, end walls, etc., as may be required to complete the work shown on the plans or established by the Engineer.

The pipe shall comply with AASHTO Design and Construction LRFD Specifications most current edition and these specifications. The more stringent requirements shall apply.

601.01.02 REFERENCE CODES AND STANDARDS:

(a) Uniform Standard Specifications for Public Works' Construction Off-Site Improvements, Clark County Area, Nevada that will henceforth be referred to as "USS" Specifications and Drawings

(b) Contract Special Provisions and Drawings

(c) NRS 338.176, NAC 625.550

(d) Most current ASTM, AASHTO, or NDOT test procedures

(e) Related Interagency Quality Assurance Committee (IQAC) procedures at

www.accessclarkcounty.com/pubworks/iqac/IQAC.htm

MATERIALS

601.02.01 GENERAL: The materials used shall be those prescribed or used for the several items which constitute the finished work and shall conform to the requirements in the following subsections:

Table 1- List of Pipe Types

Material Type	Section or Subsection
Bituminous Coated Corrugated Metal Pipe and Pipe Arches	709.03.02
Clay Pipe	708.03.04
Corrugated Aluminum Pipe	709.03.05
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	707.03.02
Thermoplastic Pipe	709.03.09

When the location of manufacturing plants allows, the plants will be inspected periodically for compliance with specified manufacturing methods. Material samples will be obtained for laboratory testing for compliance for materials quality requirements as specified in the referenced specifications. This can be the basis for acceptance of manufacturing lots.

All materials will be subject to inspection for acceptance as to condition at the latest practicable time the Engineer has the opportunity to check for compliance prior to or during incorporation of materials in the work.

The lengths shown on the plans are approximate.

For structural plate pipe and arches, attention is directed to Section 606, "Structural Plate Pipe, Pipe Arch, and Arch Culverts."

CONSTRUCTION

601.03.01 EARTHWORK: Excavation and backfill shall conform to the requirements of Section 206, "Structure Excavation" and 207, "Structure Backfill," or Section 208, "Trench Excavation and Backfill" when the culvert is placed in a trench. The pipe shall be bedded as shown in the standard specifications and/or drawings appended to the plans or as specified in the Special Provisions. When no bedding class is specified, the requirements for normal bedding as shown in the Uniform Standard Drawings shall apply. The lines and grades will be established by the Engineer or as designated in the contract provisions.

Where pipes are to be installed in new embankments on a steep slope or in a difficult location, the height of new embankments may be varied as directed by the Engineer before installing pipes.

When headwalls are not required and granular materials are used for backfilling, the fill at the ends of the structure shall be sealed against the infiltration of water by bedding the ends of the structure using class II CLSM or concrete.

601.03.02 HEADWALLS: Where shown on the plans, inlet and outlet headwalls shall be constructed or installed in connection with culvert pipes. Where such headwalls are constructed or installed, the ends of pipes shall be placed flush or cut off flush with the headwall face, unless otherwise permitted by the Engineer. Headwalls are to be constructed to conform to the applicable requirements of Sections 501, "Portland Cement Concrete" and 502, "Concrete Structures."

601.03.03 END SECTIONS: The bed for the end section shall be excavated to the required width and grade. For metal end sections with toe plates, a trench shall be excavated for the toe plate in a manner to permit the toe plate 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.

Precast concrete end section shall be placed with its tongue (or groove) fully entered in the groove (or tongue) of the pipe.

Thermoplastic pipe greater than 30" shall not be used at the open-end sections.

601.03.04 JACKED PIPES: Culvert pipe to be jacked in place between the limits shown on the plans shall conform to the requirements of the respective section of pipe culverts.

The strength of pipe or gage of pipe will be determined for vertical load only in embankment conditions. Any additional reinforcement or strength required to withstand jacking pressure shall be determined and furnished by the Contractor at his expense.

Variation from theoretical alignment and grade at the time of completion of placing shall not exceed 0.2 foot (6.1 centimeters) for each twenty (20) feet (6.1 meters) of pipe placed.

The diameter of the excavated hole shall not be more than 0.1 foot (3 centimeters) greater than the outside diameter of the pipe. Sluicing and jetting with water will not be permitted. When the material tends to cave in from outside these limits, a shield shall be used ahead of the first section of pipe or the face of excavation shall not extend beyond the end of the pipe greater than one and one-half (1-1/2) feet (0.46 meters) unless permitted by the Engineer.

Areas resulting from caving or excavating outside the above limits shall be backfilled with sand or grout by a method, which will fill the voids.

601.03.05 LAYING CULVERT PIPE: Laying of culvert pipe shall conform to the requirements of the respective sections of culvert pipe.

601.03.06 EXTENDING EXISTING CULVERTS: Where shown on the plans or directed by the Engineer, existing culverts shall be extended in accordance with the provisions for installing new culverts and the following additional provisions.

Existing headwalls shall be demolished and removed and disposed of or moved to the extended location as indicated on the plans or ordered by the Engineer. Attention is directed to Section 202, "Removal of Structures and Obstructions."

A headwall that is not to be reset shall be demolished without injury to the existing culvert and removed and disposed of in accordance with the provisions of Section 202, "Removal of Structures and Obstructions." If shown on the plans or ordered by the Engineer, a new concrete headwall shall be constructed in accordance with the provisions of Section 501, "Portland Cement Concrete" of these specifications, or a flared end section shall be attached thereto.

METHOD OF MEASUREMENT

601.04.01 MEASUREMENT: The materials to be paid for under these specifications will be listed in the contract items by size, class, type, gage, or whatever information is necessary for identification.

The quantity of culvert pipe to be measured for payment will be the actual number of linear feet (meters) of pipe including the stub on end sections, complete and in place. When pipes are cut to fit a structure or slope, the quantity to be paid for will be the length of pipe necessary to be placed before cutting, measured in even two (2) foot (61 centimeters) increments.

Attention is especially directed to plan sheets titled "STANDARD DETAILS -- STRUCTURE EXCAVATION & BACKFILL -- METHOD OF MEASUREMENT," which shall pertain.

Culvert pipe bends, wyes, tees, and other branches will be measured and paid for by the linear foot (meter) for the sizes of pipes involved. Wyes, tees, eccentric reducers, and other branches will be measured along centerlines to the point of intersection.

Structure excavation and structure backfill, Portland cement concrete and reinforcement required for headwalls, end walls, structures, and other items of work required by the plans and special provision to complete the work, will be measured and paid for as separate items as provided for under their respective sections of these specifications, or the contract documents. Structure excavation and backfill will not be measured for payment on preformed end sections.

No separate measurement or payment will be made for constructing jacking pits and backfilling all pits after the pipe is jacked, or for excavation and backfill between the limits shown on the plans for jacking the pipe. Full compensation therefore will be considered as included in the price paid for jacked pipe.

Culvert pipe to be placed outside the limits for jacked pipe shall conform to the requirements of the respective section of pipe culverts. The limits for payment of structure excavation and backfill will be the original ground line before jacking pits are excavated.

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

BASIS OF PAYMENT

601.05.01 PAYMENT: The accepted quantities of culvert pipe measured as specified in Subsection 601.04.01, "Measurement," will be listed under the respective sections of pipe culverts.

When any of the various sizes, types, and gages of pipe are installed by the jacking method, the contract price paid per linear foot (meter) for jacked pipe shall include full compensation for furnishing the pipe, excavating, jacking, furnishing and placing backfill material, and all incidentals and for doing all the work involved in jacking the pipe, as specified.

Full compensation for furnishing pipe with end finish, including distortion if required, will be considered as included in the price paid per linear foot (meter) for the pipe involved and no additional compensation will be allowed therefore. Full compensation for bedding will be considered included in the price paid per cubic yard (cubic meter) 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.

Provisions for handling of whatever water may be encountered at the site shall be an obligation of the Contractor, and payment therefore shall be considered as subsidiary to the items involved, and no further compensation will be allowed therefore.

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: 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 the requirements of these specifications.

MATERIALS

602.02.01 GENERAL: Materials and their use shall conform to the applicable requirements of Subsection 603.02.01 of Section 603, "Reinforced Concrete Pipe" and Subsection 601.02.01 of Section 601, "Pipe Culverts - General."

CONSTRUCTION

602.03.01 GENERAL: The construction requirements shall be as prescribed in Subsection 603.03.01 through 603.03.06 of Section 603, "Reinforced Concrete Pipe," with the following modifications:

(a) External bands of Class "C" mortar as designated in Subsection 501.03.11 may be placed around the pipe joints as herein specified. Several sections of pipe shall be joined before commencing banding operations, but the placing of external bands shall never be more than five (5) lengths of pipe behind joining operations.

Immediately in advance of placing external band mortar, the external surface of the pipe sections at the joints shall be thoroughly cleaned and wetted to insure proper bonding of the band mortar with the pipe. Care shall be exercised to make a union between the band and the mortar which was placed under the joint before the pipe sections were abutted. The band shall not be less than three-eighths (3/8) inch (0.95 centimeters) thick at the pipe joint and shall be approximately four (4) inches (10 centimeters) wide, overlapping the abutting ends of the pipe sections approximately two (2) inches (5 centimeters). The edges of the band shall adhere to the pipe surface to prevent peeling and shall be finished in a workmanlike manner. Rubber gaskets may be used to join the pipe. Rubber gaskets shall conform to the requirements of Subsection 707.03.02, "Rubber Gaskets."

(b) When irrigation or sewer pipe is placed beyond the limits of roadway excavation or embankment, the initial covering of backfill material shall be fine earth or sand approved by the Engineer. Placing the remainder of the trench backfill in layers and compacting to a relative compaction of ninety (90) percent will not be required.

(c) Openings shall be cut into irrigation or sewer pipe and connections made thereto as shown on the plans or directed by the Engineer.

Openings shall be cut to proper sizes. Connections shall be cut to fit closely and shall be strongly cemented to the pipe with banding mortar. In all cases, the area of pipe where the connection is made shall be clean and wet when the mortar is applied.

METHOD OF MEASUREMENT

602.04.01 MEASUREMENT: Method of measurement shall conform to the requirements of Subsection 601.04.01, "Measurement," with the exception that backfill will not be measured for payment when placed beyond the limits of roadway excavation or embankment.

BASIS OF PAYMENT

602.05.01 PAYMENT: Payment shall conform to the requirements of Subsection 601.05.01, "Payment," and in addition thereto, the following requirements shall apply.

The accepted quantities of non-reinforced concrete or clay pipe will be paid for at the contract bid price per linear foot (meter) for the types and sizes specified.

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

Payment will be made under:

PAY ITEM	PAY UNIT
(Size) Non-reinforced Concrete Pipe (type)	Linear Foot (Meter)
(Size) Clay Pipe (type)	Linear Foot (Meter)

SECTION 603

REINFORCED CONCRETE PIPE

DESCRIPTION

603.01.01 GENERAL: 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 the requirements of ASTM C76, C655, or C507 with design basis in accordance with Section 708, "Concrete and Clay Pipe and Drains" and where indicated in these specifications. The installation shall conform to the requirements of AASHTO LRFD Construction Specifications and where indicated in these specifications.

603.01.02 REFERENCE CODES AND STANDARDS:

(a) Uniform Standard Specifications for Public Works' Construction Off-site Improvements, Clark County Area, Nevada that will henceforth be referred to as "USS" Specifications and Drawings

(b) Contract Special Provisions and Drawings

(c) NRS 338.176, NAC 625.550

(d) Most current ASTM, AASHTO, ACI or NDOT test & inspection procedures

(e) Related Interagency Quality Assurance Committee (IQAC) procedures at

www.accessclarkcounty.com/pubworks/iqac/IQAC.htm

MATERIAL

603.02.01 GENERAL: Materials and their use shall conform to the applicable requirements of Subsection 601.02.01 of Section 601, "Pipe Culverts - General," and in addition thereto, the following requirements shall apply.

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).

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.

Rubber gaskets are required for all circular pipes and mastic for elliptical, and shall conform to the requirements of Subsection 707.03.02, "Rubber Gaskets."

If Joint mortar is required, it shall be as specified in Subsection 501.03.11, Class "C".

Sand shall conform to the requirements of Subsection 706.03.04, "Grout and Mortar Sand" of these specifications.

The materials shall be mixed to a consistency suitable for the purpose intended. All mortar shall be used within thirty (30) minutes after the mixing water has been added.

Admixtures of hydrated lime, fire clay, diatomaceous earth, or other approved inert material may be used in the mortar to facilitate workability if the Contractor elects. The amount of admixture to be added shall be the quantity determined by the Engineer.

CONSTRUCTION

603.03.01 GENERAL: Construction methods shall conform to the requirements of Subsections 601.03.01 through 601.03.06 of Section 601, "Pipe Culverts - General" and in addition thereto, shall meet the following requirements. All pipe installations shall conform to the workmanship and inspection requirements of AASHTO LRFD Bridge Construction Specifications and this specification as applicable.

No pipe shall be laid which is cracked, checked, spalled, or damaged, and all such sections of pipe shall be permanently removed from the work. Pipes, which show defects due to handling, shall be rejected at the site of the installation regardless of prior acceptance.

603.03.02 EARTHWORK: Where pipes are to be installed in new embankment (projection), the embankment shall first be constructed to the required elevation as set forth below. The height of embankment to be constructed in advance of installing the pipe may be varied when permitted by the Engineer.

In the case of pipes twenty-four (24) inches (600 millimeters) or less in diameter the roadway embankment shall be constructed to an elevation of six (6) inches (150 millimeters) above the grade proposed for the top of the pipe, after which the trench shall be excavated and the pipe installed.

In the case of pipes more than twenty-four (24) inches (600 millimeters) in diameter, the roadway embankment shall be constructed to an elevation of thirty (30) inches (750 millimeters) above the grade proposed for the bottom of the pipe, after which the trench shall be excavated and the pipe installed.

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: Construction installation shall comply with the AASHTO LRFD Bridge Construction Specifications, Section 208, "Trench Excavation and Backfill", and this subsection. The installation shall be conducted by a certified supervisor/foreman at the crew level who is responsible for the work. The certified person is the designated installation inspector for the contractor and shall generate a daily report attesting to the workmanship for the pipe zone locations as described in Table 2. This does not relieve the contractor responsibility for other Quality Control aspects of this and other specifications.

Installation Components:

(a) Bedding

(b) Pipe Condition

(c) Pipe Installation

(d) Haunch Compaction

(e) Complete pipe zone compaction

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.

Pipe sections shall be checked for alignment and grade at the time of joining the sections. Pipe laying shall begin at the downstream end of the pipeline except for extensions of existing pipes. Place the bottom of the pipe in contact with the shaped bedding throughout its full length. 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. Maintain the manufacturer's recommended minimum and maximum cover at all times unless otherwise shown in the contract.Pipe will be inspected before any backfill is placed. Ensure that no rocks greater than seventy five (75) mm (3 in.) or other rigid or jagged material is present in

the bedding material where pipe may be laid directly on the material. Take up and relay or replace pipe that is out of alignment, unduly settled, or damaged.

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.

Backfill:

Prior to placing backfill material, all handing holes in concrete culverts shall be completely filled with grout.

603.03.04 RUBBER GASKETED JOINTS: Circular Reinforced concrete culvert pipe, shall use rubber or neoprene gasketed joints may be used in lieu of other types of joints.

Rubber gaskets shall not be exposed to the direct rays of the sun for more than seventy-two (72) hours.

The contractor shall make every effort to provide a concrete to concrete connection and pull the pipe completely home. 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. 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). If pipes are laid that exceed the tolerances in Column 2, the pipe will need to be removed and relaid or an acceptable concrete collar will need to be installed.

Table 1 - Maximum Joint Gap Tolerances[1]

Inner Diameter of Pipe	Column 1 Maximum Joint Gap Tolerance	Column 2 Maximum Joint Gap Tolerance (with Grouting)
12" to 36"	5/8"	3/4"
42" to 48"	7/8"	1-1/8"
54" to 90"	1.0"	1-1/4"
96"	1- 5/8"	1-3/4"
Sizes above 96" up to 144"	As recommended by Manufacturer	As recommended by Manufacturer

Where reinforced concrete collars or bells with rubber gaskets are used at the pipe joints, mortar will not be required in the outer annular space. Where pipes are used with exposed metal surfaces at the joint, both the inner and outer annular joint spaces between pipe sections must be completely filled with cement mortar, except that pipes less than twenty-four (24) inches (61 centimeters) in diameter may be pointed inside by brushing smooth and removing all surplus mortar. The rubber gasket shall be the sole element depended upon to make the joint watertight for the purposes intended.

603.03.05 SIPHONS AND PRESSURE PIPE: Reinforced concrete pipe used for siphons or pressure pipe shall be laid in accordance with the above provisions, be connected by flexible, watertight rubber gasket joint, and prior to backfilling, be subject to the following hydrostatic test:

The pipeline shall be filled with water at a hydrostatic head of that required to maintain the designed pressure. The pressure head shall be maintained for a period of not less than twenty-four (24) hours and any visible leak or other defects, which develop under test, shall be corrected by the Contractor at his expense.

[1] In no case shall maximum joint gap tolerance exceed one half (½) of the length where the gasket seats within the pipe

Sweating that does not develop into a flow or drip will not be considered as leakage. The test shall be repeated until all leaks or other defects are eliminated

603.03.06 JUNCTIONS: All junctions of laterals with a main line or junctions of two or more main lines, which are not made in a manhole or concrete junction structure, shall be in a manufactured wye or tee 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: All pipe joints and lengths shall be one hundred (100) percent inspected. Inspection and Testing by the contractor during and after installation to ensure proper performance. Installation of bedding and backfill materials, as well as their placement and compaction, shall adhere to the requirements of this section. During the initial phases of the installation process, inspection shall concentrate on detecting improper practice and poor workmanship. 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. Bell/spigot joints shall be properly assembled to prevent the infiltration of soil fines. Gaskets shall be properly seated to prevent groundwater infiltration and should appear uniformly oriented around the pipe. Shallow cover installations shall be checked to ensure the minimum cover level is provided.

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 thirty (30) days after final backfill has been placed. 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. Damaged pipe will need to be repaired or replaced. The replacement pipe shall also be subject to the same testing. Joints that do not meet the specification shall be repaired or pipe replaced at the contractor's expense. All inspection results shall be submitted and approved by the Engineer before final payment.

The video camera shall physically verify quality of the pipe installation and is not limited by poor lighting, waterflow, pipe length, or other limiting conditions of the installed environment.

For locations where the pipe does not conform, an evaluation shall be conducted by the Contractor and a recommendation by their Nevada Professional Engineer submitted to the Agency Engineer for review and approval considering the severity of the structural integrity, environmental conditions and the design service life of the pipe. Do not reinstall damaged pipe, but remove and replace with new pipe. The replacement pipe shall also be subject to the same testing.

All inspection and testing results shall be submitted to the Engineer for approval.

The Agency Engineer shall be allowed access to randomly inspect at least ten (10) percent of the total number of pipe runs.

METHOD OF MEASUREMENT

603.04.01 MEASUREMENT: Method of measurement shall conform to the requirements of Subsection 601.04.01, "Measurement" and in addition thereto, the following requirements shall apply.

The quantity of precast end sections, culvert pipe or oval pipe measured for payment will be the number of units of each size of each class complete and in place. Pre-cast 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.

The measurement for the quantity of radius RCP will be measured as standard RCP of the equivalent size.

All measurements will be made in accordance with Subsection 190.01, "Measurement of Quantities."

BASIS OF PAYMENT

603.05.01 PAYMENT: Payment shall conform to the requirements of Subsection 601.05.01, "Payments," and in addition thereto, the following requirements shall apply.

The accepted quantities of reinforced concrete pipe measured as specified in Subsection 603.04.01, "Measurement," will be paid for at the contract unit price bid per linear foot (meter) 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, de-watering 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. End sections will be paid for at the contract unit price bid per each for the kind and sizes specified complete and in place, which payment shall include structure excavation and backfill for precast end sections.

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

Payment will be made under:

PAY ITEM	PAY UNIT
(Size) Reinforced Concrete Pipe (class)	Linear Foot (Meter)
(Size) Oval Reinforced Concrete Pipe (class)	Linear Foot (Meter)
(Size) Reinforced Concrete Siphon Pipe (class)	Linear Foot (Meter)
(Size) Reinforced Concrete Pipe (class) Jacked	Linear Foot (Meter)
(Size) Precast End Section	Each
(Size) Precast Oval End Section	Each

SECTION 604

CORRUGATED METAL PIPE AND METAL ARCH PIPE

DESCRIPTION

604.01.01 GENERAL: This work shall consist of furnishing and installing corrugated metal pipe, corrugated metal arch pipes and 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. The installation shall conform to the requirements of AASHTO LRFD Construction Specifications and where indicated in these specifications.

604.01.02 REFERENCE CODES AND STANDARDS:

(a) Uniform Standard Specifications for Public Works' Construction Off-site Improvements, Clark County Area, Nevada that will henceforth be referred to as "USS" Specifications and Drawings

(b) Contract Special Provisions and Drawings

(c) NRS 338.176, NAC 625.550

(d) Most current ASTM, AASHTO, ACI or NDOT test & inspection procedures

(e) Related Interagency Quality Assurance Committee (IQAC) procedures at

www.accessclarkcounty.com/pubworks/iqac/IQAC.htm

MATERIALS

604.02.01 GENERAL: Materials and their use shall conform to the applicable requirements of Subsection 601.02.01 of Section 601, "Pipe Culverts - General," and in addition thereto, the following requirements shall apply. Design in accordance with Section 709, "Metal and Thermoplastic Pipe".

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).

Corrugated metal pipe shall be furnished in the sizes, gages and corrugation patterns as shown on the project plans.

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: Construction methods shall conform to the requirements of Subsections 601.03.01 through 601.03.06 of Section 601, "Pipe Culverts - General," and in addition thereto shall meet the following requirements. All pipe installation shall conform to the workmanship and inspection requirements of AASHTO LRFD Bridge Construction Specifications AASHTO M36, M196 and this specification as applicable. The more stringent requirements shall apply.

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). If the manufacturer is not authorized, the contractor must provide a Quality Control Program with test and inspection data to the Engineer for approval. Subsequent submittals and reports are to be reviewed by the Contractor for compliance then transmitted to the Engineer for approval. It is then the responsibility of the Contractor to visit the manufacturer in order to assure that the non-authorized source is conforming to the QC program requirement.

Culverts shall be handled in such a manner as to prevent bruising, scaling, or breaking of the spelter coating. Pipes, which show defects due to handling, shall be rejected at the site of the installation regardless of prior acceptance

604.03.02 EARTHWORK: Where pipes are to be installed in new embankment (projection), the embankment shall first be constructed to the required elevation as set forth below. The height of embankment to be constructed in advance of installing the pipe may be varied when permitted by the Engineer.

In the case of pipes twenty-four (24) inches (600 millimeters) or less in diameter the roadway embankment shall be constructed to an elevation of six (6) inches (150 millimeters) above the grade proposed for the top of the pipe, after which the trench shall be excavated and the pipe installed.

In the case of pipes more than twenty-four (24) inches (600 millimeters) in diameter, the roadway embankment shall be constructed to an elevation of thirty (30) inches (750 millimeters) above the grade proposed for the bottom of the pipe, after which the trench shall be excavated and the pipe installed.

When pipe having bells or hubs is used, cross trenches shall be excavated for them to prevent non-uniform loading of the joints.

604.03.02 LAYING CULVERT PIPE: Construction installation shall comply with AASHTO LFRD Bridge Construction Specifications Section 208, "Trench Excavation and Backfill" and this subsection. The installation shall be conducted by a certified supervisor/foreman at the crew level who is responsible for the work. The certified person is the designated installation inspector for the contractor and shall generate a daily report attesting to the workmanship for the pipe zone locations as described in Table 1. This does not relieve the contractor responsibility for other Quality Control aspects of this and other specifications.

Installation Components:

(a) Bedding

(b) Pipe Condition

(c) Pipe Installation

(d) Haunch Compaction

(e) Complete pipe zone compaction

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.

Pipe section shall be checked for alignment and grade at the time of joining the sections. They shall be fitted and matched so that when laid in the work they will form a smooth and uniform invert. Pipe laying shall begin at the downstream end of the pipeline except for extensions of existing pipes. Place the bottom of the pipe in contact with the shaped bedding throughout its full length. The first section of pipe to be laid shall be

firmly placed to the designated line and grade at the outlet end. Corrugated metal pipe with riveted seams shall be so laid that flow is over the lap of the sheets. Field joints shall be made by butting the ends of pipe together and the sections joined with a band bolted firmly in place. Coupling band details for corrugated metal pipe arches shall be as shown on the Standard Plans. Maintain the manufacturer's recommended minimum and maximum cover at all times unless otherwise shown in the contract.

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 lying, or is damaged, shall be taken up and re-laid at the Contractor's expenses.

Pipe will be inspected before any backfill is placed. Ensure that no rocks greater than seventy-five (75) mm (3 in.) or other rigid or jagged material is present in the bedding material where pipe may be laid directly upon the material it. Ensure that no "floating" occurs during installation of plastic pipe culverts. Take up and relay or replace pipe that is out of alignment, unduly settled, or damaged.

604.03.03 SLOTTED PIPE: This specification covers Slotted Drain pipe used for the removal of surface water as shown on the plans. The corrugated steel pipe used to manufacture the Slotted Drain shall meet the requirements of Section 709, "Metal and Thermoplastic Pipe". The diameter, gage and metallic coating shall be as shown on the plans.

The corrugated steel pipe shall have a minimum of two re-rolled annular ends. The connecting bands shall be modified Hugger-type bands to secure the pipe and prevent infiltration of the backfill. When the Slotted Drain is banded together, the adjacent grates shall have a maximum three (3) inch gap.

The grates shall be manufactured from ASTM A1011, Grade 26 steel and fabricated as per Caltrans Standard Plan D98B[1]. The spacers and bearing bars (sides) shall be 3/16 inches material plus or minus 0.008 inches. The spacers shall be on six (6) inches centers and welded on both sides to each bearing bar (sides) with four (4) 1-1/4" long 3/16" fillet welds on each side of the bearing bar. 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" grate

(b) T=15,000 pounds for six (6) inches grate

The grates shall be vertical (straight sides) or trapezoidal with a 1-3/4" opening in the top and 30° slanted spacers, as shown on the plans. The grate shall be 2-1/2" or six (6) inches high as shown on the plans.

If variable height grate is shown on the plans, the grate shall be vertical (straight sides) with a 1-3/4" opening in the top and spacers will be placed on six (6) inch centers. The top and bottom grates shall be 2-1/2" or six (6) inches high, as needed, and plate extenders shall be attached to achieve the slope shown on the plans.

The grate (and plate extenders for variable height grate) shall be galvanized in accordance with ASTM A123, except with a two (2) oz. galvanized coating. The grate shall be fillet welded with a minimum weld one (1) one long to the CSP on each side of the grate at every other corrugation.

Finished Slotted Drain, in twenty (20) feet nominal lengths, will satisfy the following tolerances:

Vertical bow ±3/8", horizontal bow ± 5/8", twist ± ½".

604.04.03.03 RUBBER GASKETED JOINTS: 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. Rubber gaskets shall not be exposed to the direct rays of the sun for more than seventy-two (72) hours.

[1] Standard plans are on the Caltrans Website

The contractor shall make every effort to provide a tight connection and pull the pipe completely home. 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. If pipes are laid that exceed the maximum, the pipe will need to be removed and re-laid.

Table 1 - Maximum Joint Gap

Inner Diameter of Pipe	Maximum Joint Gap Tolerance
10" to 12"	3/4"
15" to 30"	1-1/4"
36" to 54"	1-1/2"
60"	1-3/4"

604.03.04 SIPHONS AND PRESSURE PIPE: Pipe used for siphons or pressure pipe shall be laid in accordance with the above provisions, be connected by flexible, watertight rubber gasketed gasket joint, and prior to backfilling, be subject to the following hydrostatic test:

The pipeline shall be filled with water at a hydrostatic head of that required to maintain the designed pressure. The pressure head shall be maintained for a period of not less than twenty-four (24) hours and any visible leak or other-defects, which develop under test, shall be corrected by the Contractor at his expense. Sweating that does not develop into a flow or drip will not be considered as leakage. The test shall be repeated until all leaks or other defects are eliminated.

604.03.05 JUNCTIONS: All junctions of laterals with a main line or junctions of two or more main lines, which are not made in a manhole or concrete junction structure, shall be in a manufactured wye or tee of the same material as the conduits to which they are joined, and shall have the same or greater stiffness as the pipe.

604.03.06 INSPECTION AND DEFLECTION TESTING: All pipe joints and lengths shall be one hundred (100) percent inspected. "Inspection and Testing" by the contractor during and after installation to ensure proper performance. Installation of bedding and backfill materials, as well as their placement and compaction, shall adhere to the requirements of this specification. 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. 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. Coupling bands shall be properly indexed with the corrugation and tightened to prevent the infiltration of soil fines. Gaskets shall be properly seated to prevent groundwater infiltration and should appear uniformly oriented around the pipe. Shallow cover installations shall be checked to ensure the minimum cover level is provided.

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 thirty (30) days after final backfill has been placed. 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. Damaged pipe will need to be repaired or replaced. The replacement pipe shall also be subject to the same testing. Joints that do not meet the specification shall be repaired or pipe replaced at the contractor's expense. All inspection results shall be submitted and approved by the Engineer before final payment.

SECTION 605

THERMOPLASTIC PIPE CULVERTS

DESCRIPTION

605.01.01 GENERAL: This work shall consist of furnishing and installing thermoplastic pipe culverts, storm drains, and conduits of the size, dimensions and at locations shown on the plans or established by the Engineer and in accordance with the requirements of the installation shall conform to the requirements of Section 709, "Metal and Thermoplastic Pipe" and where indicated in these specifications and exceptions/addition in these specifications. The more stringent requirements shall apply.

605.01.02 REFERENCE CODES AND STANDARDS:

a) Uniform Standard Specifications for Public Works' Construction Off-site Improvements, Clark County Area, Nevada that will henceforth be referred to as "USS"
b) Contract Special Provisions and Drawings
c) NRS 338.176, NAC 625.550
d) Most current ASTM, AASHTO, ACI or NDOT test & inspection procedures
e) Related Interagency Quality Assurance Committee (IQAC) procedures at
www.accessclarkcounty.com/pubworks/iqac/IQAC.htm

MATERIALS

605.02.01 GENERAL: Materials and their use shall conform to the applicable requirements of Subsection 601.02.01 of Section 601, "Pipe Culverts - General," and in addition thereto, the following requirements shall apply.

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).

605.02.02 MARKINGS: Markings on pipe shall be per the appropriate specification of Section 709, "Metal and Thermoplastic Pipe."

CONSTRUCTION

605.03.01 GENERAL: Construction methods shall conform to the requirements of Subsections 601.03.01 through 601.03.06 of Section 601, "Pipe Culverts - General," and in addition shall conform to the workmanship and inspection requirements of AASHTO LRFD Bridge Construction Specifications, AASHTO M 278, M 294, or M 304 and this specification as applicable. The more stringent requirement shall apply.

The pipe shall be excavated and backfilled per section 208 "Trench Excavation and Backfill".

Non-UV protected pipe shall be protected from direct sunlight until the day of installation.

605.03.02 EARTHWORK: Where pipes are to be installed in new embankment (projection), the embankment shall first be constructed to the required elevation as set forth below. The height of

embankment to be constructed in advance of installing the pipe may be varied when permitted by the Engineer.

In the case of pipes twenty-four (24) inches (600 millimeters) or less in diameter the roadway embankment shall be constructed to an elevation of six (6) inches (150 millimeters) above the grade proposed for the top of the pipe, after which the trench shall be excavated and the pipe installed.

In the case of pipes more than twenty-four (24) inches (600 millimeters) in diameter, the roadway embankment shall be constructed to an elevation of thirty (30) inches (750 millimeters) above the grade proposed for the bottom of the pipe, after which the trench shall be excavated and the pipe installed.

When pipe having bells or hubs is used, cross trenches shall be excavated for them to prevent non-uniform loading of the joints.

605.03.03 LAYING CULVERT PIPE: Construction installation shall comply with the AASHTO LRFD Bridge Construction Specifications Section 30 and Section 208, "Trench Excavation and Backfill" and this subsection. The installation shall be conducted by a certified supervisor/foreman at the crew level who is responsible for the work. The certified person is the designated installation inspector for the contractor and shall generate a daily report attesting to the workmanship for the pipe zone locations as described in Table 2. This does not relieve the contractor responsibility for other Quality Control aspects of this and other specifications.

Installation Components:

a) Bedding

b) Pipe Condition

c) Pipe Installation

d) Haunch Compaction

e) Complete pipe zone compaction

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, grade, and camber, and upgrade, unless otherwise permitted 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 pipe. Blocking shall not be used to bring the pipe to grade.

Pipe laying shall begin at the downstream end of the pipeline except for extensions of existing pipes. Place the bottom of the pipe in contact with the bedding throughout its full length. Place the spigot or outside circumferential laps of pipes facing upstream such that a shingling effect is obtained. Place pipe with longitudinal laps or seams with the laps or seams at the sides. Maintain the manufacturer's recommended minimum and maximum cover at all times unless otherwise shown in the contract.

Pipe will be inspected before any backfill is placed. 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. Ensure that no "floating" occurs during installation of plastic pipe culverts. Take up and relay or replace pipe that is out of alignment, unduly settled, or damaged.

605.03.04 RUBBER GASKETED JOINTS: Rubber gaskets shall not be exposed to the direct rays of the sun for more than seventy-two (72) hours.

Rubber gaskets of the type requiring lubrication shall be lubricated with the lubricant supplied by the manufacturer of the pipe. Manufactured self lubricating gaskets are also acceptable.

The contractor shall make every effort to provide a tight connection and pull the pipe completely home. 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. If pipes are laid that exceed the maximum, the pipe will need to be removed and re-laid.

Table 1 - Maximum Joint Gap[1]

Inner Diameter of Pipe	Maximum Joint Gap Tolerance
10" to 12"	3/4"
15" to 30""	1-1/4"
36" to 54"	1-1/2"
60"	1-3/4"

605.03.05 SIPHONS AND PRESSURE PIPE: Pipe used for siphons or pressure pipe shall be laid in accordance with the above provisions, be connected by flexible, watertight rubber gasketed joint, and prior to backfilling, be subject to the following hydrostatic test:

The pipeline shall be filled with water at a hydrostatic head of that required to maintain the designed pressure. The pressure head shall be maintained for a period of not less than twenty-four (24) hours and any visible leak or other defects, which develop under test, shall be corrected by the Contractor at his expense. Sweating that does not develop into a flow or drip will not be considered as leakage. The test shall be repeated until all leaks or other defects are eliminated.

605.03.06 JUNCTIONS: All junctions of laterals with a main line or junctions of two or more main lines, which are not made in a manhole or concrete junction structure, shall be in a manufactured wye or tee 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: All pipe joints and lengths shall be one hundred (100) percent inspected. Installation of bedding and backfill materials, as well as their placement and compaction, shall adhere to the requirements of this specification. During the initial phases of the installation process, inspection shall concentrate on detecting improper practice and poor workmanship. 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. Joints shall be properly assembled to prevent the infiltration of soil fines. Gaskets shall be properly seated to prevent groundwater infiltration and should appear uniformly oriented around the pipe. Shallow cover installations shall be checked to ensure the minimum cover level is provided.

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 thirty (30) days after final backfill has been placed. The line shall be cleaned and inspected for damage, joint gaps and deflection using visual physical measurement or other replacement pipe shall also be subject to the same testing. Joints that do not meet devices, including but not limited to calibrated television or video cameras, subject to approval by the Engineer. Damaged pipe will need to be repaired or replaced. The specification shall be repaired or pipe replaced at the contractor's expense. All inspection results shall be submitted and approved by the Engineer before final payment.

The video camera shall physically verify quality of the pipe installation and is not limited by poor lighting, waterflow, pipe length, or other limiting conditions of the installed environment.

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[1] in no case shall maximum joint gap tolerance exceed one half (½) of the length where the gasket seats within the pipe

For pipe greater than thirty six (36) in (900 mm) inside diameter, deflection determination by physical measurement may be performed using four cross section measurements taken beginning at the vertical for each 900 interval with a longitudinal frequency of once every ten (10) feet of the pipe.
The minimum diameter at any point shall be five (5) percent less than the nominal diameter (minus fabrication tolerance per AASHTO M294 Section 7.2.3) of the pipe being tested.

If a mandrel is used, it must be approved before use. It shall be a rigid, nonadjustable, odd-numbered legged (minimum 9 legs) mandrel having a length not less than its nominal diameter. It must befitted 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. Use of an unapproved mandrel or a mandrel altered or modified after approval will invalidate the test. If the mandrel fails to pass, the pipe is over deflected. A properly sized proving ring shall be used to check or test the mandrel for accuracy. The mandrel shall be pulled through the pipe with a force not greater than one thousand (1000) pounds.

For locations where pipe deflection exceeds five (5) of the inside diameter and/or fail other quality pipe criteria, an evaluation shall be conducted by the Contractor and a recommendation by their Nevada Professional Engineer submitted to the Agency Engineer for review and approval considering the severity of the deflection, structural integrity, environmental conditions and the design service life of the pipe. For locations where pipe deflection exceeds seven and one half (7.5) percent of the inside diameter, remediation or replacement of the pipe is required.

Unless otherwise permitted, pipe that does not meet the specification shall be uncovered and, if not damaged, corrected as per the Agency Approved recommendation from the Contractor at the contractor's expense. Do not reinstall damaged pipe, but remove and replace with new pipe. The replacement pipe shall also be subject to the same testing.

The Agency Engineer shall be allowed access to randomly inspect at least ten (10) percent of the total number of pipe runs.

MEASUREMENT

605.04.01 MEASUREMENT: Method of measurement shall conform to the requirements of Subsection 601.04.01, "Measurement" and in addition thereto, the following requirements shall apply.

The contract unit price paid for thermoplastic pipe shall be full compensation for excavating trench, disposal of excess material, hauling, placing and compacting backfill, de-watering, 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.

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

BASIS OF PAYMENT

605.05.01 PAYMENT: Payment shall conform to the requirements of Subsection 601.05.01, "Payment," and in addition thereto, the following requirements shall apply.

The accepted quantities of thermoplastic pipe, measured as specified in Subsection 601.05.01, "Measurement," will be paid for at the contract unit price bid per linear foot (meter) for the types and sizes specified.

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 thereof.

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

Payment will be made under:

PAY ITEM	PAY UNIT
(Size) Thermoplastic Pipe (type)	Linear Foot (Meter)
(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: This work shall consist of furnishing and installing structural plate pipe and pipe arch culverts conforming to the requirements of these specifications, and of the sizes and dimensions required in the plans, and installing such structures at locations designated in the plans or established by the Engineer, and in conformity with the lines and grades established by the Engineer. The work shall also include the reinstallation of salvaged structural plate pipe and pipe arch culverts.

Plates for a pipe arch shall form a cross section made up of four circular arcs tangent to each other at their junctions and symmetrical about the vertical axis. The top shall be an arc of not more than one hundred eighty (180) degrees nor less than one hundred fifty-five (155) degrees. The bottom shall be an arc of not more than fifty (50) degrees nor less than ten (10) degrees. The top shall be joined at each end to the bottom by an arc having a radius between sixteen (16) and twenty-one (21) inches (41 and 53 centimeters) and of not more than eighty-seven and one-half (87-1/2) degrees nor less than seventy-five (75) degrees.

MATERIAL

606.02.01 GENERAL: Materials meeting the requirements of AASHTO Designation M 167, "Structural Plate Pipe and Pipe Arches."

If called for in the bid schedule, plates for pipes and pipe arches shall be bituminous coated in accordance with AASHTO Designation M 190, Type A, B or C.

When bituminous coating is applied to plates for structural steel plate pipe, arches and pipe arches, each plate shall have the thickness painted on the inner surface so that the plate thickness can be readily identified.

The portion of 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.

Damaged bituminous coating shall be repaired by the Contractor by applying bituminous material conforming to the provisions of AASHTO Designation M 190 or other approved material.

The bottom plates of structural plate pipes and arches shall be one gage heavier than the gage specified in the bid schedule, which will apply to top and side plates. When gage one (1) is specified, the bottom plates shall also be gage one (1).

Plates shall be shipped and handled in such a manner as to prevent bruising, scaling, or breaking of the spelter coating. Damaged spelter coating in lieu of the requirements of AASHTO Designation M 36, may be repaired by thoroughly wire brushing the damaged area and removing all loose and cracked spelter coating after which the cleaned area shall be painted with two coats of zinc oxide-zinc dust paint conforming to the requirements of Federal Specification MIL-P-15145. The paint shall be properly compounded in a suitable vehicle in the ratio of one part zinc oxide to four parts zinc dust by weight.

Planned lengths and sizes are approximate. The Contractor shall not order and deliver the plates until a list of sizes and lengths is furnished him by the Engineer.

base, the surface shall be thoroughly cleaned and the adhesive specified below shall be applied. 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. The cleaned surface shall be free from dust, loose material or oil.

The adhesive shall consist of two (2) components which shall be mixed together at the site of the work and shall conform to the requirements of "Subsection 728.03.11, Binder (Adhesive), Structural Epoxy."

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. 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. A grade line gage 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.

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.

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 ten (10) feet (3 meters) 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 (0.30 centimeters) from the edge of the straightedge, except at grade changes or curves.

Crawler track driven extrusion machines shall not be used on finished course plantmix surface. Concrete shall be fed to the machine at a uniform rate. 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 three-sixteenths (3/16) inch (0.48 centimeters) in diameter and requiring no further finishing, other than light brushing with a brush filled with water only. Finishing with a brush application of grout will not be permitted.

Expansion joints shall be required at E.C. and B.C. of curb returns, and also along the line of work at regular intervals not to exceed three-hundred (300) feet (91 meters). Unless otherwise specified transverse weakened plane joints on curb and gutter produced by an extrusion machine shall be constructed at ten (10) feet (3 meters) intervals along the line of the work.

Weakened plane joints shall be constructed as specified in Subsection 613.03.10.

Expansion joints shall be constructed as specified in Subsection 613.03.09.

Curing of slip form curb, gutter, and sidewalk shall be done as specified in Subsection 613.03.15.

613.03.07 PLACING CONCRETE: Concrete shall be placed on a subgrade sufficiently dampened to insure that no moisture will be absorbed from the fresh concrete.

Concrete shall be placed in curb, gutter, and curb and gutter forms in horizontal layers not exceeding six (6) inches (15 centimeters) in thickness, each layer being spaded along the forms and thoroughly tamped. Concrete may be placed in layers of more than six (6) inches (15 centimeters) in thickness only when authorized by the Engineer and the spading and tamping is sufficient to consolidate the concrete for its entire length.

After the concrete for walk has been placed, a strike-off shall be used to bring the surface to the proper elevation when compacted. It shall be spaded along the form faces and tamped to assure a dense and compact mass, and to force the larger aggregate down while bringing to the surface not less than three-eighths (3/8) inch (1 centimeter) of free mortar for finishing purposes.

Concrete shall be placed in cross gutters in horizontal layers of not more than four (4) inches (10 centimeters) 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 one operation.

After the concrete has been placed and tamped, the upper surface shall be struck off to the specified grade.

613.03.08 JOINTS: Joints in concrete curb, gutter, and walk shall be designated as expansion joints and weakened plane joints.

613.03.09 EXPANSION JOINTS: Expansion joints shall be constructed in curbs, walk and gutter as shown on the plans, Standard Drawings or as specified herein. Such joints shall be filled with pre-molded joint filler conforming with the requirements prescribed in Section 707. No such joints shall be constructed in cross gutters, alley intersections or driveways except as may be approved by the Engineer.

One-half inch (1.3 centimeters) 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 they shall be placed at the ends of the cross gutter transition. No joints shall be constructed in returns. Where monolithic curb and gutter is constructed adjacent to concrete pavement, no expansion joints will be required except at E.C. and B.C. of curb returns.

Expansion joint filler one-half (1/2) inch (1.3 centimeters) thick shall be placed in walk at the E.C. and B.C. of all walk returns, around all utility poles which may 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. At the E.C. and B.C. and around utility poles, the joint filler-strips shall extend the full depth of the concrete placed. Joint filler strips between walk and curb shall be the depth of the walk plus one (1) inch (2.5 centimeters) with the top set flush with the specified grade at the top of curb.

All expansion joint filler strips shall be installed vertically, and shall extend to the full depth and width of the work in which they are installed, and be constructed perpendicular to straight curb or radially to the line of the curb constructed on a curve. Expansion joint filler materials shall completely fill these joints to within one-fourth (1/4) inch (0.6 centimeters) of any surface of the concrete. Excess filler material shall be trimmed off to the specified dimension in a neat and workmanship manner. 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: Weakened plane joints shall be straight and constructed in accordance with paragraphs (a) or (b) below, unless otherwise shown on the plans.

In walk, joints shall be transverse to the line of work and at regular intervals not exceeding ten (10) feet (3 meters). At curves and walk returns, the joints shall be radial.

In gutter, including gutter integral with curb, joints shall be at regular intervals not exceeding ten (10) feet (3 meters). Where integral curb and gutter is adjacent to concrete pavement, the joints shall be aligned with the pavement joints where practical.

(a) **Control Joint.** After preliminary trowelling, the concrete shall be parted to a depth of two (2) inches (5 centimeters) with a straightedge to create a division in the coarse aggregate. The concrete shall be refloated to fill the parted joint with mortar. 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 one-half (1/2) inch (1.3 centimeters) and a radius of one-eighth (1/8) inch (0.3 centimeters). The finished joint opening shall not be wider than one-eighth (1/8) inch (0.3 centimeters).

SECTION 622 - BLANK

SECTION 623

TRAFFIC SIGNALS AND STREET LIGHTING

DESCRIPTION

623 G.01.01 GENERAL: Electrical work shall consist of furnishing and installing, modifying or removing traffic signals, school flashers, flashing beacon systems, street and highway lighting systems, sign illumination systems, traffic count stations, electrical equipment in structures, falsework lighting, partial installations for future systems, or combinations thereof, all as shown on the plans, and as specified in these specifications and the Special Provisions. Standard Drawings for Street Lighting and Traffic Signals shall be the "Uniform Standard Drawings, Volumes I and II."

Unless otherwise indicated on the plans or specified in the Special Provisions, all materials shall be new.

The locations of signals, beacons, standards, lighting fixtures, signs, controls, services, and appurtenances shown on the plans are approximate and the exact locations will be established by the Engineer in the field.

All materials furnished and used shall conform to the provisions in Section 106. The materials shall be manufactured, handled, and used in a manner to insure completed work in accordance with the plans, specifications, and Special Provisions.

All systems shall be complete and in satisfactory operating condition at the time of acceptance of the contract. Where an existing system is to be modified, the existing material shall be reused in the revised system, removed, salvaged, and stockpiled or abandoned as shown on the plans, as specified in the Special Provisions or as directed by the Engineer.

623 G.01.02 REGULATIONS AND CODE: 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. In addition to the requirements of the plans, these specifications, and the Special Provisions, all materials and workmanship shall conform to the requirements of the National Electrical Code (NEC); National Electrical Safety Code (NESC); Standards of the American Society for Testing and Materials (ASTM); American National Standards Institute (ANSI) manuals; International Municipal Signal Association (IMSA) cable specifications; Institute of Electronic and Electrical Engineers (IEEE); Illumination Engineering Society (IES); Rural Electrification Association (REA); Nevada Occupational Safety and Hazard Act (NOSHA); National Board of Fire Underwriters (NBFU); Manual on Uniform Traffic Control Devices (MUTCD); Uniform Standard Drawings, Clark County Area; and any local ordinance which may apply.

Wire sizes shall be indicated in American Wire Gage (AWG).

All work performed on any traffic signal component must be under the direct on-site supervision of an IMSA Certified Technician. Effective March 30, 2000 the level of certification required is Level I, and the level of certification required shall be increased to Level II effective March 30, 2001.

623 G.01.03 EQUIPMENT LIST AND DRAWINGS: Unless otherwise permitted in writing by the Engineer, the Contractor shall within fifteen (15) days following approval of the contract, submit to the Engineer for approval, a list of equipment and materials which he proposes to install. The list shall be

complete as to name of manufacturer, size, and identifying number of each item. The list shall be supplemented by such other data as may be required, including scale drawings of cabinets showing location and spacing of shelves, terminal blocks and equipment, including dimensioning.

All of the above data shall be submitted, in triplicate, for review. Where electrical equipment is constructed as detailed on the plans, the submission of detailed drawings and diagrams will not be required.

Where a basic controller cabinet wiring diagram is provided, circuit diagrams for detector plug connections, peripheral equipment, and external solid-state logic shall be provided.

The Contractor shall furnish five (5) blueline and one (1) mylar reproducible set of cabinet schematic wiring diagrams 24 inches x 36 inches in size, multiple sheets may be used. The diagrams shall show the location of the installation and shall list all equipment installed in each cabinet. In addition, for each signal installation, the Contractor shall furnish an intersection sketch showing poles, detectors, field wire connection terminals and phasing as shown on the plans. The Contractor shall also furnish a minimum of five (5) operating manuals and five (5) maintenance manuals with each controller and cabinet type. The manuals shall include any and all peripheral equipment specified herein or in the Special Provisions to be installed with the controller, such as preempt system, if specified.

All schematic wiring diagrams of the controllers and auxiliary equipment, all cabinet diagrams, and all operation manuals shall be submitted at the time the controllers are delivered for testing, or, if ordered by the Engineer, previous to purchase. This diagram shall show in detail all circuits and parts. Such parts shown thereon shall be identified by name or number and in such manner as to be readily interpreted.

623 G.01.04 WARRANTIES, GUARANTEES, AND INSTRUCTION SHEETS: 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.

MATERIALS

623 G.02.01 CONDUIT: Underground conductors shall be installed in conduit unless otherwise specified in the Special Provisions or the drawings. Conduit shall be listed by the Underwriters' Laboratories Inc., and shall bear the U.L. label on each length.

Signal conductors and low voltage conductors shall not be installed in high voltage light standards.

The conduit sizes to be used will be indicated on the plans, or specified in the Special Provisions. Conduit shall be 1-1/4 inches (32 millimeters) minimum diameter, unless otherwise indicated on the plans or Special Provisions.

The Contractor may, at his own expense 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.

P.V.C. coated rigid steel conduit shall consist of galvanized rigid steel conduit conforming to applicable federal specifications and Underwriter's Laboratories. 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 (0.01 millimeter) thick. A polyvinyl chloride compound shall then be bonded to the prepared conduit with a thickness not less than 0.035 inch (0.9 millimeter) for the full length of the conduit except the threads. The bond between the metal and the plastic shall be equal or greater than the tensile strength of the plastic coating. In addition, the P.V.C. compound shall have the following physical characteristics:

(a) Hardness: 85+ Shore A Durometer

(b) Dielectric Strength: 400 (Volts/mil @ 60 cycles)

(c) Tensile Strength: 3500 psi

623 G.02.02 PULL BOXES: Pull boxes shall be precast reinforced concrete or composite boxes of the sizes and details shown on the plans and standard drawings. Reinforcement shall be 3/4 inch (19 millimeters) mesh, No. 20 U.S. gage, hardware cloth or bar reinforcement. Either steel, cast iron or non-conductive lids shall be used. For traffic signal systems, pull box covers shall be inscribed "TRAFFIC SIGNALS," and for lighting systems the covers shall be inscribed "STREET LIGHTING." Any voltage over 600 shall be inscribed "HIGH VOLTAGE."

Pull boxes for structure installation shall conform to the dimensions and locations shown on the plans. Boxes or vaults formed in concrete shall have metal frames and covers with wording inscribed on the covers as shown on the plans.

All metal parts shall be hot-dip galvanized and shall conform to the applicable portions of ASTM Designation A 153, after fabrication. Gasket surfaces shall form a true plane. Gaskets shall be one piece neoprene 1/8 inch (3 millimeters) thick, and shall cover the contact surface between the frame and cover.

All metal parts shall have provisions for attaching an equipment grounding conductor.

623 G.02.03 EXPANSION FITTINGS: Expansion fittings, as detailed on the plans, shall be installed where the conduit crosses an expansion joint in the structure. Each expansion fitting shall be provided with a bonding jumper of No. 6 AWG copper wire, or equal. Expansion fittings shall be used where they exit a structure or bridge abutment.

623 G.02.04 CONDUCTORS AND CABLE: Conductors and cable shall conform to the following specifications:

(a) Insulation for multiple circuit lighting conductors shall be rated at 600 volts, 75 degrees C. minimum. Conductors, unless otherwise specified, shall be single conductor, solid or stranded copper of the gage shown, or indicated herein, insulated with THW grade plasticized polyvinyl chloride.

Copper wire shall conform to the applicable portions of ASTM Designation D 2220, B3 and B8.

(b) Conductors for series lighting shall be No. 8 AWG, solid copper wire insulated with 10/64 inch (4 millimeters) approved polyethylene compound and rated at 5000 volts.

Conductors for traffic signals shall be IMSA approved signal cable of proper size for the required installation unless otherwise shown on the drawings or specified in the Special Provisions.

623 G.02.05 SPLICING: Overhead wire shall be No. 6 M.H.D. solid bare copper continuous from standard to standard with no splices.

Double wire circuits shall have pressed steel conductor arms at 45 degrees from the pole and 180 degrees from the direction of service.

Where overhead lines change direction, up to 45 degrees, they 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.

623 G.02.06 COLOR CODING: 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

CONSTRUCTION

623 G.03.01 MAINTENANCE OF EXISTING AND TEMPORARY ELECTRICAL SYSTEMS: Existing electrical systems (traffic signal, ramp metering, highway and street lighting, flashing beacon and sign illumination), or approved temporary replacements thereof, shall be kept in effective operation for the benefit of the traveling public during the progress of the work, except when shutdown is permitted to allow for alterations or final removal of the systems. Traffic signal shutdown shall be as specified in the Special Provisions or as requested by the Engineer. Lighting system shutdowns shall not interfere with the regular lighting schedule, unless otherwise permitted by the Engineer. The Contractor shall notify the Operating Engineer's Agency in writing three (3) normal working days prior to performing any work on existing systems.

The Contracting Agency and/or Agency's Operating Engineer shall be notified in writing three (3) normal working days in advance by the Contractor prior to any operational shutdown of a traffic signal system.

The Contracting Agency will continue operation and maintenance of existing electrical facilities.

Where damage is caused by the Contractor's operations, the Contractor shall at his expense, repair or replace, at the direction of the Engineer, damaged facilities promptly in accordance with these specifications. Should the Contractor fail to perform the required repairs or replacements, the cost of performing such repairs or replacements will be deducted from any monies due or to become due the Contractor.

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.

Where roadways are to remain open to traffic and existing lighting systems are to be modified, the lighting systems shall remain in operation and the final connection to the modified circuit shall be made so that the modified circuit will be in operation by nightfall of the same day.

Temporary electrical installations shall be kept in effective operation until the temporary installations are

no longer required for the traveling public.

These provisions will not relieve the Contractor in any manner of his responsibilities as provided in Subsection 107.11, "Responsibility for Damage," and Subsection 107.16, "Contractor's Responsibility for the Work and Materials."

A temporary overhead cable system may be used for the existing signal system circuitry in lieu of maintaining the underground installations during construction if approved by the Operating Engineer's Agency.

Where an existing system is being modified, work not shown on the plans or specified in the Special Provisions and which is considered by the Engineer as necessary to keep all or any part of the existing system in effective operation shall be considered as included in the prices paid for the systems, or units, therefore no additional compensation will be allowed.

COMMUNICATIONS INFRASTRUCTURE FOR THE FREEWAY AND ARTERIAL SYSTEM OF TRANSPORTATION (FAST): Communications infrastructure installed for the use of the FAST shall meet the following guidelines:

(1) For rights-of-way one hundred (100) feet (30.5 meters) or greater where public roadway is to be originally constructed, a four (4) inch (100 millimeter) PVC conduit shall be installed on each side of the roadway with "P30" pullboxes, as shown in the Standard Drawings, with "FIBER OPTIC" inscribed on the lid, placed at a nominal spacing of five hundred (500) feet (150 meters). For developments where street frontage is less than five hundred (500) feet (150 meters), "FIBER OPTIC" pull boxes shall be placed adjacent to the roadway at each property line. If adjacent property has "FIBER OPTIC" pull box already installed directly adjacent to proposed pull box location, the entity Engineer may waive placement of the new box for this particular location.

(2) For rights-of-way from eighty (80) feet (24.4 meters) to ninety-nine (99) feet (30.2 meters) where public roadway is to be originally constructed, a three (3) inch (76 millimeter) PVC conduit shall be installed on each side of the roadway with "P30" pullboxes, as shown in the Standard Drawings, with "FIBER OPTIC" inscribed on the lid, placed at a nominal spacing of five hundred (500) feet (150 meters).For developments where street frontage is less than five hundred (500) feet (150 meters), "FIBER OPTIC" pull boxes shall be placed adjacent to the roadway at each property line. If adjacent property has "FIBER OPTIC" pull box already installed directly adjacent to proposed pull box location, the entity Engineer may waive placement of the new box for this particular location.

(3) For rights-of-way from sixty (60) feet (18.3 meters) to seventy-nine (79) feet (24.1 meters) where public roadway is to be originally constructed, a two (2) inch (51 millimeter) PVC conduit shall be installed on each side of the roadway with "P30" pullboxes, as shown in the Standard Drawings, with "FIBER OPTIC" inscribed on the lid, placed at a nominal spacing of five hundred (500) feet (150 meters). These locations shall be reviewed on a case-by-case basis by the Intelligent Transportation System maintenance organization. For developments where street frontage is less than five hundred (500) feet (150 meters), "FIBER OPTIC" pull boxes shall be placed adjacent to the roadway at each property line. If adjacent property has "FIBER OPTIC" pull box already installed directly adjacent to proposed pull box location, the entity Engineer may waive placement of the new box for this particular location.

(4) For each of the right-of-way widths in 1-3, the communications conduit shall run "straight through" the pullbox, entering the side of the box near the bottom, to allow for a continuous fiber optic pull of no more than six thousand (6000) feet (1800 meters). A #8 bare or green conductor shall be

installed in all empty conduits.

(5) For rights-of-way less than sixty (60) feet (18.3 meters) in a residential area, conduit and pullboxes will not be required unless specified by the Agency and approved by the FAST System manager and the installation is in concert with the area's communications facilities used for the Intelligent Transportation System.

(6) Installation of conduit in areas of existing offsites should be normally limited to one side of the roadway.

(7) The cover depth from the finish grade of all conduits shall be a minimum of 30 inches (760 millimeters) with allowances for conduit to rise near pullboxes 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. If "match" will requires new conduit to be installed in violation of existing standards, the governing entity Engineer shall remedy the situation and ensure conduit meets minimum requirements.

(8) The installation of a "Type 200" Splice Vault as shown in the Standard Drawings with the letters "FIBER OPTIC" inscribed on the lid shall be mandated at intersections where trunks lines shall meet and where splicing is to be performed, or at any other locations deemed necessary for use with the regional Intelligent Transportation System. At these splice point locations, a "sweep" with radius of 36 inches (900 millimeters) 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.

(9) Innerduct shall not be used unless specifically required on design plans. If innerduct is proposed, the specific use of each innerduct cavity shall be identified on project plans.

(10) All buried conduits shall have underground marking tape placed twelve (12) inches (300 millimeters) above the installed conduit and marked with the letters "FIBER OPTIC".

(11) All communication facilities shall be identified by the Contractor with "survey grade" GPS locating equipment. GPS coordinates shall be collected for conduit location every 100 feet (30 meters) maximum, for each pull box location and as required by the governing entity Engineer for existing locations of conduit or pull boxes which have been modified. These coordinates must be supplied electronically and in hard copy to the ITS maintenance organization for inclusion into the system's database.

(12) For roadway projects where the sidewalk, curb and gutter are already installed and communications facilities are required, the appropriate size conduit shall be installed at the lip of gutter with a large sweeping elbow laying sideways under the curb. The angle of the elbow's entry into the "P30" pullbox or "Type 200" communications vault shall be determined in order to provide a straight pull over the lip of the pullbox lid. The spacing of these pullboxes or the inclusion of this conduit shall be determined by the FAST system manager or th appropriate ITS staff during the review/design process and shall be dependent upon the existing infrastructure. All decisions shall be in conjunction with the continually updated master planed approach for the Valley's communication facilities.

(13) When fiber optic cable is installed, a minimum of thirty (30) feet (9.1 meters) of slack shall be safely coiled into each "P30" pullbox and a minimum sixty (60) feet (18.3 meters) in each "Type 200" vault, hung on the sidewall attachment.

MAINTAINING FREEWAY AND ARTERIAL SYSTEM OF TRANSPORTATION (FAST) INTERCONNECT CABLE: The exact location of existing conduits and pull boxes shall be ascertained by the Contractor before using any equipment that may damage such facilities or interfere with the FAST. Any damage to the traffic system interconnect cable is considered by the Contracting Agency to constitute an emergency.

Where damage is caused by the Contractor's operations, the Contractor shall, at his expense, begin temporary repairs immediately after the damage occurs and shall proceed with repairs expeditiously until complete. Occupancy permits may be held at the request of the Signal Systems Manager if the repairs are not completed expeditiously and satisfactorily.

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.

Each conductor in all cable runs in which damage occurs shall be tested for continuity and resistivity to ensure no latent damage exists elsewhere in the cable.

Cable meeting the FAST Specification, 22 AWG, has a D.C. resistivity of 17.4 ohms/1000 feet at 20 degrees C. Any cable exhibiting a D.C. resistivity in excess of 18.3 ohms/1000 feet at 20 degrees C. in more than one (1) pair of conductors shall be deemed to be damaged when tested hereunder and shall be replaced/repaired in accordance with this provision.

Pull box splicing shall not be permitted for permanent restoration unless specifically approved in writing, after a system review, by the FAST Signal Systems Manager.

ACCEPTABLE METHODS OF REPAIR AND RESTORATION: Temporary repairs of damage at a single discrete point in the interconnect cable may consist of a splice made with a re-enterable splice kit in a standard pull box placed temporarily. Direct burial of a splice is not permitted. The Contractor shall be responsible for maintaining the temporary repair until such time as the permanent repairs are completed.

Temporary repairs of damage to an extended length of cable or of damage at more than a single discrete point may consist of placing cable overhead until permanent replacement is completed. Permanent restoration of a damaged interconnect cable shall be made in one (1) of the following methods as approved by FAST personnel:

Method 1. Pulling out all damaged cable and replacing with a new cable conforming to R.E.A. Specification 39, 22 AWG, between existing terminal boards housed in controller, junction cabinets, or engineering office at each end of the damaged cable run. The new cable shall be tested after installing for continuity and with a "megger" to ensure no damage resulted from the installation process.

Method 2. Install a new standard junction cabinet if the damage occurs within a street intersection no closer than 300 feet to an existing junction, controller cabinet, JMC or TMC.

Method 3. All repairs of fiber optic cable shall be made per manufacturer's recommendations.

All damaged 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 local agency.

All cable repairs or restoration shall be made only under inspection by FAST personnel or Traffic Operations personnel from the local agency in whose jurisdiction the repair is being made.

All materials, equipment and workmanship incorporated into any cable repair or restoration shall be guaranteed for a period of one (1) year after the final acceptance of the work or equipment. If during the guarantee period any defects or faulty materials are found the Contractor shall immediately, upon

notification by the local agency or FAST, proceed at his own expense to replace and repair same, together with any damage to all finishes, fixtures, equipment and furnishings that may be damaged as a result of this defective equipment or workmanship.

623 G.03.02 SCHEDULING OF WORK: Traffic signals shall not be placed in operation for use by public traffic without the energizing of street lighting at the intersection to be controlled if street lighting exists or is being installed in conjunction with the traffic signals.

Traffic signals shall not be placed in operation until all discrepancies are corrected and the roadways to be controlled are open to public traffic, unless otherwise directed by the Engineer.

Roadway lighting and traffic signals shall not be placed in operation, including flashing operation, prior to commencement of the functional test period specified in Subsection 623 T.02.03(e),(f), and (g), "Field Tests," unless ordered otherwise by the Engineer.

Conductors shall not be pulled into conduit until pull boxes are set to grade, crushed rock sumps installed, and metallic conduit bonded.

In vehicular undercrossings, soffit lights shall be placed in operation as soon as practicable after falsework has been removed from the structure. Lighting for pedestrian structures shall be placed in operation prior to opening the structure to pedestrian traffic.

If the Engineer orders soffit lights or lighting for pedestrian structures placed in operation before permanent power service is available, the cost of installing and removing temporary power service will be paid for as extra work as provided in Subsection 104.03, "Extra Work."

Traffic signals or street lighting shall not be inspected for acceptance or turn on until a completed set of red lined plans is received by the local agency. This does not preclude the preparation and submittal of as-built plans.

623 G.03.03 SAFETY PRECAUTIONS: Before starting work on existing series street lighting circuits, the Contractor shall obtain daily a safety circuit clearance from the responsible local agency. By-pass shall be switched to the "off" position, fuses shall be removed, and signs posted at the switch box before any work is done.

623 G.03.04 EXCAVATING AND BACKFILLING: Excavations required for the installation of conduit, foundations and other facilities, shall be performed in such a manner as to cause the least possible damage to the streets, sidewalks, and other improvements. Excavations shall not be larger than necessary for the proper installation of conduit, electrical facilities and foundations. Excavating shall not be performed until immediately before installation of conduit, facilities, and foundations.

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.

Surplus excavated material shall be removed and disposed of by the Contractor outside of the right-of-way.

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.

Structural excavation and backfill shall conform to the requirements of Section 206, "Structure Excavation" and 207, "Structure Backfill."

Trench excavations shall be backfilled in conformance with the requirements of Section 208, "Trench Excavation and Backfill."

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 208.03.05, "Cutting and Restoring Street

Surfacing."

Unless otherwise specified in the Special Provisions, excavation in the street and highway shall be performed in such a manner that not more than one lane of traffic is restricted in either direction at any time, unless otherwise approved by the Engineer.

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.

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.03.05 REMOVING AND REPLACING IMPROVEMENTS: 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.

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 of Structures and Obstructions."

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 (38 millimeters) with an abrasive type saw prior to removing the sidewalk and pavement material. Cut for the remainder of the required depth may be made by any method satisfactory to the Engineer. Cuts shall be neat and true with no shatter outside the removal area.

623 G.03.06 FOUNDATIONS: Foundations for posts, standards, and pedestals shall be concrete conforming to the applicable requirements of Section 501, "Portland Cement Concrete."For posts, standards, and pedestals, a four (4) inches (100 millimeters) minimum foundation cap consisting of grout or concrete as designated by the entity engineer shall be poured after the post, standard, or pedestal is in proper position. Grout shall conform to Subsection 501.03.11, "General Mortar)". Arms shall be considered live load and may be mounted only after complying with Subsection 502.03.19. The exposed portions shall be formed to present a neat appearance. The bottom of concrete foundations shall rest on firm undisturbed ground. In addition, for traffic signal installations, the bottom two-thirds (2/3) minimum of the concrete foundation shall be poured against undisturbed soil. If signal foundation is to be placed in area which has been filled, fill shall meet compaction requirements as specified in the Standard Specifications or special provisions and bottom two thirds (2/3) minimum of the foundation shall be poured in drilled compacted fill and/or undisturbed soil.

Forms shall be true to line and grade. Tops of footings for posts and standards, except special foundations, shall be finished one (1) inch (25 millimeters) above grade of curb or sidewalk or as ordered by the Engineer.

Forms shall be rigid and securely braced in place. Conduit ends and anchor bolts shall be held in place by means of a template until the concrete sets. Both forms and ground which will be in contact with the concrete shall be thoroughly moistened before placing concrete. Forms shall not be removed until the concrete has thoroughly set.

Ordinary surface finish shall be applied to exposed surfaces of concrete. Where the edge of a concrete foundation extends within eighteen (18) inches (450 millimeters) of any existing concrete improvement, a slab with a minimum thickness of four (4) inches (100 millimeters) shall be extended to meet said existing improvement.

Concrete for Type XX poles and/or XX-A poles shall set for a minimum of ten (10) days unless otherwise approved by the Engineer. Concrete for smaller bases shall set for a minimum time of seventy-two (72) hours.

623 G.03.07 WIRING: Wiring shall conform to appropriate articles of the National Electrical Code. Wiring within cabinets, junction boxes, etc., shall be neatly arranged and laced. Powdered soapstone, talc, or other approved lubricant shall be used when installing conductors in conduit.

Each conductor shall have eighteen (18) inches (450 millimeters) of slack coiled within each standard and at least two feet (600 millimeters) of slack coiled in each pull box.

Series lighting cable shall be installed without splices from luminaire to luminaire and from service to luminaire unless otherwise specified. Multiple lighting conductors may be spliced in the base of standards or in pull boxes adjacent thereto. Signal cable shall run from terminal to terminal without splices unless otherwise indicated on the plans.

Splices for street light cables and traffic signal cables shall be split bolt or "gel-cap" type as designated by the entity Engineer. 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. The silicon gel shall not become hard or brittle and shall have a temperature tolerance of -40°F (-40°C) to +221°F (105°C). The cap, clamp, and gel used for the "gel-type" splice kit shall be UV-resistant. Kits shall contain a split bolt connector and shall accommodate range of cable sizes specified by the entity Engineer. "Gel-cap"-type connection shall also permit removal and re-entry of wiring for maintenance purposes without damage to the splice kit.

Conductors shall be joined by the use of a connector approved by the Engineer.

Conductor insulation shall be well penciled, trimmed to conical shape, roughened and meet manufacturer's recommendations before applying splice. 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. When new conduit is installed for future use, it shall have a #8 green (stranded) pull which is secured at both ends.

The ends of all conduits shall be well reamed to remove burrs and rough edges. 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. Slip joints or running threads shall not be permitted for coupling metal conduit.

When a standard coupling can not be used, an approved union coupling shall be used.

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.

Conduit ends shall be threaded and capped with standard pipe caps until wiring is started. When caps are removed, the threaded ends shall be provided with approved conduit bushings.

Manual or power-operated equipment normally used for cutting rigid steel conduit is acceptable for use in cutting P.V.C. coated rigid steel conduit. P.V.C. shall not be peeled back before cutting and all cuts shall be reamed. Threading shall be the same as for non-coated rigid conduit. All scarred and grip marked areas shall be touched up with approved heavy consistency coating compound.

For P.V.C. coated rigid steel, all couplings and threaded fittings shall be hand tightened before using a wrench. Use strap wrench for the final two turns only. All wrench marks and scores shall be recoated and joints must be sealed with heavy consistency P.V.C. compound. Ensure that the final installation does not have any exposed metal areas.

Conduits shall be bent, without crimping or flattening, and no single run shall include more than two 45 degree bends and two 90 degree bends without prior approval of the Engineer.

P.V.C. coated rigid steel conduit, 2 inches (51 millimeters) in diameter or larger, shall be used for all bends, except for 90 degree bends at street light pole foundations. Standard field bending techniques shall be used which typically uses a shoe one size larger to accommodate the larger pipe diameter. The minimum radius of the bend shall be 36 inches (914 millimeters) for P.V.C. coated rigid steel conduit.

Conduit shall be placed to a depth of not less than 24 inches (600 millimeters) below the finished grade in all areas with the following exceptions. Conduit may be laid on top of and secured to the existing

pavement where such pavement is covered by a raised dividing strip having concrete curb. Conduit under railroad tracks shall be installed to railroad specifications. Conduit shall be placed under existing pavement by approved jacking or drilling method. Pavement shall not be disturbed without the approval of the Engineer, and then only in the event obstructions are encountered; however, upon approval of, or as required by the Engineer, small test holes may be cut into the pavement. Jacking or drilling pits shall be kept two (2) feet (600 millimeters) from the edge of any type of pavement whenever possible. Use of water which might undermine pavement, or soften subgrade, will not be permitted.

Conduit terminating in pedestals shall be a minimum of two (2) inches (50 millimeters) and a maximum of four (4) inches (100 millimeters) above the foundation and should be sloped toward the handhole opening.

Conduit shall enter concrete pull boxes from the bottom and shall terminate two (2) inches (50 millimeters) inside the box wall and not less than two (2) inches (50 millimeters) nor more than four (4) inches (100 millimeters) above the bottom, and shall be sloped to facilitate pulling of conductors. Conduit entering the bottom of a pull box shall be located near the end walls to leave the major portion of the box clear. At all outlets, conduit shall enter from the direction of the run.

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.

Conduit runs shown on the plans are for bidding purposes only and may be changed with the approval of the Engineer to avoid underground obstructions.

623 G.03.08 SERVICE: Service points when required by the Contracting Agency for street lighting, traffic signals, etc. shall be as indicated on the drawings.

Since service points indicated by those other than the Contracting Agency may be subject to change (subdivision street lighting) the Contractor shall obtain the points of attachment from the serving utility company and shall be as close to the center of the circuit as possible.

Padmount service, when called for, shall conform to Uniform Standard Drawings, Clark County Area as applicable.

The Contractor shall furnish and install conduit and conductors to the service point as shown on the plans or as required to complete the installation.

No service point will be considered acceptable unless approved in writing by the serving utility company and the Contracting Agency Engineer or his designee.

TRAFFIC SECTION

MATERIAL

623 T.02.01 CABINETS ENCLOSURE: The type of 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, Clark County Area, Nevada. This is commonly referred to as an "R" cabinet. All external seams exposed to the outside shall be 100% welded (no gaps). The cabinet shall be painted with two coats white enamel both inside and outside, or polished aluminum, depending upon contract provisions. There shall be a minimum of 4 shelves provided with each cabinet.

All cabinets shall be provided as a complete unit to include all shelves, foundations, anchor bolts with template, a standard #2 lock, two (2) door stops, etc., and to be completely painted white inside and outside if required by the contract plans. The police panel shall be keyed with a standard police key lock.

All cabinets shall be weatherproof, properly ventilated, and have at least two (2), 110 CFM ventilation fans, with each fan having an independent thermostat. All cabinets shall have the door mounted with hinges

welded to door and jamb. There shall be a standard multi-point door stop, along with a supplemental, single-arm door stop. The location of these will be at the top and bottom of the cabinet door, and they shall be fully retractable as not to interfere with the door's closing and opening operation.

Each cabinet must fit the anchor bolt locations and foundations as specified in Standard Drawing 404.213. This shall be accomplished without modification to the cabinet or foundation.

Cabinets shall have two (2) fluorescent fixtures and lights mounted in the cabinet interior. One mounted over the door, at a location least likely to be damaged. The length shall be determined by the cabinet width. The second, an 8 to15 watt lamp, shall be attached to the bottom of the lowest shelf above the field terminals, yet it still must illuminate the back panel connection terminals. Both fixtures shall have an on-off switch which automatically illuminates the lights when the door is opened, and de-energizes them when the door is closed. The "Back Panel" in each cabinet shall be wired to the NEMA TS2 TYPE 2 standard inputs and outputs. There shall be standard NEMA "A," "B," & "C" connectors with all pins provided a termination point onto the back panel, including spares or unassigned pins. The terminals shall be clearly marked as to their associated function, with silk-screen or other approved method of marking.

Only cabinets that are designed to use rails with infinite adjustability ('uni-strut' design) on the side of the cabinet that the shelves and panels are connected to will be accepted. These utilize "spring nuts" in the rail channel to tighten the bolts that are used. Cabinets that use carriage bolt assemblies are not acceptable.

When specified a rear access door shall be provided. Permanently affixed lifting eyes shall be provided.

(a) All cabinet harnesses and wiring shall be neatly and firmly laced or bound together (with ty-rap or approved equivalent).

(b) Every terminal shall be numbered and identified in accordance with the cabinet wiring diagrams and prints.

(c) The cabinet shall contain a plastic envelope that can be sealed, which is attached to the cabinet door. This will be used to house wiring diagrams. The cabinet wiring diagrams shall show and identify the connectors for all equipment, switches, terminal blocks, relays, flashers and signal control bases. There shall be included three (3) complete sets of wiring diagrams on "D" size paper, along with a complete copy of the cabinet wiring diagram on a 3 ½ " floppy disk drawn in Autocad LT95, Autocad Rev. 12, program or approved equivalent.

The cabinet wiring diagram shall have an intersection sketch with signal heads and push-buttons identified as related to phasing. A generic phasing layout similar to the following would be acceptable. The cabinet "controller" phasing shall be referenced as follows:

(d) All mechanical relays shall have clear dust covers.

(e) The following equipment shall be furnished and wired in all cabinets:

(1) Three (3), single-pole, surface-mount circuit breakers: One (1), 20-amp circuit breaker to operate all the electronic equipment, (e.g. controller, conflict monitor, detection equipment, and preemption equipment) and the upper utility plug. One (1) 15-amp circuit breaker for the fan, light, and lower utility plug. One (1) 60-amp circuit breaker to operate the other cabinet equipment, and to illuminate all the indications at the intersection external from the cabinet.

The circuit breakers must accommodate a #2 AWG stranded conductor which comes from the utility company's service meter. If not, the cabinet must have a supplemental terminal block that can accept this wiring requirement. This terminal block must be a Buss 16204-3, or approved equivalent.

(2) There shall be a specific terminal, unfused, able to accept # 2 wire for the neutral wire of the power supply line. This terminal point shall be in the Buss 16204-3 terminal block, or approved equivalent.

(3) There shall be a specific terminal, unfused, able to accept # 2 wire for the chassis ground wire of the power supply line. This terminal point shall be in the Buss 16204-3 terminal block, or approved equivalent.

(4) The terminal blocks for connecting the pedestrian and vehicle field wires which illuminate the independent signal heads shall be Thomas and Betts #35301, or approved equivalent. The mounting height to the bottom of these terminal blocks must be 14" from the bottom of the cabinet base.

(5) Terminal blocks Cinch 12-142 with Thomas and Betts chair lugs, or approved equivalent will be used for connection of pedestrian push button "field" conductors.

(6) Terminal blocks for all pins on the wiring harnesses on all connectors of the controller, conflict monitor, detection systems, and preemption systems must be provided separately. All connector pins shall be wired and terminated.

(7) A minimum of two (2), sixteen terminal, "Compression type" Copper Ground Strips, with one

mounted and grounded to each side of the cabinet wall, for connection of all common conductors must be provided in the cabinet. These terminal strips will be connected to the terminal block that accepts the # 2 stranded wire for the neutral ground wire. These shall be mounted from 2" to 4" up from the bottom of the cabinet.

(8) Two compression-type mechanical ground strips shall be mounted on and grounded to the cabinet wall for connection of all mechanical grounds. One shall be mounted on the left and one on the right side of the cabinet 2" to 4" above the cabinet base, and they must be tied to the ground wire from the service point through the terminal block that is used to accept the #2 stranded wire.

(9) Two, dual-circuit, solid state NEMA jack-mounted flashers having a flash rate of 50 to 60 flashes per minute (see Section 8, SOLID STATE FLASHERS, of the 1983 TS1 NEMA specifications) will be installed.

Channel "A" on the first flasher is to be wired to flash phases 1 and 4, while channel "B" is wired to flash phases 5 and 8. Channel "A" on the second flasher shall be wired to flash phases 6 and 7, while channel "B" shall be wired to flash phases 2 and 3.

Overlaps driven flash is:

1A does phase 1, 4, & OLA

1B does phase 5, 8, & OLB

2B does phase 2, 3 & OLC

2A does phase 7, 6 & OLD

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 must be energized to operate the traffic signal with colors.

(10) A single, duplex, "U" ground type of convenience outlet shall be furnished for tools and lighting. It shall have an integral ground fault protection device. This will be located on the door, or within the lower half of the cabinet. The power source for this outlet shall be the 15-amp circuit breaker.

A second, single, duplex, "U" ground type of convenience outlet shall be furnished for video equipment and other electronic test equipment. It shall not have an integral ground fault protection device. This will be located no more than a foot from the roof of the cabinet, on the right or left hand side. The power source for this outlet shall be the 20-amp circuit breaker.

(11) Police Panel Switch: There shall be a double-pole, double-throw switch behind the police auxiliary door. This shall be identified "Auto/Flash." With the switch placed in the "Flash" position the switch shall be wired to:

(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, must 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 on 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 must be diode-isolated.

When the police switch is placed back into the "Auto" position the intersection shall be transferred from red flashing operation to normal operation.

(12) The following switches shall be installed on the interior of the cabinet. They must act in the specified manner:

(a) "Controller Power" switch (identified "On-Off") wired to de-energize only the controller power when switched to the "off" position.

(b) "Tech Flash" switch (identified "Auto-Flash") shall be wired to de-energize signal light power feeding the load switches and transfer relays when the switch is placed in the "Flash" position. This switch shall cause the intersection signals to flash red, but must keep controller (and all other equipment) energized. Additionally, the controller shall NOT be activated to stop-time, while providing logic ground to inform the 2070N controller that the Tech Flash Switch has been put on flash (Controller Plug "A," Pin "AA"). When the Tech Flash switch is placed back into the "Auto" position the intersection shall be removed from Flash and return to normal operation.

(c) "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.

(d) "Interval Advance" switch, which must be a 'Momentary ON' switch, (identified "Interval Advance") shall be enabled by the "MCE" switch and wired to manually step the controller through intervals. The Interval Advance switch shall have a guard to keep from accidentally advancing the controller.

(e) "Manual Control Enable" switch" (identified "MCE") shall be wired to enable "MCE" in controller, while allowing the Interval Advance switch to operate.

(f) "Pedestrian And Vehicle Test" switches (identified "On/Off/Test") shall be provided in each cabinet. These should be installed on a vehicle and pedestrian detector test panel located on the inside of the cabinet door. They shall be equipped according to contract provisions as follows:

(1) With toggle switches (on-off-momentary on) wired for permitting the introduction of manual calls into the controller for every possible vehicle and pedestrian detector input. Each toggle switch, in the up position, shall permit calls into the controller from the vehicle and pedestrian detection source. Each toggle switch, in the center position, shall disconnect the vehicle and pedestrian detection source and permit calls into the controller only via manual push down actuation. All possible vehicle and pedestrian detector circuits shall have a separate toggle switch. Toggle switches shall be provided for 8 vehicle and 8 pedestrian phases and wired independently to the terminal blocks.

(2) With toggle switches (on-off) wired for permitting the introduction of manual calls

via a separate normally open push button switch into the controller for every possible vehicle and pedestrian detector input. Each toggle switch, in the up position, shall permit calls into the controller from the vehicle and pedestrian detection source, and permit calls into the controller via manually depressing the associated push button for the related phase. Each toggle switch, in the lower position, shall disconnect the vehicle and pedestrian detection source and the related push button. All possible vehicle and pedestrian detector circuits shall have a separate toggle and push button switch. These switches shall be for all 8 vehicle and all 8 pedestrian phases and wired independently to the terminal blocks.

(3) All switches and the "lower" convenience outlet may be combined on a single panel and mounted on the inside cabinet door behind the police auxiliary panel, if desired by the supplier.

(g) 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.

623 T.02.02 CABINET EQUIPMENT:

(a) **Solid State Load Switches, Red Transfer Relays, and Sockets:** All necessary cabinet wiring, connecting cables, terminal blocks and sockets shall be provided for complete and proper functionality of a 8 vehicle, 4 pedestrian, and 4 overlap phase operation.
A total of 16 NEMA load switches shall be provided with each cabinet. There will be two (2) discrete NEMA flashers accompanying each cabinet. Refer to the 1983 Sections 5 and 8 of the NEMA standard publication for operational and dimensional requirements. It is mandatory that a wide angle, high intensity LED, clearly visible in sunlight shall be provided for each load switch and flasher indication.
A minimum of 6 transfer relays shall be delivered with each cabinet. These shall conform to the 1983 NEMA TS1 specifications. Load bay panels shall not exceed 0.125 inches (3 mm) of flex under 5 pounds pressure.

(b) **Pedestrian Push Button Circuit Isolation:** To separate the pedestrian detector input circuits to the controller from the pedestrian push button circuits in the field, six solid state isolation circuits shall be provided in the cabinet. For four pedestrian movements; channels one, two, three, and four shall correlate to phase 2, 4, 6, and 8. Therefore, the wiring shall be appropriately terminated within the cabinet. Channels five and six shall be spares and be terminated to allow access from the front side of the detector panel. The "field" push button circuits shall be energized by a 12 VAC source. The isolation circuits shall be mounted on an edge connector-type P.C. board with all required components; i.e., transformer, chips, etc. and shall display an LED indication showing status of field buttons.

(c) **Video Detection:** All cabinets must be wired for Video Detection in the following manner. This is a requirement whether or not standard loop detection cables are installed into the cabinet.

Every cabinet shall have installed and wired into it a discrete "Video Detection Interface Panel" (VDIP). Phase 1 through 8, and overlap A, B, C, & D 24 VDC green and red outputs from the controller must be wired to the VDIP, from the back panel. Also, vehicle and pedestrian phase "calls" 1 through 8 must have a termination point on the VDIP.

This VDIP shall be installed under the assumption that the wiring harnesses that accompany all Video Detection Systems will be connected to these independent termination points at some time.

This VDIP shall be installed at a location within the cabinet where the terminal blocks are easily accessible.

(d) **Loop Detection:** When specified, the cabinet shall be wired for 24, single-channel loop amplifier wiring harnesses, 6, 4-channel loop amplifier wiring harnesses, or a multi-position "rack-mount" style detection system with the breakdown as follows:

(1) **For Single-Channel Detectors:**

There shall be two (2), single-channel loop amplifier wiring harnesses for each of the phases 1, 3, 5, and 7, for left turn operation. These harnesses and plugs conform to the TS-1 1983 specifications. These will be wired as presence loops, with each conductor independently terminated onto an individual terminal. The "Relay Common" ("B" pin) must terminate, then it must be wired to logic ground.

There shall be three (3), single-channel loop amplifier wiring harnesses for each of the phases 2, 4, 6, and 8, for thru traffic extension loop operation. These harnesses and plugs conform to the TS-1 1983 specifications. These will be wired as presence loops, with each conductor independently terminated onto an individual terminal. The "Relay Common" ("B" pin) must terminate, then it must wired to logic ground.

There shall be one (1), single-channel loop amplifier wiring harnesses for each of the phases 2, 4, 6, and 8, for thru-traffic "call loop" operation. These harnesses and plugs conform to the TS-1 1983 specifications. These will be wired not to output a call during the detected phase green service, with each conductor independently terminated onto an individual terminal. The "Relay Common" ("B" pin) must terminate independently, then it must then be wired to the red and yellow output from the controller (this must be diode isolated).

(2) **For Four-Channel Detectors:**

There shall be 6 complete wiring harnesses to match with the standard four channel detection unit for a total of 24 channels of detection specified in NEMA TS-1 standards, Section 11.2.28.2. These shall be wired to so the channel inputs of all channels are terminated directly to logic ground. The number of detection outputs per phase shall be as below:

4 outputs per each even phase (2, 4, 6, 8)

2 outputs per each odd phase (1, 3, 5, 7)

(3) **For "Rack-Mounted" Detection:**

There shall be a Card rack installed with enough capacity to accommodate 24 separate detection channels. Contract provisions shall specify whether two-channel or four-channel rack-mounted detectors are to be utilized. The number of detection outputs per phase shall be as below:

4 outputs per each even phase (2, 4, 6, 8)

2 outputs per each odd phase (1, 3, 5, 7)

All wiring harnesses, and rack positions must be clearly marked as to the appropriate phase to

which it belongs.

The wiring harnesses shall be of sufficient length for them to reach the top-most shelf inside the cabinet.

(e) **Optical Preemption Terminal Strip Panel:** Every cabinet supplied shall be wired with an "Optical Emergency Preemption Panel," and shall be marked accordingly. The panel shall have termination points for four preemption outputs directly wired to the discriminator. The M138 Emergency Preemption cable coming from the Optical Detectors shall be terminated to a terminal strip located on this panel.

The wiring from this panel to the back panel shall be as follows:

Channel "A" to Controller Plug "A," Pin "q"

Channel "B" to Controller Plug "A," Pin "y"

Channel "C" to Controller Plug "B," Pin "W"

Channel "D" to Controller Plug "B," Pin "X"

(f) **Supplemental 2070N "D" Plug Interface Panel** (for additional information, see 623 T.02.03)

Every cabinet shall have a "D" panel wired to which the wiring harness for the "D" plug for the controller will terminate. The plug used for the "D" plug on the 2070N controller shall be an MS3116-24-61S. The wiring from this plug's harness shall have independent termination points as shown on the panel below. All wiring on this panel, except for the "D" plug connector wiring harness itself shall be performed by the Agency's staff after delivery and acceptance of the controller cabinet.

(g) **Conflict Monitor Units:** The wiring harness that the conflict monitor plugs use shall have independent termination points. Each and every conductor shall be terminated independently onto a single terminal. There will be no conductors bound, hanging loose, or not terminated.

All conflict monitors shall be NEMA standard, meeting all requirements of section 6 of the 1983 TS1 specifications. In addition, all monitors shall be equipped with the features defined below:

All cabinets shall be equipped with a conflict monitor harness completely wired in the cabinet to a separate panel as shown above for twelve (12) channels of operation. Conflict monitors shall be provided in all cabinets supplied.

Minimum vehicle clearance time monitoring with a time value of 3.0 to 4.0 seconds (able to be selected on a per channel basis).

Separate indicators for activity on each of the red, amber, green and walk inputs of each monitor channel.

Front panel indicators showing active channel(s), date, time and description of the current status, while showing a log of six or more of the most recent failures. All such data shall be stored in a non-volatile memory.

Liquid crystal front panel displays shall be provided.

Failure status indicators for CVM, 24-1, 24-2, conflict, red failure, clearance failure, minimum green failure, dual indication, and program card insertion.

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.

Front panel connectors "A" and "B" mounted directly to printed circuits will not be accepted.

For every integrated circuit custom-programmed device, or any sole source component, within the unit which is of such special design that replacement units would not be available from any local wholesale electronics distributors, one fully programmed duplicate of each IC/device contained therein shall be furnished directly for each conflict monitor delivered.

All conflict monitors shall have RS-232 capability. The vendor shall supply a software program which when run on an IBM compatible computer will communicate with the monitor unit for the downloading of failure event information and any other programmable event including timing, etc.

623 T.02.03 TRAFFIC SIGNAL CONTROLLERS:

(a) **General**

(1) **Controller Assemblies.** 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 cabinet. All equipment required to provide the operation shown on the plans and specifications, shall be provided.

(2) **Flashing Operations.** All controllers shall be equipped for flashing operation of signal lights. 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 schematic diagram of the controllers and auxiliary equipment furnished under the contract shall be submitted at the time the controllers are delivered or, on demand of

by the Engineer, prior to purchase. This diagram shall give in detail all circuits and parts, and such parts shown thereon shall be identified by name or number and in such manner as to be readily interpreted.

(4) **Operating Voltage.** All equipment including interconnection facilities and excepting pedestrian push buttons and pressure detectors, shall be designed to operate on 120 volts, 60 Hz. AC. Operation shall be satisfactory at voltages from 105 to 130. The voltage for pedestrian push buttons shall not exceed 24 volts.

(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) Test for grounds in each circuit

(C) A megohmeter test on each circuit between the circuit conductor and ground. The insulation resistance shall not be less than 150 megohms at 500 volts.

(D) A functional test in which it is demonstrated that each and every part of the system functions as specified or intended herein.

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 approved by the Engineer, and the same test shall be repeated until no fault appears. 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. Any fault or failure to the system during this period shall be corrected by the Contractor at his own expense and the system will then be required to function for a period of 14 calendar days without failure. This procedure will continue until the system successfully operates continuously without failure for 14 calendar days.

(6) **System Turn-On:** The Contractor must have approval of the date for turn-on, at least five (5) working days prior, from the Traffic Engineer. Systems shall be permitted to be made operational at Agency's direction. Controller manuals shall be available to the Signal Maintenance Division at time of turn-on. The controller manufacturer shall provide a technical representative at the intersection during the turn-on and testing period to provide technical assistance.

The supplier shall provide a manufacturer's representative, with a minimum of an IMSA Level II, Traffic Signal Technician Certification at time of installation for on-street service of all equipment provided.

(b) **NEMA Controller Construction Specification.**

When a NEMA controller is supplied, it shall meet all requirements of the NEMA standards publication, TS2, Type 2 or later version as well as the following requirements:

(1) Phase reversal shall be activated by applying a logic ground to controller connector "B."

Pin B shall reverse phase 1 & 2

Pin W shall reverse phase 3 & 4

Pin X shall reverse phase 5 & 6

Pin v shall reverse phase 7 & 8

(2) Each controller unit shall be provided complete with all of the following components and timing features:

Four keyboard programmable overlaps

Three NEMA connectors "A", "B", "C"

Two DB25-RS232C ports on the front of each controller. One port shall be for communications and the second port shall be used for occasional connection to a portable computer having priority over port one.

Each controller will be menu driven, with keyboard programming for listing program, status, utilities, and special options. Being able to move between programs, menus, and/or sub-menus and having the ability to copy timing data from one phase to another. The controller shall be able to dim phase outputs by phase or individual phase color. Readout on the display to be visible in bright sunlight or in the dark with back lighting.

The equipment housing shall be a completely enclosed painted metal fabrication that is easily removed and replaced. The design shall include vent holes. The unit shall consist of a frame and mother board, with separate printed circuit modules (CPU, Memory, I/O, etc.) which will facilitate simple and rapid maintenance. The connectors for interfacing with the controller shall be part of the input/output module and are to be located on the front of the unit for ease of access.

The circuit components shall be standard production types that are readily available from any industrial electronics supply house. All components mounted to the circuit boards shall have their circuit reference symbol clearly marked on the board and be identifiable by referencing to the pictorial assembly drawings.

The power supply shall be self contained in a separate and removable module.

The circuit component design life under continuous duty operation shall not be less than 10 years.

All programmed timing and operational parameters shall be retained within electrically erasable and programmable read only memories (EEPROM'S) or equivalent. No batteries for any such backup systems will be acceptable, except as necessary to maintain TOD clock time-keeping during power failure.

(3) A complete operations and repair manual shall be supplied with each controller unit. Each manual shall completely describe all features, keystroke sequences, etc. as necessary to activate all functions provided in the controller. Complete schematic diagrams by circuit function, and separate diagrams by module. Complete block diagrams of equipment circuits, and complete parts listing. Detailed circuit-by-circuit description of the operation that follows component-by-component with the schematic diagram or block by block with the logic diagram. This requirement may be waived at the discretion of the purchasing Agency.

(4) It shall be possible to perform a series of diagnostic tests of the system, which shall include the following:

Wrap around Input/output check of connectors A, B and C.

Wrap around Input/output check of communications and printer ports.

RAM memory check.

EEPROM check.

Where special test connectors are required, 2 complete sets of connectors shall be provided per bid order.

(5) The vendor shall supply a software program to the Agency which when run on an IBM compatible PC connected to the controller will demonstrate to the Agency the controller's communications with respect to baud rates, uploads, downloads, monitoring and activity logging.

(6) All requisite hardware and software shall be provided fully installed and complete in order to provide the uploading, downloading, monitoring and logging functions required.

(7) **Double Clearance Overlaps:** The four NEMA required overlap outputs ("A", "B", "C" and "D") shall provide timed double clearance operation. The settings for this type of operation shall include the ability to select which phases and other overlaps may start timing, or commence the display of their green indications, respectively, during the double clearance timer intervals after the terminating parent phase has completed its all red. It shall also be possible to program which phases "on's" and which phases "next's" concurrent output shall cause the double clearance green (lag green interval) to be skipped. It shall be possible to specifically program for each overlap:

Compatible phases

Conflicting phase

This will allow the overlap to go red during the timing of a phase conflicting with the overlap in one ring even though the overlap movement is compatible with a phase timing concurrently in the other ring.

Independent amber and all red clearance timers shall be provided for each overlap of which shall always operate during an overlap clearance. Output suppression of all drivers during the green (only), or green and amber displays of designated phases for use with "Illinois type" right turn overlap or "Florida style" left turn signal indications, respectively. When such operation is selected, the otherwise unused red of the odd phase load switch drivers shall output a "not red" indication for use in red monitor failure prevention.

Each controller shall also internally provide the option to program each of all load switch driver outputs other than overlaps A through D as an overlap of any or all of the timing phases. This shall be true of the red, yellow, and green outputs of phases 1 - 8, outputs and any or all of the eight unused walk, steady ped clear, and flashing ped clear outputs.

(8) **Power Up Phase and Interval Sequence:** The controller start up point shall be programmable to be either the start of green or the start of amber of any legal phase combination.

(9) **Scheduled Flash:** The scheduled flash shall be generated internal to the controller, and

blink the load switch driver inputs independently of the cabinet (conflict monitor) flash circuitry. It shall be possible to program the following parameters:

Last phases before scheduled flash begins, along with the first phases after scheduled flash ends.

The monitor's red enable function shall be active whenever the signal bus is energized, including periods of controller load switch flash. During a scheduled flash all pedestrian outputs shall remain dark as stated in MUTCD. Scheduled flash may be provided as a form of internal controller preemption, callable for the internal time base coordination schedule, as well as by activation of NEMA test input "A". It shall be possible to specify in every other internal preempt program provided whether or not a call for that preempt overrides scheduled flash operation.

(10) **Primary Phase Assignments:** It shall be possible to program each detector input for phase assignment and as to whether the input places

(a) no call

(b) call only

(c) extension only

(d) both call and extension for each phase

(e) Upon bulk initialization detector inputs 1 - 8 shall default to the conventional NEMA one to one detector input number to phase number correspondence, placing both call and extensions on those phases. The inputs shall be routed according to these phase assignments provided that the conditions for detector switching are not true.

(11) **Alternate Phase Assignments:** It shall be possible to program each detector input for phase assignment and as to whether the input places:

(a) no call

(b) call only

(c) extension only

(d) both call and extension for each phase

(e) Upon bulk initialization, detector inputs 1 - 8 shall default to the conventional NEMA one to one detector input number to phase number correspondence, placing both call and extensions on those phases. The inputs shall be routed according to these phase assignments provided that the conditions for detector switching are not true.

(12) **Detector Switching:** It shall be possible to program the conditions under which each detector input shall switch to the alternate phases assignments. The conditions for each input shall be defined by the condition of phases 1-8 as to whether each phases, (0) not applicable, (1) has a call, (2) is "on".

(13) **Recall Mode:** Each phase shall be programmable as to (code definitions shall be displayed with each entry screen) the type of recall mode required as listed below:

(a) Memory off

(b) Memory on

(c) Minimum recall

(d) Maximum recall

(e) Minimum and pedestrian recall

(f) Maximum and pedestrian recall

(g) Non-Actuated

(h) Omit

(i) Soft recall or No rest w/detector memory off

(j) Soft recall or No rest w/detector memory on

(14) **Max Mode:** Each phase shall be programmable as to (code definitions shall be displayed with each entry screen) the maximum green value required as listed below:

(a) Max inhibit (code only assignable for background cycle operation)

(b) Max I

(c) Max II

(15) **"No Skip" Phases:** Note that it shall be possible to condition this function to be specific to only those other phases specifically selected (i.e., "Phases always preceded by this one", and "phases always followed by this one").

(16) Red rest.

(17) Conditional re-service/service phases, and phases to be either omitted or serviced twice-per-cycle during timing plans called up at certain times of day.

(18) **Actuated Rest In Walk Operation Phases:** When active, such phase shall rest at the end of its "WALK" interval in the absence of any serviceable opposing call, and shall proceed to time the pedestrian clearance interval as soon as any such opposing call is received and becomes serviceable. The phase shall revert to the beginning of, and proceed to retime the "WALK" interval immediately whenever all opposing calls are lost, so long as the phase remains green and is not under pedestrian omit, whether or not the pedestrian clearance has completed timing.

(19) **Last Car Passage Phases:** The last car passage and subsequent rest intervals shall not be reset or extended by additional vehicle actuations except in dual ring applications where simultaneous gap is also active and the other ring has not yet reached last car passage or rest.

(20) Inhibit gap reset after timeout phases (non-simultaneous gap termination).

(21) **Preemption:** The software shall provide a minimum of handling six unique preempt sequences, and shall operate similarly and provide for transitional timing and signal display to a programmed preempt condition and exit transition timing and display to a programmed

return to normal condition. Preempt input priority and the lower four inputs served on a first come first-served basis.

(22) **Coordination:** The software shall provide a minimum of : Four cycle lengths, Three offsets per cycle, Four splits per cycle, Manual control, Free control and standard interconnect operation.

(23) **Features Associated With The Internal Time Clock Setting Time/Date:** The internal clock shall be accurately programmable to the second. At the time the clock is updated by the user, all internal commands, coordination patterns and offsets shall also be automatically updated.

MANUAL COMMAND - It shall be possible to manually activate the pattern, offset the system command type.

DAYLIGHT SAVINGS CORRECTION - Provisions shall be made for automatic clock correction for the start and end of daylight savings time (DST), including the ability to revise the month and week of month (1-last) of which DST starts and ends from the keyboard Sync Pulse Reference Time (Hour/Minute) - This sync pulse shall be calculated from this point in time. The internal time base clock shall contain at least 50 event command entries which shall be displayed in chronological order but need not be entered in that order.

DAY SCHEDULE - The programming of the internal time base coordination event clock shall be of the type in which any event instruction may be directly associated with one or more days of the week or holiday, and not of the type in which day program schedules must be first programmed, and then associated with the calendar days to which they apply. It shall be possible to program any or all of days 0 through 9 for each TOD command with the following association of each number as defined below:

(1) 0 = Special day program

(2) 1 = Sunday

(3) 2 = Monday

(4) 3 = Tuesday

(5) 4 = Wednesday

(6) 5 = Thursday

(7) 6 = Friday

(8) 7 = Saturday

(9) 8 = Special day program

(10) 9 = Special day program

(c) **2070N 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:

(2) 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.

(3) A communications modem shall be supplied per FAST system requirements. The modem shall be delivered complete with the power cord and a five (5) foot DB25 to DB25 RS232 cable for connection of the EX2 connector on the 2070-8 to the DTE connector on the modem.

(4) 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.

(5) Except when waived by the purchasing agency, the proposed supplier or apparent low bidder shall furnish a complete and fully operational 2070-N, along with the associated communications equipment, within 2 weeks of bid opening, but prior to contract award. This unit will be returned to the supplier/bidder following the demonstration test and functional assessment. Contract awards shall be contingent upon obtaining agency approval on all proposed equipment submitted for evaluation, including any proposed "approved equivalents" of supplied equipment.

(6) 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.

(7) The evaluation by the potential purchasing agency will include, but not be limited to:

(a) proper implementation of all TEES, and the above, specifications.

(b) monitoring the operation in a test cabinet environment.

(c) confirming that the LCD display and the display cover shall be environmentally sealed to keep dust and other particles from entering between them.

(d) verifying operation with short power outages, and momentary surges.

(e) verifying operation with the following provisions of software operation and compatibility.

(8) All 2070N controller units must be compatible and function properly with the latest revision of the Next Phase Intersection Management Software developed by Gardner Transportation Systems.

(9) All 2070N controller units must be compatible and function properly with the ICONS communication package developed by Gardner Transportation System 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 ICONS central software.

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	
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	
Q	
R	
S	
T	
U	
V	
W	
X	
Y	
Z	
a	
b	
c	
d	
e	
f	
g	
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i	
j	
k	
l	
m	
n	
p	
q	
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s	
t	
u	
v	
w	
x	
y	
z	

Pins are user defined, and are to be wired.

623 T.02.04 LOOP DETECTORS:

(a) **General.** 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 plans and specifications, a sensor unit with solid state switching output, and a power source. Loop detectors shall meet the requirements and operate in accordance with the latest edition of the NEMA Standards Publication No.TS1. In addition, the following requirements must be met:

(1) All detectors shall give a constant output with an "open" or failed loop.

(2) All detectors shall be of "shelf mounted" or the "rack mounted" variety, depending upon contract provisions.

(3) All detectors must come fitted with a fully functional LCD display that is used for both monitoring and programming purposes.

(4) All programming must be accomplished with the cover left intact, preferably through the display.

(5) The LCD 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) There must be fully functional delay/extend functions incorporated into the programming. There must also be a phase green override input on the detector.

(7) Presence or pulse modes of operation are required in each detector.

(8) There shall be two or four channels per each loop detector, per contract special provisions.

Loop wires shall be installed after the final layer of asphalt concrete and before any seal coat. The loop or loops shall be installed in slots cut in the pavement and shall be oriented and color-coded or taped in accordance with the Standard Drawings and plans. Sawed slots shall be blown clean of all loose material and dried. Loop wire shall be carefully placed into slot, avoiding damage to the wire insulation. When more than one loop terminates in a pull box, each loop shall have a separate sawed slot for its leads and leads shall be properly marked as shown on the Standard Drawings. A minimum of 5 feet (1.5 meters) shall be provided at both ends of the loop wire to be coiled and stored in the pull box. Sawed slots shall be spaced a minimum of six (6) inches (150 millimeters) apart. The loop system shall be wired with a cable-in-duct assembly, No. 12 AWG minimum, meeting IMSA Specification No. 51-5 as indicated in the Standard Drawings. The loop lead-in cable shall be one (1) pair No. 12 AWG per IMSA Spec. No. 19-2 or 20-2. Each loop system shall have a separate lead-in to the controller cabinet. All loops shall be megohmeter tested.

(b) **Slot Sealant Tests and Acceptance**

1. **Insulation Test.** Insulation tests for each loop to ground shall be in accordance with the latest edition of the NEMA Standards Publication No.TS-1. Insulation test between loops shall not be less than 5 meg ohms.

2. **Sensitivity Test.** The completed loop detector shall be capable of detecting any vehicle that may be licensed by the State of Nevada.

(c) **Installation of Inductive Detector Loop Sealant.** Detector loop sealant shall be either a two component epoxy, or a polyurethane material that cures in the presence of moisture or a hot-melt, rubberized asphalt material and which conforms to the following specifications. Sealant shall be suitable for use in both asphalt concrete and Portland cement concrete pavements.

(1) **Two Component Epoxy Composition:**

Component A	**Parts by Weight**
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	**Parts by Weight**
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
Shore D Hardness, Minimum	50

Color shall match Federal Standard No. 595. The color range shall be 26081 to 26173.

(2) **Polyurethane Sealant**

Property and Results	**Measuring Standard and Conditions**
Hardness (indentation)--65-85	ASTM D 2240 Rex Type A, Model 1700 77 degrees F (25 degrees C) 50% relative humidity
Tensile Strength--500 psi (minimum)	ASTM D 412 Die C, pulled at 20 IPM
Elongation--400%, minimum	ASTM D 412 Die C, pulled at 20 IPM
Flex at -40 degrees F--no cracks	25 mil Free Film Bend (180 degrees C) over ½" Mandrel
Weathering Resistance-- Slight Chalking	ASTM D 822 Weatherometer 350 hrs. Cured 7 days at 77 degrees F (25 degrees C) 50% relative humidity
Salt Spray Resistance--500 psi, minimum tensile; 400% minimum elongation	ASTM B 117, 28 days at 100 degrees F(38 degrees C) 5% NaCl, Die C, pulled at 20 IPM
Dielectric Constant--Less than 25% change over a temperature of -30 degrees C to 50 degrees C	ASTM D 150

Chemical Resistance

Chemical and Results	**Test Method**
De-Icing Chemical--No Effect	ASTM D 471
Gasoline--Slight Swell	ASTM D 471
Hydraulic Brake Fluid--No Effect	ATSM D 471
Motor Oil--No Effect	ASTM D 471
Calcium Chloride (5%)--No Effect	ASTM D 471

Tests conducted on deaerated, 20 mil (0.020"), dry film liquid immersion. 28 days at 77degrees F (25 degrees C).

(3) **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 D 3407, Section 6, 140 degrees F.

Property and Limits	**Measuring Standard and Conditions**
Resilience --60% minimum	ASTM D3405, 77 degrees F.
Softening Point – 200 degrees F.	ASTM D 36
Ductility -- 30 - 55 centimeters	ASTM D 113, 77 degrees F., 5 cm./sec.
Flash Point –575 degrees F.	ASTM D 92, COC
Viscosity -- 2500 - 3500 centipoise (Brookfield)	ASTM D 3236 375 degrees F.

TRAFFIC SIGNALS AND FITTINGS

623 T.02.05 VEHICLE SIGNAL FACES: All vehicle signal faces shall consist of individual signal sections rigidly fastened together. Each section shall have a separate and complete housing. The actual number and type of sections shall be shown on the plans and in accordance with the Standard Drawings. Vehicle signal face shall be installed as indicated on the plans. All vehicle signal faces shall be mounted onto their supports by mounting assemblies in accordance with the requirements of the Standard Drawings. All new vehicle signal faces installed at any one intersection shall be the product of the same manufacturer.

(a) **Optical Units.** Each optical unit shall consist of a lens, a reflector or reflector assembly, a lamp receptacle, and a clear traffic signal lamp. Lenses, reflectors, reflector assemblies, lamp receptacles and wiring, and candlepower distribution shall conform to the provisions in ANSI Standard D-10.1. Reflectors shall be made of silvered glass or of specular aluminum with an anodic coating. All reflectors shall conform to the provisions in ANSI Standard D-10.1.

(b) **Red Light Display Detector.** When specified, a red light display detector shall be provided. The agency will give exact field placement and installation procedures.

(1) Specifications

Physical dimensions - 2.5" x 3" x 1.5"

Power requirement - 120VAC at 2.5 watts

Multi-directional capabilities.

Visibility at distance of approximately 150 to 250 yards.

One year warranty on all parts from date of installation.

(2) Installation

Drill one (1) 25/64 hole in the traffic signal head on which the RLD is to be mounted.

Utilizing a 1/8" brass pipe and fitting, mount the RLD and aim toward direction of viewing.

Wire into the signal head red indication following standard N.E.C.

Seal all openings with an outdoor silicone sealant to prevent moisture and dust form entering the signal head and RLD.

(c) **Lamp receptacles** shall be as specified in Subsection 623 T.02.05 (d), "Electrical Components." Lenses may be made of either glass or an ultraviolet stabilized polycarbonate plastic conforming to the specifications of ASTM Designation D 2473. Plastic lenses shall not distort due to heat from the highest wattage lamp meeting the requirements specified below. Lamps for vehicular signal faces shall conform to the Institute of Traffic Engineers "Standard for Traffic Signal Lamps" and the following. Lamps for the eight (8) inch (200 millimeters) faces shall be 655 lumen rated initial output, 120 volt (60 watt), 8,000 hour rated life, clear, traffic signal lamps. Lamps for the twelve (12) inch (300 millimeters) faces shall be 1,950 lumen rated initial output, 120 volt (165 watt), 8,000 hour rated life, clear, traffic signal lamps.

Krypton-filled, energy-saving lamps must have no less than 80% of total fill gas as Krypton. Energy-saving lamps for the eight (8) inch (200 millimeters) faces shall be 610 lumen rated initial output, 120 volt (60 watt), 8,000 hour rated life, clear, traffic signal lamps. Lamps for the twelve (12) inch (300 millimeters) faces shall be 1,750 lumen rated initial output, 120 volt (135 watt), 8,000 hour rated life, clear, traffic signal lamps.

(d) **Housing.** Each signal section housing shall be either die-cast or permanent mold-cast aluminum conforming to ANSI Standard C-10.1. Maximum height of a signal section shall be ten (10) inches (250 millimeters) for each eight (8) inch (200 millimeters) section and 14-1/16 inches (357 millimeters) for each twelve (12) inch (300 millimeters) section. Each section shall be complete with a one-piece, hinged door mounting for the lens and other parts of the optical system, watertight gaskets, and a simple door-locking device. The optical system shall be so mounted that the various parts may be swung open for ready access or removal. The sections shall be interchangeable and so constructed that sections can be removed or added. There shall be an opening in the top and bottom of each section to receive a 1-1/2 inch (38 millimeters) pipe. All exposed bolts, screws, hinge pins, and door-locking devices shall be stainless steel. All interior screws and fittings shall be stainless steel or approved non-ferrous, corrosion-resistant material. All gaskets, including door, lens and reflector gaskets, but not including lampholder gaskets, shall be of neoprene. Lampholder gaskets shall be of material not affected by heat. The lampholder gasket

will not be required when the lampholder is not in direct contact with the reflector. Each signal section shall be constructed in such a manner that structural failure of the housing will not occur with a wind load pressure of 25 pounds per square foot (1.2 KPa) on the projected area of the complete signal face housing, including backplate and visors. 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.

(e) **Electrical Components.** Lamp receptacles and wiring shall conform to ANSI Standard D-10.1. Each lamp receptacle shall be wired with a white conductor connected to the shell of the lamp receptacle and a black or colored conductor to the bottom or end terminal of the lamp receptacle. These conductors shall, in turn, be connected to a terminal block mounted inside at the back of the housing. The terminal block shall have sufficient screw type terminals to terminate all field conductors and lamp conductors independently, with separate screws. The terminals to which field conductors are attached shall be permanently identified or conductors shall be color coded to facilitate field wiring. Lamp receptacle conductors shall be No. 18, or larger, 600 volt, appliance wiring material (AWM), with 30 mil thickness insulation rated 105 degrees C. or with insulation that conforms to Military Specification MIL W-16878 D, Type B, with vinyl nylon jacket rated 115 degrees C. The manufacturer's name or trademark, conductor size, insulation type letter designation and temperature rating shall be marked on the insulation.

(f) **Visors.** Each section shall be provided with a removable, full-circle, metal visor conforming to ANSI Standard D-10.1 and the Standard Drawings, unless otherwise shown on the plans.

(g) **Directional Louvers.** Where shown on the plans, directional louvers shall be furnished and installed in signal visors. Directional louvers shall be so constructed as to have a snug fit in the signal visors. The outside cylinder shall be constructed of 0.030 inch (0.8 millimeters) nominal thickness, or thicker, sheet steel or the cylinder and vanes shall be constructed of 3003 H14 aluminum alloy of equivalent thickness. Dimensions of louvers and arrangements of vanes shall be as shown on the plans.

(h) **Backplates.** Where shown on the plans backplates shall be furnished and installed on signal heads. Dimensions, materials and installation details shall be as shown in the Standard Drawings. No background light shall show between the backplate and the signal face or between sections. Where a backplate consists of two or more sections, the section shall be fastened with rivets or with aluminum bolts peened after assembly to prevent loosening.

(i) **Signal Mounting Assemblies.** Assemblies for the mounting of signal faces shall consist of 1-1/2 inch (38 millimeters) standard steel pipe and necessary fittings, slip-fitters and terminal compartments. Each terminal compartment shall be fitted with a terminal block containing a minimum of 12 poles, each with 2 screw-type terminals. Each terminal shall be designed to accommodate at least 5 No. 14 conductors. A cover shall be provided on the compartment to give ready access to the terminal block. Where used to bracket-mount a signal the terminal compartment shall be designed to bolt securely to a pole or standard. The dimensions of mounting assembly members between the axis through the center of the terminal compartment, or slip-fitter, shall not exceed 11 inches (275 millimeters), except where required to provide proper signal face alignment or permit programming of programmed visibility signal faces or when otherwise directed by the Engineer. Each mounting assembly shall be oriented to provide maximum horizontal clearance to the adjacent roadway. All mounting assembly members shall be either plumb or level,

symmetrically arranged and securely assembled. Construction shall be such as to permit all conductors to be concealed. Mounting assemblies shall be water-tight and free of sharp edges or protrusions which might damage conductor insulation. For post-top mounting of signals, a slip-fitter shall be used. Slip-fitter shall fit over a 4-1/2 inch (113 millimeters) outside diameter pipe or tapered standard end. Each slip-fitter shall be provided with cadmium-plated steel set screws, arranged as shown on the plans. Each slip-fitter used to post-top mount signals with brackets shall be provided with an integral terminal compartment. Each mounting assembly shall be provided with positive locking, serrated fittings which, 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. Signal faces shall not be installed at any intersection until all other signal equipment, including the controller, is in place and ready for operation at that intersection, except that the signal faces may be mounted if they are not directed toward traffic or if they are covered. During the time period between signal assembly erection and system turn-on, all signal assemblies shall be completely covered by use of six (6) mil minimum thickness black plastic bags.

(j) **Internally Illuminated Street Name Signs.** Internally illuminated street name signs, when specified, shall be 8 feet (2.44 m) long, as indicated on the project drawings, by 22 5/16" (568 mm) high. Sign shall be weather-tight and consist of 6063 T-5 alloy aluminum housing with 0.078" (2 mm) minimum thickness and translucent plastic face plate composed of white wide-angle prismatic translucent reflective sheeting, reverse-screened with manufacturers' recommended green ink and clear coating, applied to a 0.060" (1.5 mm) gage polycarbonate clear substrate. Ballast shall be a 200 ma 120V ballast. Lamps shall be 430 ma cool white. Only one ballast per lamp may be used. Two lamps, spaced six inches apart, are required for each lighted sign.

623 T.02.06 PROGRAMMED VISIBILITY VEHICLE SIGNAL FACES: Each programmed visibility signal face and the installation thereof shall conform to the provision in Subsection 623 T.02.05, "Vehicle Signal Faces," and Subsection 623 T.02.05(g) "Backplates," and Subsection 623 T.02.07(k).05(h), "Signal Mounting Assemblies." Each programmed visibility signal section shall provide a nominal twelve (12) inch (300 millimeters) diameter circular or arrow indication. Color and arrow configuration shall conform to ANSI Standard D-10.1. Each section shall be provided with a sun visor. Each signal section 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. Terminal connection shall permit external adjustment about the mounting axis in 5 degree increments. The signal shall be mountable with ordinary tools and capable of being serviced without tools. Adjustment shall be preset at 4 degrees below the horizontal, unless otherwise specified. 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. 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. Each such signal section shall be capable of having its visibility programmed to achieve the following luminous intensities: a minimum of 3,000 candela on the optical axis, a maximum of 100 candela at from ½ to 2 degrees horizontal from the axis and a maximum of 10 candela at from 2 to 15 degrees horizontal from the axis. 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. 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. Lamp intensity

shall not be less than 97 percent of uncontrolled intensity at 1000 footcandles, and shall reduce to 15 ± 2 percent of maximum intensity at less than one footcandle. The dimming device shall operate over an applied voltage range of 95 to 130 volts, 60 Hz. and a temperature range of -40 to 165 degrees F. (-40 to 73.9 degrees C.). The Contractor shall have a manufacturer's representative program the heads.

623 T.02.07 PEDESTRIAN SIGNAL FACES: Each pedestrian signal face shall conform to the following: Messages shall be Lunar White "WALKING PERSON" and Portland Orange "HAND" conforming to the requirements of the Manual on Uniform Traffic Control Devices. Each pedestrian signal face shall be installed at the location and mounted in the manner shown on the plans. All new pedestrian signal faces installed at any one intersection shall be of the same make and type.

(a) **Types.** Pedestrian Signal faces shall be one of the following types:

TYPE A - Type A signals shall consist of internally illuminated symbols formed by painting the message plate except for the area forming the symbols. The message plate on which the symbols are formed shall be either 1/8 inch (3 millimeter) nominal thickness ultraviolet stabilized polycarbonate plastic with external prismatic pattern, or 3/16 inch (5 millimeter) nominal thickness ultraviolet stabilized plastic with extended prismatic pattern, or 1/8 inch (3 millimeter) nominal thickness glass fiber reinforced plastic. Each compartment shall be illuminated by one 69 watt, 120 volt, 69A21/TS incandescent traffic signal lamp with medium screw base.

TYPE B - Type B signals shall consist of internally illuminated symbols formed by painting the message plate except for the area forming the symbols. The message plate on which the symbols are formed shall be either 1/8 inch (3 millimeters) nominal thickness ultraviolet stabilized polycarbonate plastic with external prismatic pattern, or 3/16 inch (5 millimeters) nominal thickness ultraviolet stabilized acrylic plastic with external prismatic pattern, or 1/8 inch (3 millimeters) nominal thickness glass fiber reinforced plastic. The tubing shall extend horizontally across the compartments and be spaced to provide even illumination of letters symbols.

TYPE C - Type C signals shall conform to the provisions for Type B signals, except message plate and tubing shall be formed into an integral weatherproof plug-in module with a molded case of 3/32 inch (2.5 millimeters) minimum thickness, white acrylonitrile butadine styrene. The message module shall operate in the Type C pedestrian signal head. The module shall not require the use of tools for insertion or removal.

(b) **Housing.** The housing shall be made of 3003 H14 die cast aluminum alloy with smooth finish on both sides. Thickness shall be 1/8 inch (3 millimeters) minimum at the points of support. The housing shall be corrosion resistant and shall provide for easy access to and replacement of all components. All machine screws, studs and washers shall be either nickel plated brass, stainless steel or other corrosion resistant material. Gaskets shall be provided as required to make the housing rain tight and dust tight. Gaskets shall conform to the provisions in ASTM Designation D 1056, Grade SBE42. The housing shall be provided with top and bottom openings for 1-1/2 inch (38 millimeters) pipe. Unused openings shall be closed with watertight closures painted to match the housing, as shown on the Standard Drawings. The housing construction design may be compatible with clamshell mounting hardware.

(c) **Sun Phantoms.** A means to stop sun phantoms while not obscuring the image shall be employed and shall be approved by the Engineer. A full vertical divider strip shall be provided between the

"HAND" and the "WALKING PERSON" indications.

(d) **Conductors.** High voltage wiring between the gas discharge tubes and the secondary side of the transformer shall be made with Gas Tube Sign and Oil Burner Ignition Cable, Type GTO-15 labeled by U.L. Other conductors shall be No. 14, or larger, with 30 mils minimum thickness Type TW insulation.

(e) **Disconnect Switch.** A fused switch consisting of 2 cartridge fuses and a lever for disconnecting the fuses for pedestrian signals shall be mounted within the signal housing to de-energize the transformer primary circuit.

(f) **Terminal Block.** A light duty terminal block shall be mounted in the housing for field wiring.

(g) **Tube Mounting.** Capped ends of gas tubing in Type B signals shall be mounted in approved heat resistant glass electrode housings.

(h) **Finish.** The outside of the housing and hood shall be painted.

(i) **Pedestrian Signal Mounting Assemblies.** Pedestrian signal housing may be mounted with clamshell mounting hardware modified to contain a twelve (12) pole terminal block with compression screw terminal pairs. For post top mounting of pedestrian signals a slip-fitter with an integral terminal compartment shall be used. The requirements for the hardware to post top mount pedestrian signals shall be the same as for post top mounting vehicle signals.

623 T.02.08 FLASHERS:

All flasher signal heads shall be a minimum 12 inch diameter lens.

(a) **Visors.** Each flashing beacon shall be provided with a tunnel type visor.

(b) **Flashing Beacon Control Assembly.** 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. The enclosure shall be as specified in the Special Provisions.

(c) **Circuit Breakers and Switches.** A single-pole 15 ampere circuit breaker shall be installed to control each ungrounded conductor entering the enclosure. A switch to permit manual operation of the sign lighting circuit shall be provided. Switches shall be of the single-hole-mounting toggle type, single-pole, single-throw, rated at 10 amperes, 125 VAC. Switches shall be furnished with an indicating nameplate reading "Auto-Test" and shall be connected in parallel with the load contacts of the photoelectric control circuit. A 15 ampere circuit breaker may be used in place of the toggle switch.

(d) **Flasher.** A 20 ampere solid state flasher shall provide for a 2 circuit alternate operation of beacons.

(e) **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.02.09 STANDARD, STEEL PEDESTALS, AND POSTS:

(a) Standards for traffic signals and roadway lighting, and steel pedestals for cabinets and other similar equipment shall be located as shown on the plans. Workmanship and finish shall be equal to the best general practice of the metal fabrication industry. All welding shall conform to AWS D 2.0, Specification for Welded Highway and Railway Bridges," and to the requirements in this Section.

(b) Types of poles, length of mast arms and height of poles shall be as indicated on the Contract Drawings.

(c) Standards and steel pedestals for controller cabinets shall be constructed of 0.120 inch (3 millimeters) or thicker steel or 4 inch (100 millimeters) standard pipe or conduit, with the top designed for post-top slip-fitter. Standard pipe shall conform to the specifications of ASTM Designations A 53 or A 120.

(d) All ferrous metal parts of standards, with shaft length of 15 feet (4.6 meters) and longer, shall conform to the details shown on the standard drawings, and the following requirements:

Standards fabricated from 0.250 inch (6 millimeters) nominal thickness or thicker materials shall be fabricated from:

(1) Sheet steel conforming to the specifications of ASTM Designation A 283, Grade D.

(2) Sheet steel of weldable grade having a minimum yield, after fabrication, of 40,000 pounds per square inch (276 MPa).

Standards fabricated from 0.179 inch (4.5 millimeters) nominal thickness or thinner material shall be fabricated from sheet steel conforming to the specifications of ASTM Designation A 570, Grade C, or from sheet steel conforming to alternative (2) above. When material conforming to alternative (2) above is used, 0.120 inch (3 millimeters) nominal thickness, or thicker, steel may be used in lieu of 0.135 inch (3.5 millimeters) nominal thickness, or thicker steel.

Standards may be fabricated of full-length sheets or shorter sections. Each section shall be fabricated from not more than 2 pieces of sheet metal. Where 2 pieces are used, the longitudinal welded seams shall be directly opposite one another. When the sections are butt-welded together, the longitudinal welded seams on adjacent sections shall be placed to form a continuous straight seam from base to top of standard. The butt-welded transverse joints shall be strengthened by inserting a metal sleeve at each joint. The sleeve shall be 0.135 inch (3.5 millimeters) nominal thickness, or thicker, steel and made from steel having the same chemical composition as the steel in the standard. The metal sleeve shall have a minimum length of one inch (25 millimeters). The sleeve shall be centered at the joint and have the same taper as the standard with the outside of the sleeve in full contact with the inside of the standard throughout the sleeve length and circumference.

All welds shall be continuous.

The weld metal at the transverse joint shall extend to the sleeve, making the sleeve an integral part of the joint. Longitudinal welds in steel tubular sections will be tested for strength. All exposed welds, except fillet welds and welds on top of mast arms shall be ground flush with the base metal. All exposed edges of the plates which make up the base assembly shall be finished smooth and all exposed corners of such plates shall be neatly rounded to 1/8 inch (3 millimeters) radius, unless otherwise shown on the plans. Shafts shall be provided with slip-fitter shaft caps.

Standards shall be straight, with a permissive variation not to exceed one (1) inch (25 millimeters) measured at the midpoint of a 28.5 foot (7.62 meters), 30 foot (9.14 meters), or 35 foot (10.67 meters) standard and not to exceed 3/4 inch (19 millimeters) measured at the midpoint of an 18 foot (5.49 meters), 20 foot (6.10 meters) or 25 foot (7.62 meters) standard.

Multi-sided poles which have a minimum of sixteen (16) sides and meet the requirements of these standard specifications may be used as directed by the entity's Engineer.

Mast arms for standards shall be fabricated from standard pipe, reamed, free from burrs, and without intermediate splices or coupling curved to the dimensions shown on the standard drawings and shall be provided with raintight connections to shafts. Standard pipe shall conform to the specifications of ASTM Designations A 53 or A 120. Mast arms which have a minimum of sixteen (16) sides and meet the requirements of these standard specifications may be used as directed by the entity's Engineer.

Tie rods for mast arms for standards shall be manufactured of structural steel and pipe as shown on the Standard Drawings. Structural steel shall conform to the specifications of ASTM Designation A 36. Tie rods shall be provided with 2 nuts and 2 lock washers at each end.

Tie rods shall be installed with no kinks or bends.

(e) The cast steel option for slip bases shall be fabricated from material conforming to the requirements of ASTM Designation A 27, Grade 70-40. Other comparable material may be used if written permission is given by the Engineer. The casting tolerances shall be in accordance with the Steel Founder's Society of America recommendations (green sand molding).

(f) Material certifications consisting of physical and chemical properties, and radiographic films of the castings shall be filed at the manufacturer's office. These certifications and films shall be available for inspection upon request.

(g) Anchor bolts shall conform to manufacturers' specifications.

(h) Handholes in the base of standards shall conform to the details shown on the Standard Drawings. Changes in configuration of mast arms will be permitted provided the mounting height and stability are maintained. Handholes shall face away from oncoming traffic.

(i) Holes left in the shafts of existing standards, due to removal of equipment or mast arms, shall be repaired by welding in a suitable disk, grinding smooth, and painting as provided for repairing damaged galvanized surfaces. Welding shall be done only after all combustible materials have been removed.

(j) All standards, steel pedestals and posts required to be galvanized shall be hot-dip galvanized per ASTM A 123.

623 T.02.10.01 LAS VEGAS AREA SYSTEM REQUIREMENTS: (When Specified)

(a) **General.** The Contractor shall furnish each controller cabinet completely configured and equipped for its intended intersection with a local communications interface unit (LCIU) panel, communication unit, and harnesses. The LCIU interface panel and harnesses are to be wired in accordance with the listing and wiring diagram shown on the following two (2) pages. The

communication unit to be used shall be a Sonex Model PTC-122A configured for the Freeway and Arterial System of Transportation.

(b) **LCIU Interface Panel.** The interface panel shall be constructed with the LCIU harnesses wired to the back of the panel, and the cabinet interface wiring to the front of the panel. The interface panel shall have 7 terminal strips having binder screws on the top and solder terminals underneath. All wires of the LCIU harnesses shall be terminated to the solder side of the terminal strips. The terminal strips shall be TRW Cinch Jones series 25-141-Y terminals or equivalent. The LCIU harnesses shall have 3 connector ends to mate with the Sonex PTC-122A unit. The connectors shall be AMP "CPC" series connectors, and wired as shown on LCIU connector plug function tables on the following two (2) pages.

(c) **Interconnect Cable Termination.** Each controller cabinet shall have a telephone terminal block for terminating the system interconnect cable. The terminal block shall be a Reliable Electric #R66B4-25 or equivalent. The first set of terminals shall be used for the TMC phone; the second set shall be used for the JMC phone. The third set shall be data in, and the fourth set shall be data out. The cabinet shall have an ample number of terminal blocks to terminate all system interconnect cables for a given intersection. Each wire pair from the interconnect cable utilized in the cabinet shall have surge protectors installed to shunt power surges to ground (i.e. RX COMM. IN, TX COMM. OUT, VOICE (TMC), and VOICE (JMC)). The surge protector devices shall be TII #317A protectors or equivalent.

PE - J1			
PIN	FUNCTION	FROM	TO
1.02e+08	+115 VAC	TB14-01	
	AC-	TB14-02	
	CHASSIS GROUND	TB14-03	
	1 GREEN (PH 5)	TB17-05	
	2 GREEN (PH 2)	TB17-08	
06	3 GREEN (PH 7)	TB17-11	
07	4 GREEN (PH 4)	TB17-14	
08	5 GREEN (PH 1)	TB16-05	
09	6 GREEN (PH 6)	TB16-08	
10	7 GREEN (PH 3)	TB16-11	
11	8 GREEN (PH 8)	TB16-14	
12	9 WALK (PH 8)	TB17-17	
13	10 WALK (PH 2)	TB17-20	
14	11 WALK (PH 4)	TB16-17	
15	12 WALK (PH 6)	TB16-20	
16	1 YELLOW (PH 5)	TB17-06	
17	2 YELLOW (PH 2)	TB17-09	
18	3 YELLOW (PH 7)	TB17-12	
19	4 YELLOW (PH 4)	TB17-15	
20	5 YELLOW (PH 1)	TB16-06	
21	6 YELLOW (PH 6)	TB16-09	
22	7 YELLOW (PH 3)	TB16-12	
23	8 YELLOW (PH 8)	TB16-15	
24	9 DW FL (PH 8)	TB17-18	
25	10 DW FL (PH 2)	TB17-21	
26	11 DW FL (PH 4)	TB16-18	
27	12 DW FL (PH 6)	TB16-21	
28	1 RED (PH 5)	TB17-07	
29	2 RED (PH 2)	TB17-10	
30	3 RED (PH 7)	TB17-13	
31	4 RED (PH 4)	TB17-16	
32	5 RED (PH 1)	TB16-07	
33	6 RED (PH 6)	TB16-10	
34	7 RED (PH 3)	TB16-13	
35	8 RED (PH 8)	TB16-16	
36	9 DW (PH 8)	TB17-19	
37	10 DW (PH 2)	TB17-22	
38	11 DW (PH 4)	TB16-19	
39	12 DW (PH 6)	TB16-22	
40	OFFSET COMMAND	TB14-16	
41	OFFSET 1	TB14-17	
42	OFFSET 2	TB14-18	
43	OFFSET 3	TB14-19	
44	CYCLE COMMAND	TB14-20	
45	CYCLE 2	TB14-21	
46	CYCLE 3	TB14-22	
47	S.F. 1 COMMON	TB15-17	TB14-4
48	S.F. 1 N.O. (REV 3+4)	TB15-18	TB19-11
49	S.F. 2 COMMON	TB15-19	TB14-4
50	S.F. 2 N.O. (REV 7+8)	TB15-20	TB19-12
51	FLASH COM	TB15-09	
52	FLASH N.O.	TB15-10	
53	FL.MON.(AC+=FLASH)	TB15-08	
54	9 PED CALL (PH 8)	TB17-01	
55	10 PED CALL (PH 2)	TB17-02	
56	AC-	TB14-02	
57	SPARE	TB14-23	
58	LOGIC GROUND	TB14-04	
59	LOGIC GROUND	TB14-04	
60	LOGIC GROUND	TB14-05	
616263	FLASH N.C.	TB15-11	
	+24 VAC	TB14-10	
	SPARE	TB14-24	
	HOLD 2+6	TB16-24	
	HOLD 4+8	TB16-25	

PF - J2			
PIN	FUNCTION	FROM	TO
01	ADDRESS BIT 1	TB15-12	
02	ADDRESS BIT 2	TB15-13	
03	ADDRESS BIT 3	TB15-14	
04	ADDRESS BIT 4	TB15-15	
05	ADDRESS BIT COM.	TB15-16	
06	SYSTEM DET 1	TB18-10	
07	SYSTEM DET 2	TB18-11	
08	SYSTEM DET 3	TB18-12	
09	SYSTEM DET 4	TB18-13	
10	SYSTEM DET 5	TB18-14	
11	SYSTEM DET 6	TB18-15	
12	SYSTEM DET 7	TB18-16	
13	SYSTEM DET 8	TB18-17	
14	LOGIC GROUND	TB14-06	
15	LOCAL DET 1 (PH 5)	TB18-01	
16	LOCAL DET 2 (PH 2)	TB18-02	
17	LOCAL DET 3 (PH 7)	TB18-03	
18	LOCAL DET 4 (PH 4)	TB18-04	
19	LOCAL DET 5 (PH 1)	TB18-05	
20	LOCAL DET 6 (PH 6)	TB18-06	
21	LOCAL DET 7 (PH 3)	TB18-07	
22	LOCAL DET 8 (PH 8)	TB18-08	
23	LOGIC GROUND	TB18-06	
24	COUNT DET 1	TB18-18	
25	COUNT DET 2	TB18-19	
26	COUNT DET 3	TB18-20	
27	COUNT DET 4	TB18-21	
28	LOGIC GROUND	TB14-07	
29	COUNT DET 5	TB18-22	
30	COUNT DET 6	TB18-23	
31	COUNT DET 7	TB18-24	
32	COUNT DET 8	TB18-25	
33	LOGIC GROUND	TB14-07	
34	C.M.FL.(GND=FL)	TB14-11	
35	PRE-EMT 1 IN	TB14-12	OD1-15
36	PRE-EMT 2 IN	TB14-13	
37	11 PED CALL (PH 4)	TB17-03	
38	12 PED CALL (PH 6)	TB17-04	
39	LOGIC GROUND	TB14-08	
40	HOLD ON LINE (HOL)	TB15-01	
41	ADVANCE	TB15-02	
42	YIELD	TB15-03	TB16-23
43	FORCE OFF (R1)	TB15-04	
44	FORCE OFF (R2)	TB15-05	
45	S.F. 3 (REV 1+2)	TB15-06	TB19-13
46	S.F. 4 (REV 5+6)	TB15-07	TB19-14
47	PRE-EMT 1 OUT	TB14-14	
48	PRE-EMT 2 OUT	TB14-15	
49	SPARE	TB14-25	
50	CALL ALL	TB18-09	
51	SIGN ON BIT	TB15-21	
52	SPARE	TB15-22	
53	SPARE	TB15-23	
54	LOGIC GROUND	TB14-08	
55	LOGIC GROUND	TB14-09	
56	SPARE	TB15-24	
57	SPARE	TB15-25	
	PHASE REV 1+2	TB20-11	
	PHASE REV 3+4	TB20-12	
	PHASE REV 5+6	TB20-13	
	PHASE REV 7+8	TB20-14	

PG - J3			
01	COMM INPUT	TB16-01	
02	COMM INPUT	TB16-02	
03	COMM OUTPUT	TB16-03	
04	COMM OUTPUT	TB16-04	

PH = CONTROLLER PHASE
M = TMC MOVEMENT
TB-14
AC+
AC-
CHAS GND
LOGIC GND
CH. FLASH
PREEMPT 1
PREEMPT 2
TB-15
H.D.L.
YIELD
F.D.1
F.D.2
SF 3
SF 4
FL MONITOR
FL COM.
FL N.O.
FL N.C.
ADDR1
ADDR2
ADDR3
ADDR4
ADDR COM.
SF1 COM.
SF1 N.O.
SF2 COM.
SF2 N.O.
SIGN ON BIT
TB-16
M5 PH1 M6 PH6 M7 PH3 M8 PH8 M11 PH4P M12 PH6P
HOLD 2+6
HOLD 4+8
COMM IN
COMM OUT
TB-17
M1 PH5 M2 PH2 M3 PH7 M4 PH4 M9 PH8P M10 PH2P
PED CALLS
TB-18
PHASE CHECKS
LOCAL DETECTION
TB-19
SPECIAL FUNCTIONS
PHASE REVERSALS
DIODES ARE 1N4006 OR EQUIV.
TB-20
TO CONTROLLER BACK PANEL PHASE DETECTORS

623T.02.10.02 GENERAL LAS VEGAS AREA SYSTEM REQUIREMENTS:

(a) **Interconnect cable Termination:** Each controller cabinet shall have a telephone terminal block for the terminating the system interconnect cable. The terminal block shall be a Reliable Electric #R66B4-25 or equivalent. The first set of terminals shall be used for the TMC phone, the second set shall be used for the JMC phone. the third set shall be data in, and the fourth set shall be data out.

(b) The cabinet shall have an ample number of terminal blocks to terminate all system interconnect cables for a given intersection. Each wire pair from the interconnect cable utilized in the cabinet shall have surge protectors installed to shunt power surges to ground i.e. RX COMM. IN, TX COMM. OUT, VOICE (TMC),and VOICE(JMC). The surge protector devices shall be TII #317A protectors or equivalent.

(c) **Interconnect Junction Cabinet:** The Interconnect Junction Cabinet shall be a Tesco Enclosure Class 22-000-NR (43" x 20" x 11") or approved equal, equipped with one (1) Reliable Electric No. R66B4-25 terminal block, or approved equal, having capacity for 25 pairs of No. 22 AWG wire. The terminal block shall be mounted on a painted wood panel secured to the back of the cabinet. 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.

(d) **Preemption.** Intersection cabinets utilizing preemption equipment shall be wired in such a manner that the outputs wired to controller and cabinet functions which are common to the outputs of the LCIU shall have proper isolation devices (relay or diode) to prevent improper operation of either unit. Vehicular preemption unit output shall also be wired to the PRE-EMPT 1 (TB14-12) input to the LCIU for traffic system surveillance purposes.

(e) **Controller Phasing.** It should be noted that for the LCIU inputs related to controller phasing (i.e., green, yellow, red, walk, pedestrian clearance, and don't walk), make reference to compass directions of an intersection rather than actual controller phases.

Controller phase outputs to LCIU inputs wiring for each intersection cabinet shall be based on the compass directions for an intersection. See the phasing table below for configuring all cabinets for a given intersection.

Controller Phase	Direction	LCIU Movement
1	North to West	5
2	Southbound	2
3	West to South	7
4	Eastbound	4
5	South to East	1
6	Northbound	6
7	East to North	3
8	Westbound	8
2 Ped	Southbound	10
4 Ped	Eastbound	11
6 Ped	Northbound	12
8 Ped	Westbound	9

Note that the phasing scheme for the LCIU Movement phase inputs DOES NOT correspond to the Standard NEMA Specifications for controller phasing.

For each intersection, a conversion must take place in the wiring of the LCIU phase return inputs vs. the controller phase outputs. This wiring conversion shall take place on the phase return input terminals of the LCIU Interface Panel.

Intersection controller phasing shall be as defined in Subsection 623 T.02.01(e) or the Special Provisions.

(f) **System Control Functions.**

Hold on line (H.O.L.): The hold on line output shall be wired to the Max Inhibits 1 and 2 of the controller, and the Call to Non-Actuated 1 input of the controller.

Yield: The yield output shall be wired to the hold inputs for controller phases (2 and 6) or (4 and 8) jumper selectable on the terminal block TB16-23/24/25, refer to communication panel drawing on previous page for proper wiring). The yield output shall be active only when the H.O.L. output is active. The yield condition shall be a release of the hold inputs to the controllers.

Force-Off 1 and 2: The Force-Off outputs shall be wired to the Force-Off inputs 1 and 2 of the

controller.

Call All: This output shall be wired through isolation diodes to the Vehicle Call inputs for all phases of the controller. Refer to Subsection 623 T.02.10(e).

Special Function 1, 2, 3, and 4: Refer to communication panel drawing on previous page for proper wiring.

Flash Command: This output shall be wired to the Flash Control line of the cabinet. When this output is active (AC+), the intersection cabinet shall be put in a "flash" mode.

Walk Rest Modifier: This controller input shall be wired to logic ground in the cabinet.

Terminated Functions: The following LCIU output functions shall be terminated on the LCIU interface panel for the capability of future use: Offset Command, Offset 1, Offset 2, Offset 3, Cycle Command, Cycle 2, Cycle 3, Special Function 1 and 2 relay outputs, and Advance.

(g) **Controller Sequence Reversal:** Dual ring controllers shall be capable of phase sequence reversal by applying a ground true signal to connector B. Applying ground true signal to pin B shall cause the controller to reverse sequence phases 1 and 2 (lead-lag). Applying ground true signal to pin W shall cause the controller to reverse sequence phase 3 and 4 (lead-lag). Applying ground true signal to pin X shall cause the controller to reverse sequence phase 5 and 6 (lead-lag). Applying ground true signal to pin v shall cause the controller to reverse sequence phase 7 and 8 (lead-lag). Applying ground true signal to both pins B and X simultaneously shall cause the controller to sequence to phases 2 and 6 before phases 1 and 5 (lagging left turns). Applying ground true signal to both pins W and v simultaneously shall cause the controller to sequence to phases 4 and 8 before phases 3 and 7 (lagging left turns).

(h) **System Control.** A controller operating in a CALL to Non-Actuated mode 1 or 2, with the phase hold active, and the walk rest modifier input active, shall rest in a walk dwell condition until a yield (release of the phase hold input). Upon a yield the controller shall be capable of timing the pedestrian clearance interval followed by the vehicle clearance interval, and all red interval without the need for other input control such as a force-off. The controller shall be capable of responding to yield durations of 500 milliseconds and perform the said function.

(i) **Inputs and Outputs.** Inputs and outputs related to external devices in the cabinet shall be related to the pin assignments prescribed by NEMA and shall not require cabinet modification for interchangeability with NEMA controllers. Any special functions required for controller operation shall utilize spare pins in the input/output connectors as specified by NEMA.

(j) **System Monitoring Functions.** Attention should be given to the input signal level for the inputs of the LCIU. Both D.C. and A.C. inputs are used, following is a list of inputs and their required levels:

D.C. Inputs, Ground True

36 Phase Returns (green, yellow, red, pedestrian)
1 Pre-empt 1
1 Pre-empt 2
1 Conflict Flash
4 Pedestrian Calls
8 Local Detectors
8 System Detectors
8 Counter Detectors

A.C. Inputs (115 VAC)

1 Controller Flash

The local LCIU detector inputs shall be wired to the respective Phase Check outputs of the controller. Refer to Subsection 623.T.02.01 (e) for cabinet controller phasing.

623 T.02.11 PEDESTRIAN PUSH BUTTONS: Where shown on the plans, pedestrian push buttons of substantial tamper-proof construction shall be furnished and installed. The assembly shall be weather-proof and so constructed that it will be impossible to receive any electrical shock under any weather condition.

The pedestrian push button switch shall be a phenolic enclosed precision snap-acting type, switching unit, single-pole, double-throw, with screw-type terminals, rated fifteen (15) amperes at one hundred twenty-five (125) volts, AC, and shall have the following characteristics:

(a) Switching unit shall have a stainless steel plunger actuator and shall be provided with U-frame to permit recessed mounting in push button housing.

(b) Switch shall have an operating force of 0.56 to 0.81 lbf (2.5 to 3.6 N) and have a minimum release force of 0.25 lbf (1.1 N).

(c) Pre-travel shall be one sixty-fourth (1/64) inch (0.4 millimeter) maximum.

(d) Over-travel shall be seven thirty-seconds (7/32) inch (5.5 millimeter) minimum.

(e) Differential travel shall be four ten-thousandths (0.0004) to two one-thousandths (0.002) inch (0.01 to 0.05 millimeter).

Push buttons shall be 2 inch (51 millimeter) minimum diameter.

Where a pedestrian push button is attached to a pole, the housing shall be shaped to fit the curvature of the pole and secured to provide a rigid installation. Saddles shall be provided to make a neat fit when required.

Where a pedestrian push button is to be mounted on top of a two and one-half (2 ½) inch (63 millimeter) diameter post, the housing shall be provided with a slip-fitter fitting and screws for securing rigidly to the post.

Push button and sign shall be installed on crosswalk side of the pole.

Arrows on push button sign shall point in same direction of corresponding crosswalk.

Mounting height of the pedestrian push button shall be per the latest published edition of the ADA Guidelines.

623 T.02.12 EMERGENCY VEHICLE PRIORITY CONTROL SYSTEM (INTERNAL PREEMPTION):

(a) **System Description.** The system employs data-encoded optical communication to identify the presence of designated priority vehicles, cause the traffic signal controller to initiate a specific preprogrammed preemption procedure, and if required by the Engineer, record the vehicle by classification and identification number at particular intersections. The matched set of components which make up the system will cause the existing traffic controller to be manipulated upon recognition of the signal from the vehicle. This communication is effective to the optical detectors at or near the intersection over a line-of-sight path. The system shall require no action of the vehicle operator other than the operation of the "emitter ON" switch located in the vehicle. The switch is to remain "ON" until the end of the emergency run. The system shall operate on a first-come, first-served basis or on a selected priority. The higher priority requests will override lower priority requests. The system shall be designed to yield to other priority demands such as railroad drawbridge etc. The system shall interface with existing traffic signal controllers without compromising normal operation or existing safety provisions. The Priority Control System shall consist of a data-encoded optical emitter, optical detectors, optical detector cable, and priority control unit.

(b) **Matched System Components.** To assure desired performance, the system shall provide the synergy of the four principal components, matched and proven through integrated testing and extensive functional experience. The matched component system shall offer compatibility with all types of traffic signal controllers. Matched components provide future compatibility of all priority control elements.

(1) **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.

(2) **Optical Detector.** Shall be a light-weight, weatherproof, adjustable, bi-directional optical detector assembly. Internal circuitry shall transform optical energy from the optical emitter assembly into electrical signals for delivery (up to 1000 feet (305 meters) via optical detector cable to the priority control unit.

(3) **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.

(4) **Priority Control Unit.** This equipment shall provide interface between the optical detectors and the cabinet controller unit and provide the following functions while not compromising the existing fail-safe provisions:

(a) Sufficient Power to all optical detectors required for the intersection.

(b) Differentiation of signals by optical detectors from one or more emitters on a first-come, first-served basis.

(c) Output signals to the cabinet 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 to be terminated on a separate panelthen wired to the controller back panel.

(e) Smooth transition to non-priority operation upon passage of the vehicle through the intersection.

(f) As required by the Engineer at designated intersections, storing up to 100 of the most recent priority control calls in non-volatile memory and retaining the record if power terminates.

(c) **System Operation.**

(1) Priority control system shall be activated by an optically transmitted signal capable of recognizing and discriminating an Optical Emitter flash rate of (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.

If a second class of preemption is used, it shall respond to a flash rate of (Class I) 9.63855 Hz ± 0.0014 Hz.

(2) The system shall cause the traffic controller to select from normally available green phases by activation of a combination of its inputs such as:

(a) channel "A" active

(b) channel "B" active

(c) channel "C" active

(d) channel "D" active

(3) The system shall not require modification or replacement of the existing controller unit beyond adding the necessary system hardware.

(4) The system shall maintain adequate minimum traffic signal displays when priority control is active.

(5) The system shall provide for up to 3 optical detectors to be connected to each channel to accomplish the following:

(a) To provide adequate optical emitter detection range to allow sufficient time to deliver the desired traffic signal display in accordance with the minimum times required to terminate non-desired traffic signal displays.

(b) To provide continuous line-of-sight contact between the data-encoded emitter and the optical detector units.

(6) Abnormal sequence of traffic signal displays will not occur.

(7) Transitions from green to red without the appropriate clearance intervals will not occur.

(8) The system shall allow the traffic signal controller to resume normal timing operation after the desired signal display is obtained and optical signals have ceased for an appropriate period.

(9) The system shall not attempt controller manipulation nor retain priority vehicle calls during periods of "Intersection Flash" operation.

(d) **System Component Specification.**

(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 three types of information:

(1) The base frequency as established in Subsection 623 T.02.12 (c)(1).

(2) The vehicle classification and identification code. The data-encoded emitter shall be capable of setting a minimum of 10 different classifications with 1000 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 span wire.

(d) The unit shall accept optical signals from four directions (northbound, southbound, eastbound, and westbound) and each shall provide an electrical output signal.

(e) The unit shall include a design feature to allow aiming of the two optical sensing inputs forskewed approaches or slight curves, and may be field verified.

(f) The unit shall be responsive to the optical emitter at a distance of 1800 feet (550 meters).

(g) The unit shall be capable of providing the necessary electrical signal to the priority control unit through up to 1000 feet (305 meters) of optical detector cable.

(3) **Optical Detector Cable.** The cable must guarantee delivery of the necessary quality signal from the optical detector to the phase selector over a non-spliced distance of 1000 feet(305 meters).The cable shall have 3 No. 20 AWG (minimum gage) stranded copper conductors and

one bare, individually tinned, copper color coded as follows:

(a) Orange for delivery of optical detector power (+)

(b) Bare for optical detector power return (-)

(c) Yellow for optical detector signal

(d) Blue for a second optical detector signal

(4) **Priority Control Equipment.** The Emergency Vehicle Priority Control System shall be a self-contained stand alone unit which shall recognize input signals for up to four separate channels of emergency vehicle preemption and to contain the following major parts:

(a) A card rack which shall contain the power supply (to be powered from AC mains in cabinet, and contain its own internal power supply to feed Optical Detectors), plug-in card edge connectors, appropriate plugs and connector harnesses to connect the whole unit to the cabinet wiring assembly.

(b) **Priority Control Discriminator Plug-in Module:** This module Unit shall be a plug-in four-channel device designed to be used with optical Emitters and Detectors. It shall be capable of recognizing and discriminating Optical Emitter flash rates, as described in Subsection 623T.02.12 (c), "System Operations", via Optical Detectors connected to each channel. If required by the Engineer in contract provisions at particular intersections, a data-encoded module may be used which is capable of recognizing and distinguishing data-encoded optical signals and shall meet the following requirements:

(1) 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:

* Classification

* Identification Number

* Priority level

* Direction

* Call Duration

* Final greens at end of call

* Duration of final greens

* Time and date call ended (second, minute, hour, day, month, year)

* Intersection near or far, indicating passage of the priority vehicle through the intersection

(2) Unit shall be capable of three levels of discrimination of data-encoded optical signals as described in 623 T.02.12 (d)(1)(b).

(3) Interface with the cabinet shall be wired as described in 623T.02.02

(e) **Reliability.** All equipment supplied as part of the optical priority remote traffic control system intended for use in the controller cabinet shall meet the electrical and environmental specifications spelled out in the NEMA standards publication TS2, Type 2 or later version.

623T.02.13 TRAFFIC SIGNAL VIDEO IMAGE DETECTION SYSTEMS: (Agency Specified)

623 T.02.14 UNINTERRUPTIBLE POWER SUPPLY SYSTEMS: (When Specified)

(a) **General:** Uninterruptible Power Supplies (UPS) are used to operate the traffic signal upon the loss of source power to the traffic signal controller, cabinet, and equipment. These are also referred to as "battery backups." The units shall conform to the following specifications:

(1) The entire UPS shall be able to installed in its entirety inside a type "R" traffic signal cabinet. It could be a shelf or wall mounted unit, not a rack mounted unit.

(2) All units must be rated from -40°C to 74°C. This includes both the batteries and the microprocessing control units.

(3) The output of the UPS must be pure, sinusoidal power. "Square Wave Power" or "Step-Wave" power will not be acceptable.

(4) All systems must come supplied with maintenance-free batteries that will be used to operate the unit in power outage situations. The typical run time for the batteries supplied shall be 8 hours with a 300 watt load placed on it.

(5) The operating mode of any UPS utilized in power failure situations shall be flashing red for the traffic signal, while still providing true sine-wave power for the modem or communication devices.

(b) (1) AC Line input switch/circuit breaker.

(2) DC Battery output switch/circuit breaker.

(3) AC Input safety fuse.

(4) AC Power pilot light.

(5) Load #1 flasher pilot light.

(6) Load #2 flasher pilot light.

(7) Time Delay dip switches.

(8) Battery Event Counter w/Manual Reset.

(9) Battery run timer.

(10) Battery Voltmeter (optional).

(11) Convenience Receptacle (optional).

CONSTRUCTION

623 T.03.01 PAINTING:

(a) The stainless steel latching devices shall not be painted. The preparation and finishing of new equipment shall be as follows:

(b) Galvanized and non-ferrous surfaces to be painted, 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).

(c) If an approved primer coat has been applied by the manufacturer and is in good condition, additional primer application by the Contractor, other than for repairs, will not be required.

(d) All traffic signal standards shall be steel poles which have been hot-dip galvanized by the manufacturer in accordance with Subsection 715.03.01. If required in the Special Provisions, standards shall also be painted as specified therein.

Directional louvers and backplates shall be painted flat black.

(e) Cabinets or controller boxes shall conform to Section 623T.02.01.

(f) 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.

(g) 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. Immediately after cleaning, all bare metal shall be primed as appropriate, or as specified for new material. A finish coat shall then be applied over newly primed areas followed by one or more finishing coats over the entire surface.

(h) Blast cleaning of galvanized metal surfaces in good condition, as determined by the Engineer, will not be permitted.

(i) Paint coats may be applied either by hand brushing or by approved spraying machines in the hands of skilled operators, except that no spraying shall be done at the jobsite. The work shall be done in a neat and workmanlike manner, and the Engineer reserves the right to require the use of brushes for the application of paint should the work done by the paint spraying machine prove unsatisfactory or objectionable, as determined by the Engineer.

(j) 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 one coat of paint shall be corrected to the satisfaction of the Engineer before the succeeding coat is applied.

(k) The final coat shall present a smooth surface, uniform in color, free of runs, sags, excessive brush marks and tiger-striping.

STREET LIGHTING SECTION

MATERIALS

623 L.02.01 MATERIALS, STANDARDS AND POSTS:

(a) Standards and posts for street lighting standards, cabinets, etc. shall be as specified in the Special Provisions or as shown on the plans or the Standard Drawings and shall conform to the following requirements:

The street lighting standard shall consist of a continuous tapered round steel pole assembly, base cover, mast arm, pole top, anchor rods and necessary bolts, nuts and washers. Workmanship and finish shall be equal to the best general practice of modern metal fabrication.

(b) **Pole Assembly.** The pole shaft shall be of round cross section with a minimum outer diameter of eight (8) inches (200 millimeters) at the base and shall uniformly decrease in diameter at the rate of 0.14 inches per foot (3.5 millimeters per 300 millimeters) of length. The shaft shall be formed from not more than three (3) pieces of sheet steel. Only one (1) piece of sheet steel shall be used for each section.

A maximum of two (2) circumferential welds and one (1) longitudinal weld will be permitted in assembling the shaft. Where the sections are butt welded together, the welded seams of adjacent sections shall be placed to form a continuous weld from the base to top of standard. After welding, all surplus weld material or protrusions shall be ground off smooth to present an indiscernible joint.

Ground joints shall maintain the strength of the surrounding unwelded metal. Butt joints shall be reinforced in the corresponding gage by three (3) inch (75 millimeters) wide tapered sleeves of the same composition as the steel in the standard. The sleeves shall be centered at the joint and have the same taper as the standard so that the outside of the sleeve is in full contact throughout its length and circumference. All welds shall be continuous. Welding shall be done by A.W.S. certified welders and shall conform to the best accepted practice. Longitudinal welds shall be performed by the submerged arc process. Exposed welds, except fillet welds, shall be ground flush with the base metal.

Standards shall be straight, with a permissive variation not to exceed 3/4 inch (19 millimeters) measured at the midpoint of 30 foot (9.1 meters) standards or poles, or ½ inch (13 millimeters) measured at the midpoint of 20 foot (6.1 meters) standard or poles. Standards shall be round with an out-of-round variation not to exceed 1/8 inch (3 millimeters).

Sheet steel used shall have an initial minimum yield of 48,000 psi (331 MPa), or which after forming or cold rolling shall develop a minimum of 48,000 psi (331 MPa), in accordance with ASTM Designation E 8, and shall be of not less than #11 gage (0.119 inch) (3 millimeters), #7 gage (0.179 inch) (4.5 millimeters) or #3 gage (0.250 inch) (6 millimeters) as called for on the plans.

(c) The pole base plate shall be a 1 inch (25 millimeters) thick by 11-1/2 inches (290 millimeters) square steel plate for #11 gage standards and 1-1/8 inch (29 millimeters) thick by 11-1/2 inch (290 millimeters) square steel plate for #7 gage standards, conforming to ASTM Designation A 27, Grade 65-35 cast steel or ASTM Designation A 36 steel plate or A 283, Grade D steel plate slotted

to accommodate four (4) one (1) inch (25 millimeters) or 1-1/8 inch (29 millimeters) anchor rods equally spaced on an eleven (11) inch (275 millimeters) bolt circle. All exposed edges of plates which make up the base assembly shall be finished smooth and all exposed corners of such plates shall be neatly rounded to 1/8 inch (3 millimeters) radius unless otherwise shown on the plans. The pole shaft shall telescope through the base plate and shall be secured by two continuous welds, one on the inside at the bottom of the plate and the other on the outside on top of the plate.

(d) The luminaire arm shall be formed with a single radius bend from two (2) inch (50 millimeters) schedule 40 pipe 8 feet (2.45 meters) in length, conforming to ASTM Designation A 120. A minimum straight portion of five (5) inches (125 millimeters) shall be provided to attach the luminaire. The shaft end of the arm shall have a weather resistant steel fitting, welded in place. The fitting shall be shaped to lock on the shaft fitting by gravity and shall be secured by a minimum of one cap screw.

(e) When twin luminaire arms are specified on the plans, they may be tapered, or two inch pipe arms 8 feet (2.45 meters) in length, conforming to ASTM Designation A 570, Grade A may be used. For tapered arms, the luminaire end shall consist of a welded two (2) inch (50 millimeters) schedule 40, 10-1/2 inch (268 millimeters) length pipe with a 7-1/2 inch (190 millimeters) exposed tenon, and the opposite end shall have a welded three bolt weather resistant steel fitting as called for on the Street Light Standard Drawing No. 314. The bolts shall be high strength conforming to ASTM Designation A 325 high strength bolts.

(f) A four (4) inch (100 millimeters) by six and a half (6-1/2) inch (165 millimeters) handhole reinforced frame and slip-resistant indented type cover located eight (8) inches (200 millimeters) from the base plate shall be provided. The cover shall include a bar with one weather and vandal resistant 1/4 inch (6 millimeters) Hex socket head screw. The pole base cover shall be two or four piece ferrous metal, hot-dip galvanized; shall cover the base plate completely; and shall be firmly secured.

(g) **Finish.** Pole assemblies and luminaire arms shall be hot-dip galvanized in conformance with ASTM Designation A 123.

(h) **Tests.** The steel used in standards shall be tested in accordance with ASTM Designation A 370, paragraph 13.1. The supplier of the standards shall furnish certified notarized test reports showing the yield strength after fabrication of material used in the shaft and subsequent standards shall conform to this certification. At the discretion of the Engineer random samples may be selected of the finished product for testing purposes and tests shall be carried out and reports furnished at no additional cost.

(i) **Tests, Deflection of Standards.** The standard, complete with modification, shall sustain a horizontal test load of 500 pounds (227 kilograms) applied eighteen (18) inches (450 millimeters) 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% of the pole shaft length measured from point of load application to the base plate.

This deflection includes a maximum allowance of ½ inch (13 millimeters) for testing and permanent set.

(j) **Tests, Deflection, Luminaire Brackets or Mast Arms.** Luminaire brackets or mast arms and related pole attachment devices shall sustain a vertical load of 100 pounds (45 kilograms) applied

within three (3) inches (75 millimeters) of the luminaire end of the support with the support attached to a rigid structure. The vertical deflection shall not exceed 5-1/2% of the bracket or mast arm length. The luminaire brackets or mast arms and related pole attachment devices shall sustain a transverse horizontal load of 50 pounds (22.7 kilograms) and a vertical load of 50 pounds (22.7 kilograms) applied within three (3) inches (75 millimeters) of the luminaire end of the support with the support attached to a rigid structure. The horizontal deflection shall not exceed 10% of the bracket or mast arm length, and the pole attached devices shall not develop any looseness within the specified loading range.

(k) **Tests, Deflection of Davit Standards.** The davit standard, complete with modification shall sustain a horizontal test load of 500 pounds (227 kilograms) applied to the vertical shaft at the point at which the davit portion becomes tangent. This load may be applied in any direction and the shaft shall sustain this load without failure of any component part, and with a deflection of not more than 7-1/2% of the length of the shaft measured from the point of load application to the base plate. This deflection includes a maximum allowance of ½ inch (13 millimeters) for testing methods and permanent set.

(l) Standards and fittings shall be cleaned and finished as specified in Subsection 623 L.03.01. After erection, all outside surfaces shall be cleaned free from dust, dirt and oil, and all abraded and damaged areas shall be neatly refinished. Tie rods, nuts, washers, and other miscellaneous ferrous parts shall be galvanized before installation by the hot-dip process conforming to ASTM Designation A 153.

(m) Posts, poles, standards, and cabinets shall not be erected until the foundation has set at least seventy-two hours, and shall be plumbed or raked, as ordered by the Engineer.

623 L.02.02 ANCHOR BOLTS: Anchor bolts shall conform to ASTM Designation A 576, Grade C-1035 for a minimum yield strength of 48,000 psi (331 MPa) and shall be provided with two nuts and two washers of 2-1/2 inch (63 millimeters) minimum O.D. Not less than twelve (12) inches (300 millimeters) of the upper end of the anchor rods and all nuts and washers shall be galvanized by the hot-dip process conforming to ASTM Designation A 153, or cadmium plated with type NS coating conforming to ASTM Designation A 165. After galvanizing or plating, the bolt threads shall accept galvanized or plated standard nuts without requiring tools or causing removal of protective coating.

Unless shown otherwise on the Drawings, anchor bolts for #7 gage standards and posts shall be 1-1/8 inch by 40 inches by 4 inches (3 by 1000 by 100 millimeters) and for standards and posts lighter than #7 gage shall be 1 inch by 36 inches by 4 inches (25 by 900 by 100 millimeters). The upper six (6) inches (150 millimeters) of anchor bolts shall be threaded. Plumbing of standards shall be accomplished by adjusting the nuts before the foundation is finished to one (1) inch (25 millimeters) minimum above final grade. Shims or other similar devices for plumbing or raking will not be permitted.

623 L.02.03 LIGHTING LUMINAIRES: The standard luminaire shall be of the high pressure sodium type, horizontal burning, cobra head style, in wattages specified in the plans. The luminaire shall consist of a precision diecast aluminum housing, globe ring and ballast module door. The lower portion of the luminaire shall be composed of two parts. One part shall contain the optical assembly and the other part shall be the ballast module door. The ballast module door shall contain all the major electrical components and shall be capable of being lowered after loosening one or two non-corrosive captive screws. The ballast shall be pre-wired to the lamp socket and terminal board. The ballast module door assembly shall be removable and

replaceable by the use of quick disconnect plugs. The refractor holder shall have an automatic latch with a safety catch on the house side. The holder shall be forced upward at the streetside by spring pressure against the gasket seal when in the closed and latched position.

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. The slipfitter shall be capable of adapting to 1-1/4 inch (33 millimeters) through 2 inch (50 millimeters) pipe bracket without rearrangement of parts and be adjustable +5 degrees from horizontal.

The optical assembly shall consist of an aluminum reflector, prismatic acrylic refractor for 100 watt luminaires, and borosilicate prismatic glass refractor for 150 through 750 watt luminaires, or when specified shall be of polycarbonate resin vandal resistant material. The socket shall have a non-cantilevered, spring loaded contact, and horizontal and vertical socket adjustment shall be provided within the reflector. The optical assembly latch shall be easily operated while wearing lineman's gloves, providing access to refractor-reflector and lamp. All ballast components shall be internally mounted on a down opening diecast ballast module door and easily removable and replaceable through the use of quick disconnect plugs. In 100 watt and 150 watt luminaires the starting aid shall be the plug-in type, removable without the use of tools. The ballast shall be pre-wired to the lamp socket and terminal board.

The ballast shall be capable of starting and operating a high pressure sodium lamp of the wattage specified in plans from a nominal 120 or 240 volt, 60 Hz power source, as indicated, within the limits specified by the lamp manufacturer. The ballast, including starting aid, must protect itself against normal lamp failure modes. The ballast shall be capable of operation with the lamp in an open or short circuit-condition for six months without significant loss of ballast life. 150 W Luminaires shall utilize 55 v. rated HPS lamps only.

The fixture manufacturer shall submit a statement to the effect that the ballast to be furnished is in full compliance with lamp-ballast specifications available to the fixture manufacturer from the lamp manufacturers at the time of bidding. Original manufacturer fixtures only are acceptable utilizing only new components. Rebuilt or remanufactured fixtures are not acceptable.

For nominal line voltage and nominal lamp voltage, the ballast design center will not vary more than 5% from rated lamp watts. At any lamp voltage, from nominal through life, lamp wattage regulation spread at that lamp voltage shall not exceed 18% for ± 10% line voltage variation. The ballast shall be a regulator type.

The luminaire manufacturer shall supply ballast electrical data, and lamp operating volt-watt traces for nominal and ± 10% rated line voltage to verify ballast performance and compliance with lamp specifications for the rated life of the lamp. The ballast must reliably start and operate the lamp in ambient temperatures down to -30°F for the rated life of the lamp. Ballast primary current during starting must not exceed normal operating current. The lamp current crest factor shall not exceed 1.8 for ± 10% line voltage variation at any lamp voltage, from nominal through life. The power factor of the lamp-ballast system shall not drop below 0.90 for ± 10% line voltage variations at any lamp voltage from nominal through life. The ballast design shall be such that the normal manufacturing tolerance for capacitors of ± 6% will not cause more than a ± 8% variation in regulation throughout rated lamp life for nominal line voltage.

When called for on the plans, a cut off luminaire shall be furnished for intersection and street lighting. This luminaire shall meet all of the above applicable specifications along with providing a true 90° cutoff and shielding with an Alzak aluminum reflector, a heat and impact resistant flat glass lens, a 2-position adjustable socket holder and a porcelain mogul screw shell socket with lamp grips. The optical system shall contain a filtering system to trap particulate contamination. Maximum candela at 80° shall be 9 and maximum candela at 90° shall be 0. The light distribution shall be ANSI/IES/MC/Type III.

Labels shall be in accordance with ANSI standards. All luminaires shall be approved by the Engineer.

Luminaires shall be leveled and adjusted in accordance with instructions of the manufacturer or as directed by the Engineer.

Unless otherwise specified on the Plans, in the specifications or in the special provisions, all streetlighting luminaires shall be furnished complete with high pressure sodium high intensity discharge streetlighting 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

The Contractor shall guarantee that all lamps which fail within one year under normal operating conditions shall be replaced at no cost to the Contracting Agency.

623 L.02.04 FUSEHOLDERS AND FUSES: (For multiple street lighting circuits) Fuseholders and fuses shall be installed in the bases of all lighting standards and shall be accessible through the handholes for the lighting standard bases. The fuseholders shall be single pole for 120 volts or double pole for 240 volts, waterproof type without the use of tape, with integral or separate conductor insulating boots, and must be certified by an independent nationally recognized testing facility. The single pole fuseholder shall consist of two sections, a line side section, and a load side section. When the line and load sections are mated per instructions from the manufacturer, the fuseholder body and terminals shall be vapor and waterproof. The design shall be such that if the fuseholder is reclosed under load, any arc will be confined within the body when a proper sized fuse is seated firmly in the terminals.

The double pole fuseholder shall contain two fuseholder chambers and consist of two sections, a line side section and a load side section. When the fuseholder is opened, both load side connections shall be simultaneously disconnected from the live side. The fuseholders shall be 30 amperes, 600 volt rating and accept 13/32 inch (10 millimeter) diameter by 1-1/2 inch (38 millimeter) fuses of the ampere rating specified in the contract. Glass, paper or indicating type fuses are not acceptable.

623 L.02.05 LOW VOLTAGE UNDERGROUND STREET LIGHTING SYSTEM: Unless otherwise specified on the plans, the low voltage lighting system shall be single phase, two wire, 240 volt multiple. The two wire system shall consist of two insulated 600 volt THW conductors of the specified gage and a green #8 THWN equipment bonding conductor as shown on the plans and shall bear the U.L. label. The service panel shall be 100 ampere, unless otherwise specified, and shall be wired for 120-240 volt with a full size neutral.

Pole and Arm Cable. Unless otherwise specified on the plans, the cable from the base of the lighting standard to the luminaire shall be two conductor No. 10 AWG plus ground, 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 PHOTO-ELECTRIC CONTROLS: Photo-electric controls shall be one of the types below, as shown on the plans or as specified in the Special Provisions. The photo-electric control shall be capable of switching multiple lighting system directly or by a separate contactor as indicated on the plans.

For series lighting systems the photo-electric control shall be capable of switching series lighting systems through a high voltage controller.

Types of photo-electric controls shall be as follows:

(a) **Type I.** Type I photo-electric control shall consist of a photo-electric unit and a contactor in a single weatherproof housing.

(b) **Type II.** Type II photo-electric control shall consist of a photo-electric unit installed at the top of the first lighting standard from the service point, and controlling the lighting contactor in the pad mounted service and control cabinet. A by-pass switch shall be included to permit manual operation of the lighting system contactor. Unless otherwise specified in the plans, specifications, or in the Special Provisions, the photoelectric units shall be for 120 volt operation on two or three wire single phase multiple lighting systems.

(c) **Equipment Details.** The photo-electric unit shall consist of a light sensitive element connected to a control relay. 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 and 1.1 footcandles.

The unit shall be so designed that a failure of any electrical or electronic component will energize the lighting circuit. The photo-electric unit shall be mounted at the top of the standard designated on the plans and shall be oriented as directed by the Engineer.

(d) **Contactor.** The contactor shall be constructed in accordance with NEMA standards for lighting contactors and shall have contacts rated to switch the specified lighting load. Contactor shall be the mechanical armature type. The mechanical type shall consist of an operating coil, a laminated core, a laminated armature, contacts and terminals. Contacts shall be silver alloy.

(e) **Housing.** The contactor may be either integral with the photo-electric unit or may be located externally from it. When located externally, the contactor shall be housed in a suitable NEMA type 3 raintight enclosure with hasp for a padlock. The raintight enclosure shall be mounted on the same standard as the photo-electric unit at a height of approximately 28 feet (8.5 meters) above the base. All contactors housings shall be approved by the Engineer prior to installation.

(f) **Wiring.** Conductors between the photo-electric 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: Unless otherwise specified in Subsection 623 L.02.01(g), all metal parts, fittings, signal heads, posts, pedestals, standards, cabinets, controller boxes, etc., shall be prepared and painted according to these specifications. Types of paints to be used shall be as specified in Section 714, "Paint and Pavement Markings."

CONSTRUCTION

623 L.03.01 GENERAL: The preparation and finishing of new equipment shall be as follows:

Galvanized and non-ferrous surfaces to be painted, shall be cleaned and coated with Vinyl Wash Primer, conforming to the requirements of Subsection 714.03.01(b). Ferrous metal surfaces shall be cleaned and immediately coated with the primer specified above.

If an approved primer coat has been applied by the manufacturer and is in good condition, additional primer application by the Contractor, other than for repairs, will not be required.

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.

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. Immediately after cleaning, all bare metal shall be primed as appropriate, or as specified for new material. A finish coat shall be then applied over newly primed areas followed by one or more finishing coats over the entire surface. Blast cleaning of galvanized metal surfaces in good condition, as determined by the Engineer, will not be permitted.

Paint coats may be applied either by hand brushing or by approved spraying machines in the hands of skilled operators, except that no spraying shall be done at the jobsite. The work shall be done in a neat and workman like manner, and the Engineer reserves the right to require the use of brushes for the application of paint should the work done by the paint spraying machine prove unsatisfactory or objectionable, as determined by the Engineer.

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 one coat of paint shall be corrected to the satisfaction of the Engineer before the succeeding coat is applied.

The final coat shall present a smooth surface, uniform in color, free of runs, sags or excessive brush marks.

Flaws in the appearance of galvanized components (i.e., tiger- or zebra-striped) shall be cause for rejection by the owner.

623 L.03.02 BONDING AND GROUNDING: 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. All non-metallic conduit shall contain a green grounding conductor as specified herein, except if none is specified, this conductor shall be sized according to Article 250 of the National Electrical Code.

Bonding and grounding jumpers shall be copper wire or copper strap of the same cross-sectional area as No. 4 AWG for series and multiple lighting circuits. Bonding of standards and foundations shall be accomplished by means of a bare No. 4 copper wire attached to each anchor bolt and to a ½ inch (13 millimeters), or larger, brass, cadmium-plated or bronze bolt installed on the lower lip of the lighting standard handhole as shown on the Standard Drawings. The No. 8 green grounding conductor from the conduit and the No. 10 luminaire ground shall be connected to the No. 4 grounding conductor. Grounding of conduit and neutral at the service point shall comply with the applicable sections of Article 250 of the National Electrical Code.

623 L.03.03 TESTING: Prior to completion of the work, the Contractor shall cause the following tests to be made on all lighting circuits, in the presence of the Engineer:

(a) Test for continuity of each circuit

(b) Test for grounds in each circuit with a 500 volt megohmmeter with a minimum acceptable reading of 200 megohms

(c) A functional test in which it is demonstrated that each and every part of the system functions as specified or intended herein

(d) A high-pot test when specified

(e) Before acceptance of the work and after adjusting the luminaire lamp sockets to produce the I.E.S. light distribution patterns specified in the plans, the Contractor shall provide the Engineer with footcandle readings showing average to minimum ratios in accordance with I.E.S. standards recommended for Average Maintained Horizontal Illumination for roadways shown in Standard Drawing No. 300.

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: The unit of measurement for "Traffic Signal Systems," "Street Lighting Systems," and "Traffic Signal and Street Lighting Systems," will be lump sum or unit price.

The quantity of "Conduit for Future Conductors," will be measured for payment by the linear foot (linear meter) of conduit complete and in place.

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

BASIS OF PAYMENT

623.05.01 PAYMENT: The lump sum price or unit prices paid for traffic signal systems, street lighting systems, sign illumination systems, 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.

Full compensation for all additional materials and labor, not shown on the plans or specified, which are necessary to complete the installations of the various systems, shall be considered as included in the prices paid for the systems, or units thereof, and no additional compensation will be allowed therefor.

The accepted quantities of "Conduit for Future Conductors," measured as provided in Subsection 623.04.01, "Measurement," will be paid for at the contract unit price bid per linear foot (linear meter) for conduit.

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
Conduit for Future Conductors Linear Foot	(Linear Meter)

SECTION 624

ACCOMMODATIONS FOR PUBLIC TRAFFIC

DESCRIPTION

624.01.01 GENERAL: This work shall consist of providing for traffic by constructing detours or special detours, permitting traffic to pass through construction, and using 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: The materials used for the construction and maintenance of facilities required for the free flow of public traffic and for protection of the work shall be those prescribed for the several items which constitute the finished work and shall conform to all the requirements for such materials as set forth herein.

CONSTRUCTION

624.03.01 SPECIAL DETOURS: Special detours shall be constructed as shown on the plans or as specified. Detour locations indicated on the plans may be approximate only; the exact location shall be as staked by the Engineer.

Grading for special detours shall consist 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 the requirements of Section 107.21, "Dust Control."

When grading of special detours has been completed and approved by the Engineer and, if required on the plans or in the Special Provisions, the special detours shall receive surfacing materials of the kind and type specified, and they shall be placed and constructed in accordance with the requirements for the particular materials used.

Water shall be applied to detours in amounts necessary to attain the compaction of graded sections and of surfacing materials.

Maintenance on special detours shall consist of performing any work necessary to maintain the detour satisfactorily, as ordered by the Engineer.

Eradication of special detours shall consist of blade grader and scraper work supplemented by other equipment if needed. Eradication will be performed to the extent that the ground will be restored as nearly as feasible to the original, and material disposed of, all as directed by the Engineer.

624.03.02 FLAGGERS: 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.

Flaggers shall have completed an approved instructional course in flagging procedures. A prospective flagger shall possess a valid flagger card attesting satisfactory completion of said instructional course conducted by the Highway Department or some other approved course given by another entity of government within the State.

making all required tests.

Sign panels shall be paid for at the contract unit price bid per square foot (square meter) for "Permanent Sign Panels (Overhead)" which payment shall be full compensation for furnishing all labor, materials, tools, supplies, equipment and incidentals and for doing all the work involved in furnishing and erecting permanent sign panels (for signs listed as overhead signs) complete in place as shown on the plans and herein specified.

Sign supports shall be paid for at the contract Lump Sum price bid for "Permanent Overhead Sign Support Structures" which payment shall be full compensation for furnishing all labor, materials, tools, supplies, equipment and incidentals and for doing all the work involved in furnishing and erecting permanent sign supports (for all signs listed as overhead signs) complete in place as shown on the plans and as herein specified, including structure excavation and backfill, concrete foundations, cast-in-place concrete piles, structural steel posts and frame, sign islands, and making all required tests.

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 and as directed by the Engineer.

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

Payment will be made under:

PAY ITEM	PAY UNIT
Permanent Signs (Ground Mounted)	Square Foot (Square Meter)
Permanent Sign Panels (Overhead)	Square Foot (Square Meter)
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: 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. As defined in Section 714, "Paint and Pavement Markings," of these specifications, Type I pavement marking materials shall be used for transverse markings such as crosswalks and stop bars as well as for symbols and legends. Type II 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: Materials for traffic striping and marking shall conform to the applicable requirements of Section 714, "Paint and Pavement Markings."

All paint, epoxy and polyurea paint traffic stripes (except black stripes) shall be beaded on the final finish coat in accordance with Subsection 714.03.09, "Reflective Material."

The retroreflective preformed pavement markings shall conform to the applicable requirements of Subsection 714.03.06, "Thermoplastic Paint and Pavement Markings". These retroreflective preformed pavement markings shall consist of plastic or thermoplastic material with pigments selected to conform to standard highway colors. Retroreflective beads shall be incorporated into the film to provide immediate and continuing retroreflection. 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."

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.

The Contractor shall warranty the applied markings for a minimum of one (1) year from the date of installation. If the manufacturer provides a longer warranty, the longer warranty shall apply. 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 the Contractor's expense.

CONSTRUCTION

628.03.01 WEATHER CONDITIONS: Pavement marking materials shall be applied only when the pavement surface is dry and clean, surface temperature shall be above forty (40) degrees Fahrenheit (4 degrees Celsius) and rising, and when the weather is not windy, foggy, or humid. Epoxy paint, Polyurea paint, and Preformed marking material, plastic or thermoplastic shall only be applied if surface temperature is a minimum of forty (40) degrees Fahrenheit (4 degrees Celsius) and rising at the time of marking installation. 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: All equipment be required to perform the work shall be approved in advance by the Engineer, and shall include, but not 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.

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. It shall have sufficient paint capacity for each color with adequate air pressure to perform the work satisfactorily without excessive stopping. The machine shall produce a uniform film thickness and cross section at the required coverage and shall produce markings with clean-cut edges without running or spattering. It must be capable of being guided within the straightness tolerances set forth in these specifications. The machine shall have suitable adjustments for painting the line with width specified and when required, shall be equipped with an automatic cycling device to produce intermittent (skip) lines. The machine shall also be equipped to produce a variable skip pattern, including simultaneous painting of a broken line on one side and a solid line on the other side of the multiple strips. An acceptable tolerance in the skip pattern is plus or minus six (6) inches (150 millimeters). The striping machine shall be capable of three-gun application consisting of one black and two yellow spray guns operating simultaneously or individually. The equipment shall also be capable of operating two white guns simultaneously. The striping machine shall have a wheel base of sufficient length to produce a straight line to meet the straightness tolerance specified in Subsection 628.03.05. The machine must also be capable of producing curved lines without abrupt breaks, in accordance with approved layouts.

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," of these specifications. Equipment shall be capable of placing two 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. The equipment shall also have a metering device able to register the accumulated footage of markings installed per day for each spray gun. 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.

Equipment shall also be designed so that pressure gauges for each proportioning pump are constantly visible to the operator at all times during its operation so that any fluctuation and pressure difference can be monitored immediately. In addition, the striping equipment must have a minimum of one twenty-four (24) inch long minimum static mixer unit for the proper mixing of the two components of the epoxy paint material.

Provision shall be made for a dispenser capable of applying glass beads at the required rate.

Word markings, letters, numerals, and symbols shall be applied using suitable spray equipment together with stencils and templates.

Equipment for the application of preformed thermoplastic or plastic pavement marking material shall be as recommended by the manufacturer and as approved by the governing entity Engineer. Thermoplastic markings require the use of a propane torch as recommended by the manufacturer in order to fuse marking to asphalt and portland cement concrete pavements by means of heat.

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. This machine shall meet all requirements of the air pollution control district having jurisdiction. All sand used in wet sandblasting shall be removed from the pavement without delay as the sandblasting operation progresses.

Removal of striping by high velocity water jet may be permitted when approved by the Engineer.

628.03.03 GEOMETRY, STRIPES, AND TRAFFIC LANES: Permanent and temporary striping and marking shall be in accordance with the MUTCD and Volume I of the Uniform Standard Drawings for the Clark County Area.

Should the Contractor elect to alter the existing traffic stripes and markings, or to divert the flow of traffic on construction projects for his own convenience and there are no specific pavement markings or lane delineations shown on the plans or in the Special Provisions, he shall with the approval of the Engineer provide the necessary temporary striping in accordance with the MUTCD at no expense to the Contracting Agency.

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. Temporary traffic lanes shall be at least ten (10) feet (3 meters) wide and no lane shall encroach within five (5) feet (1.5 meters) of an open excavation or within two (2) feet (600 millimeters) of a longitudinal curb.

628.03.04 PREPARATION OF EXISTING SURFACES: Existing markings and striping, either permanent or temporary, which are to be abandoned or obliterated shall be removed by wet sandblasting or other approved methods. 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. Alternate methods of marking removal require prior approval of the Engineer. Obliteration of traffic striping with black paint or light emulsion oil shall be done only with the prior approval of the Engineer.

Before applying pavement markings, the existing pavement surface shall be cleaned by washing, sweeping, blowing vacuuming or other methods recommended by the manufacturer, as necessary to remove moisture, dirt, grease, oils, acids, laitance, curing compound of portland cement concrete or other foreign matter which would reduce the bond between the pavement marking material and the pavement. After cleaning, the surface shall be dried before applying pavement markings.

628.03.05 LAYOUT, ALIGNMENT, AND SPOTTING: When necessary, the Engineer will furnish the needed control points for required pavement striping and markings. The Contractor shall establish pilot lining between these points by stringline or other method to provide striping that will vary less than a half (1/2) inch (13 millimeters) in fifty (50) feet (15 meters) from the specified alignment.

The Contractor shall stripe or otherwise delineate the traffic lanes per the Uniform Standard Drawings and the MUTCD in the new roadway, portion of roadway, or detour before opening it to traffic if it is required by the Contract Documents.

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: Traffic striping and marking shall be applied at locations and to the dimensions and spacing indicated on the approved plans in accordance with requirements of this specification and Section 714, "Paint and Pavement Markings," or as provided in the Special Provisions. Where temporary traffic striping and marking is required, it shall not be applied until the layouts, alignments, sequencing, and condition of the existing surface have been approved.

Pavement marking material shall be mixed in accordance with the manufacturer's instructions. It shall be mixed thoroughly and applied to the surface at the proper temperature, at its original consistency without the addition of any paint thinner or other materials.

If traffic paint is applied in two coats, the first coat shall be thoroughly dry before the second coat is applied. Retroreflective beads will be required only in the second coat. The first coat shall be thoroughly dry before the second coat is applied. On open graded surfaces, second coat shall follow no sooner than ten (10) calendar days after initial application.

Application of retroreflective beads and or reflective elements shall be applied using the double drop method and per manufacturer's recommendations. Application rate of beads shall be as required by the manufacturer to meet retroreflectivity requirements specified in Subsection 714.03.06, "Thermoplastic Paint and Pavement Markings," of these specifications. In addition, retroreflective beads shall be applied to traffic markings in accordance with Subsection 714.03.09, "Reflective Material."

Ten days shall elapse between the application of a bituminous seal coat and the permanent traffic marking material. The traffic paint, epoxy paint, or polyurea paint shall not bleed, curl or discolor when applied to bituminous surfaces. If bleeding or discoloring occurs, the unsatisfactory areas shall be corrected as directed by the governing entity's Engineer.

Straight stripes deviating more than a half (1/2) an inch in fifty (50) feet (13 millimeters in 15 meters) shall be obliterated by sandblasting or other approved method and the markings corrected. The width of markings shall be as designed, within a tolerance of four (4) percent. When existing striping and markings are to be repainted, they shall be repainted so as to completely cover the old markings within a quarter (1/4) inch (6 millimeters). Stripe repainting shall be retraced within a longitudinal tolerance of six (6) inches (150 millimeters) plus or minus at the end of each stripe. Abrupt breaks in striping alignment will not be allowed. The striping shall be a continuous operation except where crossovers are required to complete painted medians. Restriping operations involving epoxy paint and polyurea paint shall be performed in accordance with manufacturer's recommendations.

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.

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.

Temporary striping and marking shall be renewed when the stripes and markings have lost fifty (50) percent of their original visual effectiveness.

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 in accordance with Subsection 714.02.01, "Certificates".

628.03.07 PROTECTION OF WORK, WORKMEN AND THE PUBLIC: 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.

Markings and striping shall be protected from injury and damage of any kind until the material is ready for traffic. Adjacent surfaces shall be protected from disfiguration by spatter, splashes, spillage, and dripping of paint, adhesives, primer or other material.

In areas of high traffic volume, the Contractor shall schedule his work to install traffic lines and markings in off-peak traffic hours.

628.03.08 DEFECTIVE WORKMANSHIP OR MATERIAL: 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 the sole expense of the Contractor.

628.03.09 INSTALLATION OF RETROREFLECTIVE PREFORMED PAVEMENT MARKINGS: Traffic striping and marking shall be applied at locations and to the dimensions and spacing indicated on the approved plans in accordance with requirements of this specification and Section 714, "Paint and Pavement Markings," or as provided in the Special Provisions.

The retroreflective preformed pavement marking materials shall not be applied within two weeks after laying and rolling asphalt concrete wearing courses unless otherwise specified in the Special Provisions of the contract. The preformed markings shall conform to the pavement contours by the action of traffic. After application the markings shall be immediately ready for traffic.

The preformed retroreflective pavement markings shall be applied in accordance with the manufacturer's recommendations, a copy of which the Contractor shall supply the governing agency prior to installing the pavement marking material.

Joints in the initial installation of new pavement markings will be allowed only on lane lines and change of direction. The longitudinal bars in crosswalks, if used, shall be one piece.

Pavement marking failures shall be removed and replaced a minimum of six (6) inches (150 millimeters) each side of the failure and the patch shall be a minimum of twenty four (24) inches (600 millimeters) in length.

MEASUREMENT

628.04.01 MEASUREMENT: The quantity of traffic striping and marking shall be measured by one or more of the following methods: lineal footage (lineal meters), the area in square feet (square meters), or one lump sum item complete in place, as shown on the plans or indicated in the Special Provisions.

The quantity of the Type I pavement marking materials for symbols and legends measured for payment shall be per each, complete and in place.

The quantity of the Type I pavement marking materials for crosswalks and stop bars measured for payment shall be the number of square feet (square meters), complete and in place.

The quantity of Type II pavement marking materials for longitudinal lines measured for payment shall be per linear foot (linear meter), complete and in place.

BASIS OF PAYMENT

628.05.01 BASIS OF PAYMENT: 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.

All costs for temporary pavement painting for the convenience of the Contractor, including costs for removal of existing lines and markings, shall be at his sole expense.

Payment shall be made under:

PAY ITEM	PAY UNIT
Type I "ONLY" Marking	Each
Type I (arrow) Marking	Each
Type I Marking for Crosswalks and Stop Bars	S.F. (SM)
Type II White 4" Marking	L.F. (LM)
Type II Yellow 4" Marking	L.F. (LM)

SECTION 629

WATER DISTRIBUTION FACILITIES

DESCRIPTION

629.01.01 GENERAL: 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.

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; the removal and/or restoration of existing improvements, and all work in accordance with the plans and specifications.

629.01.02 STANDARDS: Wherever the words "Standard Specifications" appear on the plans or in these specifications, they shall refer to the Standard Drawings and Specifications for Public Works Construction OffSite Improvements, Clark County Area, Nevada.

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 two prints of each shop drawing. The term "shop drawing" as used herein shall be understood to include lists, graphs, operating instruction, etc. Unless otherwise required, said drawings shall be submitted at a time sufficiently early to allow review of same by the Engineer, and to accommodate the rate of construction progress required under the contract. Within 10 calendar days after receipt of said prints, the Engineer will return one print of each drawing to the Contractor with his 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. 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. The Contractor shall have no claim for damages or extension of time due to any delay resulting from making required revisions to shop drawings. The review of said 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 herein 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: Unless otherwise specified in the Special Provisions, all lines and grades required for proper execution of the work shall be furnished by the Contractor. The Contractor shall be responsible for the preservation of all bench marks and survey marks and shall be responsible

SECTION 633

PAVEMENT MARKERS

DESCRIPTION

633.01.01 GENERAL: This work shall consist of furnishing and placing pavement markers at the locations shown on the plans or where directed by the Engineer.

The markers shall have the shape, dimensions and tolerances shown on the plans.

Pavement markers will be of the type and color shown on the plans.

MATERIALS

633.02.01 NON-REFLECTIVE PAVEMENT MARKERS: Non-reflective pavement markers shall consist of a heat-fired, vitreous, ceramic base and a heat-fired, opaque, glazed surface to produce the properties required in these specifications. The markers shall be produced from any suitable combination of intimately mixed clays, shales, talcs, flints, feldspars, or other inorganic material which will meet the properties herein required. The markers shall be thoroughly and evenly matured and free from defects which affect appearance or serviceability.

The top surface of the non-reflective marker shall be convex and the radius of curvature shall be between 3-1/2 inches (8.9 centimeters) and six (6) inches (15 centimeters), except that the radius of the half (½) inch nearest the edge may be less. Any change in curvature shall be gradual. The top and sides shall be smooth and free of mold marks, pits, indentation, air bubbles, or other objectionable marks or discolorations. 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 which will increase the effective bonding surface area of adhesive. The faces of the protrusions shall not deviate more than five one-hundredths (0.05) inch (1.3 millimeters) from a flat surface. The areas of protrusion shall have faces parallel to the bottom of the marker and shall project approximately four one-hundredths (0.04) inch (1 millimeter) from the bottom. The area of protrusions shall constitute a minimum of thirty (30) percent of the area of the bottom of the marker and shall increase the bonding surface area by a minimum of twenty-four (24) percent. To facilitate forming a mold release, the sides of the protruded area may be tapered. This taper shall not exceed fifteen (15) degrees from the perpendicular to the marker bottom.

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 min. (4.82 MPa)
(2) Glaze Thickness ..... 0.005" min. (.013 centimeter)
(3) Moh Hardness ..... 6 min.
(4) Directional reflectance (white markers only):
  (a) Glazed surface ..... 75 min.
  (b) Body of marker ..... 70 min.

(5) Yellowness Index (white markers only)
  (a) Glazed surface ..... 7 max.
  (b) Body of marker ..... 16 max.
(6) Color (yellow markers only):
  (a) Purity ..... 76% to 96%
  (b) Dominant wave length ..... 579 to 585 mu
  (c) Total luminous reflectance (Y value x 100) ..... 41 min.
(7) Autoclave - Glaze shall not spall, crack or peel
(8) Strength ..... 1500 pounds minimum
(9) Water absorption ..... 2.0% max.

633.02.02 REFLECTIVE PAVEMENT MARKERS: Reflective pavement markers shall be of the prismatic reflector type consisting of methyl methacrylate or suitable compounded acrylonitrile budadiene styrene (ABS) filled with a mixture of an inert thermosetting compound and filler material. The exterior surface of the shell shall be smooth and contain one or two methyl methacrylate, impact modified methacrylate or polycarbonate prismatic reflector face(s) of the color specified. Reflective pavement markers shall be impact-resistant and abrasion-resistant.

The base of the marker shall be flat (the deviation from a flat surface shall not exceed 0.05 inch (1.3 millimeter)), rough textured and free from gloss or substances which may reduce its bond to the adhesive. The angle between the face of the marker and the base shall be no greater than forty five (45) degrees. Marker dimensions are as set forth in the Standard Drawings.

In accordance with ASTM D4280, the adhesive bond strength to the bottom surface of the marker shall not be less than five hundred (500) psi (3.45 MPa), when tested with epoxy adhesive. Markers with length and width both equal to four (4) inches (10.2 millimeters) shall undergo flexural strength testing and must withstand a minimum two thousand (2000) lbs (909 kg) without breakage or significant deformation. Markers with length less than four (4) inches (10.2 millimeters) shall undergo compressive strength testing and must support a minimum load of six thousand (6000) lb (2727 kg) without breakage or significant deformation.

The color of the reflector when illuminated by an automobile headlight shall be an approved clear, yellow, or red. Off-color reflection shall constitute grounds for rejection. The reflective markers shall have initial minimum retroreflectance values specified as the product of Tables 1 and 2 when measured in accordance with ASTM E 809. 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). One candela per lux equals 10.76 candelas per footcandle.

Table 1 - Minimum RI Values

Entrance angle $b_2 = (b_1 = 0°)$	0°	±20°
Observation angle:	.2°	.2°
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

All reflective pavement markers shall meet the requirements of the minimum retroreflectance values specified as the product of Tables 1 and 2 shown above for the following tests:

Abrasion Resistance: Entire lens surface of the marker shall be subjected to one hundred (100) rubs with a one (1) inch (25.4 millimeter) diameter flat pad of No. 3 coarse steel wool conforming to Federal Specification FF-W-1825A. A load of fifty (50) ± 0.5 lb (22 ± 0.2 kg) is applied to steel wool pad during testing.

Temperature Resistance: The marker shall be conditioned for twelve (12) hours at 145°F ± 5°F (62.7°C ± 2.5°C).

Testing: Pavement markers shall be sampled and tested prior to use in accordance with Test Method Number 669 of the California Division of Highways. Lots of markers which 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: The pavement marker adhesive shall be either a hot-melt bituminous adhesive or an epoxy adhesive which provides effective bonding of pavement markers to both asphalt and concrete pavement surfaces. The adhesive shall not permit excessive marker movement at hot summer temperatures and shall remain flexible at winter temperatures.

The bituminous adhesive shall be an asphaltic material with a homogeneously mixed mineral filler which shall comply with the requirements of ASTM D4280, A1, "Specification for Bituminous Adhesive for Pavement Markers". Epoxy adhesives shall comply with Subsection 728.03.10.

The Contractor shall furnish the Engineer with certificates of compliance executed by the manufacturers of the markers and adhesive attesting that they conform to the requirements of these specifications.

CONSTRUCTION

633.03.01 INSTALLATION: The portion of the highway surface to which the markers are to be bonded by the adhesive shall be free of dirt, curing compound, grease, oil, moisture, loose or unsound layers, paint and any other material which would adversely affect the bond of the adhesive. Cleaning shall be done by blast cleaning on all pavement surfaces; only air blast cleaning will be permitted on asphalt concrete surfaces. 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. 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. Soft rags moistened with mineral spirits conforming to Federal Specifications TT-T291 or kerosene may be used if necessary, to remove adhesive from exposed faces of pavement markers. No other solvent shall be used. The markers shall be protected against impact until the adhesive has hardened to the degree designated by the Engineer.

The adhesive shall not be used when either the pavement or the air temperature is less than fifty (50) degrees Fahrenheit (10 degrees Centigrade). No markers shall be installed if the relative humidity of the air is greater than eighty (80) percent or if the pavement is not surface dry. The adhesive shall be prepared and applied according to the manufacturer's requirements and specifications. The Engineer shall be the judge as to when the adhesive has set sufficiently to bear traffic.

All markers shall be applied in accordance with the manufacturer's recommendations. Reflective markers shall be placed in such manner that the reflective face of the marker is perpendicular to a line parallel to the roadway centerline. No pavement markers shall be placed over longitudinal or transverse joints of the pavement surface.

METHOD OF MEASUREMENT

633.04.01 MEASUREMENT: The quantity of each type of pavement marker to be measured for payment as units will be the number of each type determined by actual count complete in place.

BASIS OF PAYMENT

633.05.01 PAYMENT: The accepted quantity of pavement markers measured as provided in Subsection 633.04.01, "Measurement," will be paid for at the contract unit prices bid per each for "Non-Reflective Pavement Markers" and Reflective Pavement Markers," which shall be full compensation for 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.

Payment will be made under:

PAY ITEM	PAY UNIT
Non-Reflective Pavement Markers	Each
Reflective Pavement Markers	Each

dimensions of structure backfill behind the wall shall be the same as those prescribed in Subsection 207.03.01 for walls and abutments, or as otherwise shown on the plans.

660.03.03 ASSEMBLY: In the construction of a wall on a curve the proper curvature for the face shall be obtained by the use of shorter stringers in the front or rear panels of retaining walls as designated in the plans or by the Engineer.

The wall height and depth may be varied. Two or more designs of retaining walls may be incorporated in the same wall by the use of standard split columns to make the connection of the step-back.

The units shall be erected as shown on the plans. Members shall be handled carefully and any which are damaged shall be removed and new members substituted at the Contractor's expense.

METHOD OF MEASUREMENT

660.04.01 MEASUREMENT: The quantity of metal bin-type retaining wall measured for payment will be the number of square feet (square meters) shown on the plans for each design type of wall, complete and in place.

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

BASIS OF PAYMENT

660.05.01 PAYMENT: 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 (square meter) for the type specified.

Structure excavation and structure backfill will be paid for in accordance with Sections 206, "Structure Excavation" and 207 "Backfill."

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

Payment will be made under:

PAY ITEM	PAY UNIT
Metal Bin-Type Retaining Wall (type)	Square Foot (Square Meter)

SECTION 680

FIBER OPTIC CABLE

DESCRIPTION

680.01.01 GENERAL: The work under this section shall consist of furnishing, installing, and testing all underground and outdoor fiber optic cables.

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) Manager, or designee, prior to installation.

MATERIALS/EQUIPMENT

680.02.01 FIBER OPTIC CABLE: 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 of Standardization (ISO) 9001 or 9002 manufacturer.

Fiber optic cable shall be dielectric and comply with the requirements of (Rural Utilities Service Standards) RUS 1755.900 except as modified by these specifications.

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° Celsius to +70° Celsius (-40° F. to 158° F.)
(14)	Min operating temperature range:	-20° Celsius to +70° Celsius (-4° F. to 158° F.)
(15)	Rated life:	Certify a 20-year life expectancy when installed to manufacturer's specifications

(a) Buffer Tubes: 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. 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. The water blocking material shall be readily removable with conventional nontoxic solvents. Buffer tubes shall be stranded around a central member using the reverse oscillation or "S-Z," stranding process. The use of filler rods in the fiber optic cable when required to lend symmetry to the cable section is mandatory.

(b) Central Strength Member: The fiber optic cable shall have a central strength member designed to prevent buckling of the cable.

(c) Cable Core: The fiber optic cable shall utilize a dry water blocking material to block the migration of moisture inside the cables.

(d) Tensile Strength Members: The fiber optic cable shall have tensile strength members designed to minimize cable elongation due to installation forces and temperature variation. Underground fiber optic cable shall withstand a 2700 N (600 lbf) tensile load where the change in attenuation does not exceed 0.2 dB during loading and 0.1 dB after loading. The cable shall be rated for an installed tensile service load of 890 N (200 lbf) or more.

(e) Cable Jacket: The fiber optic cable jacket shall be constructed of a High Density Polyethylene or Medium Density Polyethylene (HDPE/MDPE) jacket that has been applied directly over the tensile strength members and water-blocking material. The jacket shall have at least one (1) ripcord designed for easy sheath removal. This cable will be rated for use in both underground and overhead installations.

(f) Conductive Line Locating Material: A six (6) pair Polyethylene (PE) 39 No. 22 (American Wire Gauge) AWG 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. This is not required if an existing interconnect cable is in place. Any other method of providing a conductive tracer wire must be approved of by the FAST Manager, or designee, prior to installation.

(g) 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; and

(3) Wasp and hornet spray.

CONSTRUCTION

680.03.01 INSTALLATION – GENERAL: The cable shall not be installed in any pull box until the pull box has been approved for pulling by the contracting agency. Cabinets shall be installed prior to cable installation. Installation of fiber optic cable shall be preformed by individuals who are certified by a nationally recognized fiber optic installation certification organization. Certifications must be approved by the FAST Manager, or designee, prior to construction. Installation of fiber optic cable shall be continuous and without splices unless approved by the FAST manager, or designee. The Contractor shall perform all final length measurements and order cable accordingly.

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. The Contractor shall not exceed fiber optic cable

bend radius at any time. Manufacturer approved pulling grips, cable guides, feeders, shoes, blowing devices, pulleys, and bushings shall be used to prevent damage to the cable during installation.

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.

The Contractor shall ensure that the tensile load on the cable does not exceed the allowed maximum by using a system that includes a means of alerting the installer when the pulling or blowing tension approaches the limit and/or displays the actual tension on the cable. Contractor may supplement this procedure with a breakaway tension limiter set below the recommended tensile limit of the cable being pulled or blown. 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.

When removing cable from the reel prior to installation, place it in a figure eight 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 eights.

If cables are to be installed in conduit with existing cables or wires that shall remain, the Contractor shall not damage the existing cables or wires. The Contractor shall disconnect, remove, reinstall, and reconnect the existing cables and wires if necessary to facilitate the installation of the new cable without any additional cost. The Contractor shall be responsible for any damage to the existing cables or wires caused by this operation. New and existing conductors shall be terminated and the labeling shall be reconciled as part of this process. Two (2) weeks prior to disconnecting any existing cables, the Contractor shall submit a schedule, for approval by the FAST Manager, or designee, with the accurate timeframes of when the existing cables are to be disconnected.

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 eight or a loose loop with a minimum of thirty (30) feet (9 meters) of slack in all pull boxes smaller than a Type 200 Vault. The Contractor shall leave a minimum of sixty (60) feet (18 meters) 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.

If the pull box has racks and hooks, the Contractor shall attach the cables to them with industry standard cable ties immediately upon entering the box. In all cases each cable shall be labeled, then looped and tied independently of one another. The labeling on the fiber optic cable shall be approximately two (2) feet (.6 meters) from the entry point, and must 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.). Cable ties should be tightened so that they prevent cable slippage but do not deform or damage the cable sheath.

The Contractor shall follow the requirements of local building codes and National Electrical Code (NEC) Article 770, inclusive of the Fine Print Notes (FPN) when installing indoor fiber optic cable.

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 following test requirements. All testing is to be performed by a certified experienced tester of a nationally recognized certification organization.

(1) Factory Testing: The Contractor shall submit factory test data and related documentation from the manufacturer to the Engineer and the FAST Manager, or designee, prior to installing the cable. This includes the "index of refraction" of the cable to be installed. This test shall demonstrate that the attenuation for each fiber string comply with the loss budgets required by these Specifications. Test blue and slate fibers at one thousand three hundred ten (1,310) nm and one thousand five hundred fifty (1,550) nm. Submit factory results for approval by the FAST Manager, or designee, prior to installing the cable.

(2) Pre-Installation Testing: The Contractor shall test all cable prior to installation. Any cable that is found to have visual cladding damage shall be rejected. Test fibers at one thousand three hundred ten (1,310) nm and one thousand five hundred fifty (1,550) nm. Submit Optical Time Domain Reflectometer (OTDR) trace results for approval by the FAST Manager, or designee, prior to installing the cable. OTDR results must be approved by the FAST Manager, or designee, prior to installation.

(3) Post-Installation Testing: Testing shall conform to "Measurement of Optical Power Loss on Installed Single-Mode Fiber Plant," latest revision. After installation, the Contractor shall perform the following tests using the procedures of "Measurement of Optical Power Loss on Installed Single-Mode Fiber Plant" latest revision and all standards and procedures invoked therein, subject to the following clarification:

(A) OTDR Tests: Conduct tests using an OTDR for each fiber. Demonstrate that the attenuation for each fiber string comply with the loss budgets required by these Specifications. Test fibers at one thousand three hundred ten (1,310) nm and one thousand five hundred fifty (1,550) nm. Submit OTDR trace results for approval and acceptance by the FAST Manager or designee.

(B) Power meter readings are required from all fibers. Submit power meter results for approval and acceptance by the FAST Manager 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 Manager, or designee, the Contractor shall compile and submit 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, and OTDR traces and power meter results of each fiber by each cable tested. The test notebook and electronic copy shall, at a minimum, 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 must have in its possession all pre- and post-testing data prior to final approval and acceptance.

METHOD OF MEASUREMENT

680.04.01 MEASUREMENT: The quantity of Fiber Optic Cable (72-strand) will be measured per linear foot installed, in place, complete and operational, and successfully tested. The cable shall be measured by the marking on the exterior cable sheath. No separate measurement will be made for lubricant in this item.

BASIS OF PAYMENT

680.05.01 PAYMENT: 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. All materials required to complete the system shall be incidental to the cable including the approval, furnishing, and installation of racks and hooks in pullboxes, for each type installed. 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. Testing, warranty, documentation, and spare parts are considered incidental to the item requiring the work.

All other components of the approved Communications Distribution Cable Assembly (CDCA) shall be specified and paid 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.

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: 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.

All other equipment shall be delivered to the Freeway & Arterial System of Transportation (FAST) Traffic Management Center (TMC) prior to project acceptance. No partial shipments will be accepted for deliveries to the TMC. 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.

All equipment shall be approved by the FAST Manager, or designee, prior to purchase.

MATERIALS/EQUIPMENT

681.02.01 UNDERGROUND SPLICE ENCLOSURES: Underground splice enclosures shall be cylindrical, butt-end style, corrosion resistant, gel sealed, and meet the requirements of GR-771-CORE. Underground splice enclosures shall gel seal, bond, anchor, and provide efficient routing, storage, organization, and protection for fiber optic cable and splices. The splice enclosure shall provide an internal configuration and single end cap with a minimum of six (6) ports for entry and exit of numerous seventy-two (72) strand backbone, trunk, and branch line cables. A fiber optic gel closure Tyco Model # Fiber Optic Splice Closure (FOSC) 450-B6-6-24-6-B3V, or equivalent as approved by the FAST Manager or designee.

All splice trays, cable baskets, and related equipment shall be supplied with the underground splice enclosure.

The enclosure shall have six (6) stackable single fusion trays for twenty-four (24) splices each to accommodate a total one hundred forty-four (144) splices, and each shall be designed specifically for housing twenty-four (24) single-mode fusion splices protected by heat-shrink sleeves. The splice trays shall be easy to install and remove, and have provisions for a minimum entry of four (4) buffer tubes. A storage basket for storing loose buffer tubes or single fiber shall be installed and delivered with the enclosure.

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: The Contractor shall provide and install Single Mode Gator Patch Intelligent Transportation System (ITS) Drop Cable or equivalent as approved by the FAST manager, or designee, which is factory terminated cable with epoxy filled patch panel with twelve (12) fiber optic Straight Tip (ST) connectors. The Gator Patch Cable is to be used between the fiber optic trunk line and controller at lengths as shown on the plans, with the required slack or twenty (20) feet (6 meters) to twenty-five (25) feet (7 meters) in each splice vault and pull box, as well as the twenty (20) feet (6 meters) slack neatly coiled in the controller cabinet.

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 three (3.0) mm buffer tube containing twelve (12) color coded fibers.

CONSTRUCTION

681.03.01 GENERAL: The Contractor shall provide all of the equipment for splices as noted on the drawings and in the quantities in the bid schedule. Additionally, the CDCA shall be installed in the conduit from the above ground facility to the splice vault and it shall be splice ready. 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: The Contractor shall label all cables to allow effective splicing. Labeling shall be done in a neat, professional manner using permanent methods and products approved by the FAST Manager or designee. The labels shall include all necessary information to properly identify the cable and its mating connection.

681.03.03 TESTING: Testing of the CDCA and related hardware in this section is included in the testing procedure of Section 680, "Fiber Optic Cable", specification and shall adhere to those requirements.

METHOD OF MEASUREMENT

681.04.01 MEASUREMENT: The quantity of Underground Splice Enclosures will be measured for payment per each supplied, complete and operational, and successfully tested.

The quantity of CDCA will be measured for payment per each installed, in place, complete and operational, and successfully tested.

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 as specified in this section.

BASIS OF PAYMENT

681.05.01 PAYMENT: 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 price shall be full compensation for the underground splice closures including gel, splice trays, cable baskets, single fusion trays, sleeves and storage baskets.

The accepted quantity of CDCA installed and tested positively will be paid for at the contract unit price bid per each, which price shall be full compensation for the cable assemblies including hardware, twelve (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 Manager or designee.

Payment will be made under:

PAY ITEM:	PAY UNIT
Underground Splice Enclosures	Each
Communication Distribution Cable Assemblies (CDCA) and Permanent Fiber Splicing	Each

SECTION 682

FIBER OPTIC TRANSCEIVER

DESCRIPTION

682.01.01 GENERAL: 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. This communications device shall contain a self-healing optical ring and perform remote control of master/slave functions. The OTR/SH provides an electrical signal interface for an Electronic Industry Association (EIA)-232/422/485 port and four (4) SMFO interfaces (two (2) transmit and two (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. The device shall be an International Fiber Systems (IFS) Model #D19130SHR, or equivalent, as approved by the Freeway & Arterial System of Transportation (FAST) Manager or designee.

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. The agency Project Manager shall be notified prior to the delivery to the TMC. No partial shipments will be accepted. All equipment supplied on this project will be delivered during a single delivery, and shall be labeled clearly with the project and location designation.

All equipment selection shall be approved prior to purchase by the FAST Manager or designee.

MATERIALS/EQUIPMENT

682.02.01 GENERAL: The OTR/SH shall require no user adjustments other than switch selection of the desired interface, anti-streaming time, and Master/Slave operation. When the OTR/SH is installed in a rack mounted card cage, the unit shall be hot-swappable with no adverse affects to itself or other units in the cage.

All equipment supplied shall have a full lifetime replacement/repair warranty.

682.02.02 MECHANICAL: The OTR/SH shall be a surface mount device (field), or rack mount (hub) configurations, when specified. The field mounted Video Optical Transceiver (VOTR) shall be enclosed in corrosion resistant housing that protects the internal circuitry from the environment. The housing shall be provided with suitable holes for mounting to a flat surface.

When it is specified, the rack mounted OTR/SH shall occupy no more than four (4) Rack Units (RU) (7 inches) of space and be of the same manufacturer and compatible with the nineteen (19) inch (48 centimeters) 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.

All OTR/SH shall have external, silk screened, labeling 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. Internal labeling shall be provided to clearly identify all dipswitches and jumper positions.

The OTR/SH shall have LED status indicators for the following signals:

(a) A-looped locked, Forward Direction

(b) A-loop locked, Reverse Direction

(c) B-looped locked, Forward Direction

(d) B-loop locked, Reverse Direction

(e) Transmit Data A

(f) Receive Data A

(g) Transmit Data B

(h) Receive Data B

(i) Power (PWR)

682.02.03 OPTICAL:

(a) The OTR/SH shall have the following characteristics:

1) Laser diodes operating at one thousand three hundred ten (1,310) millimeters
2) Link loss budget of twenty (20) dB (minimum)
3) Less than two (2) µsec optical repeating delay
4) Straight Tip (ST) connectors four (4)
5) Minimum connection of 0.67 meters (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 two (2) OTR/SH's.
2) Scenario 2: A self-healing ring configuration is functioning, then two (2) cable breaks occur, one (1) on the working ring and one (1) on the protect ring between two (2) OTR/SH's.
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 one hundred (100) kbps
4) Bit error rate of ten (10) – eleven (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 such that 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 thirty-two (32) slave units on the self-healing ring.

682.02.05 CONTROL: The OTR/SH shall operate in either the "Master" mode or "Slave" mode. The OTR/SH master shall transmit digital signals from a hub location to a number of field (slave) OTR/SH locations. Both master and slave units shall be identical. The determination of master or slave shall be accomplished by either a manual switch on the OTR/SH or by remote contact closure. A "closed" remote contact closure would put the OTR/SH in the Master mode.

682.02.06 POWER: The OTR/SH shall operate to specification when supplied with 120 ± 15 VAC, 60 ± 3 Hz single- phase power. 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: The OTR/SH shall be designed to operate from negative forty (-40) degrees Celsius (-40 degrees F.) to seventy-four (+74) degrees Celsius (165 degrees F.) with no cooling airflow, 0-95 percent relative humidity, non-condensing. The OTR/SH shall be compliant with National Electronics Manufacturers Association (NEMA) TS-l/TS-2 and Caltrans Traffic Signal Control Equipment Specifications for shock, vibration, and voltage transient protection.

682.02.08 NINETEEN (19) INCH RACK MOUNTED CARD CAGE: When required at a hub location, the OTR/SH shall be able to be installed in a nineteen (19) inch rack mounted card cage. The cage height shall not exceed four (4) U. The cage shall contain a fault tolerant power converter compatible with OTR/SH module power requirements. The cage shall include provisions for interconnecting cabling and be designed to accommodate a minimum of twelve (12) OTR/SH modules that shall be easily mountable and removable from the cage. When installed in the cage, the OTR/SH modules shall be securable. The module's maintenance indications shall not be distributed after being mounted in the drawer. A failure of one 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: Four (4) fiber optic jumper cables shall be delivered with each transceiver supplied, and the fiber optic jumper cables shall meet the following requirements:

(a) Two hundred fifty (250) μm buffering of each fiber;

(b) Nine hundred (900) μm buffering of each fiber applied after the initial two hundred fifty 250 μm buffering;

(c) Maximum factory measured insertion loss of 0.5 dB per EIA/Telecommunications Industry Association (TIA) 455-171;

(d) Less than 0.2 dB loss when subjected to EIA/TIA-455-1B, 300 cycles, 0.5 kg;

(e) Aramid yarn strength member;

(f) Rugged three (3) millimeters (0.12 inch) (approximate) Polyvinyl Chloride (PVC) sheathing;

(g) Minimum bend radius of three hundred twenty (320) millimeters (12 inches) following installation, six hundred forty (640) millimeters (25 inches) during installation;

(h) Minimum tensile strength of four hundred and 444N (100 lbs);

(i) And ST connectors that are factory terminated with strain relief.

CONSTRUCTION

682.03.01 INSTALLATION OF EQUIPMENT: 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. Mounting methods using tape, Velcro, and sticky back material will not be permitted. All necessary power adapters and cabling needed to obtain power from the power distribution assembly shall be provided.

As noted above, the Contractor shall also supply the four (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 four (4) optical inputs of the OTR/SH. Contractor shall also supply the data cables for the DB-25 data connector. This consists of a sixty (60) inch DB-25 M-M connector to plug into the OTR/SH on one end and the 2070N traffic signal controller on the other. 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: The quantity of Shelf Mount Fiber Optic Transceivers with Cables will be measured per each complete and successfully tested.

The quantity of Rack Mount Fiber Optic Transceivers with Cables will be measured per each complete and successfully tested.

The quantity of nineteen (19) inch Rack Mounted Card Cage will be measured per each, complete and successfully tested.

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.

Mounting hardware and power conversion hardware, if required, are incidental to the OTR/SH bid item and will not be measured or paid separately.

The equipment delivered will be tentatively accepted pending testing by the FAST Manager 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: 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 Measurement, complete including warranty, delivery to FAST, optical transceiver(s), SMFO cable, hardware, housing, four (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.

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 Section 682.04.01, "Measurement," complete including warranty, delivery to FAST, optical transceiver(s), SMFO cable, hardware, four (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. The accepted quantity of nineteen (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 Section 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.

SECTION 683

VIDEO OPTICAL TRANSCEIVER WITH BI-DIRECTIONAL DATA CHANNEL

DESCRIPTION

683.01.01 GENERAL: 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. Each VOTR pair delivered shall provide one (1) unidirectional National Television Standards Committee (NTSC) color video channel from the CCTV field location to another designated point and one (1) bi-directional data channel between both locations. There will be a designated video transmitter and a video receiver. The devices shall be International Fiber Systems (IFS) Model #VT4930WDM and IFS Model #VR4930WDM, or equivalent, as approved by the Freeway & Arterial System of Transportation (FAST) Manager or designee.

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. No partial shipments will be accepted. All equipment supplied on this project will be delivered during a single delivery, and shall be labeled clearly with the project and location designation.

The VOTR will be able to be connected to each end of one single mode optical fiber with Straight Tip (ST) connections to establish a point-to-point communication topology for the locations shown on the Drawings. VOTR's designed for mounting in card cages shall be hot-swappable.

All equipment selection shall be approved by the FAST Manager or designee.

MATERIALS/EQUIPMENT

683.02.01 GENERAL: All equipment supplied will have a full manufacturer's warranty.

683.02.02 MECHANICAL: The VOTR shall be a surface mount device (field), or rack-mount (hub) configurations, when specified. The field mounted VOTR shall be enclosed in corrosion resistant housing that protects the internal circuitry from the environment. The housing shall be provided with suitable holes for mounting to a flat surface.

When it is specified, the rack-mounted VOTR shall occupy no more than four (4) Rack Units (RU) (7 inches) of space and be of the same manufacturer and compatible with the nineteen (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.

All VOTR's shall have external, silk screened, labeling 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. Internal labeling shall be provided to clearly identify all dipswitches and jumper positions.

The VOTR shall have LED status indicators for presence of video carrier, input power, and data transmission.

683.02.03 OPTICAL:

(a) Laser both directions (wavelength 1310/1550 nm) over one (1) single mode fiber

(b) Link loss budget of 23dB (minimum)

(c) ST Connectors only

(d) Minimum connection of 0.67 meters (2 feet) of cable with no optical attenuation

683.02.04 DATA:

(a) Bi-directional data communications (simplex and full duplex operating modes)

(b) Selectable Electronic Industry Association (EIA)-232, EIA-422, or two (2)-wire EIA-485 interfaces

(c) Data rates from DC to 100kbps

(d) Bit error rate of ten (10) – nine (9)

(e) 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) NTSC Color, compliant with EINTIA-250-C for Medium-Haul Transmission and EIA-170 Video Standards.

(b) Bandwidth range of 5Hz to 6.5MHz

(c) Signal-to-Noise Ratio > 60dB

(d) Differential Gain < 3 percent

(e) Differential Phase < 3 degrees

(f) Tilt < 1 percent

(g) BNC Connection

683.02.06 POWER: The VOTR shall operate to specification when supplied with 120 ± 15V AC, 60 ± 3 Hz single-phase power. 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: The VOTR shall be designed to operate from minus 40 (-40) degrees Celsius (-40 degrees F.) to seventy-four (+74) degrees Celsius (165 degrees F) with no cooling airflow, 0-95 percent relative humidity, non-condensing.

The VOTR 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.

683.02.08 NINETEEN (19) INCH RACK MOUNTED CARD CAGE: When required at a hub location, the VOTR shall be able to be installed in a nineteen (19) Inch rack mounted card cage. The cage height shall not exceed 4U. The cage shall contain a fault tolerant power converter compatible with VOTR module power requirements. The cage shall include provisions for interconnecting cabling and be designed to accommodate a minimum of seven VOTR modules that shall be easily mountable and removable from the cage. When installed in the cage, the VOTR modules shall be securable. The module's maintenance indications shall not

be distributed after being mounted in the drawer. A failure of one (1) VOTR module shall not impact the operation of other VOTR modules installed within rack mounted cage.

683.02.09 FIBER OPTIC JUMPER CABLES: Four (4) fiber optic jumper cables shall be delivered with each transceiver supplied, and the fiber optic jumper cables shall meet the following requirements:

(a) 250 μm buffering of each fiber;

(b) 900 μm buffering of each fiber applied after the initial 250 μm buffering;

(c) Maximum factory measured insertion loss of 0.5dB per EIA/Telecommunications Industry Association (TIA) 455-171;

(d) Less than 0.2dB loss when subjected to EIA/TIA-455-1B, 300 cycles, 0.5 kg;

(e) Aramid yarn strength member;

(f) Rugged 3 millimeters (0.12 inch) (approximate) Polyvinyl Chloride (PVC) sheathing;

(g) Minimum bend radius of 320 millimeters (12 inches) following installation, 640 millimeters (25 inches) during installation;

(h) Minimum tensile strength of 444 N (100 lbs.);

(i) And ST connectors that are factory terminated with strain relief.

CONSTRUCTION

683.03.01 GENERAL: 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 VOTR's securely in the cabinet. Mounting methods using tape, Velcro, and sticky back material will not be permitted. All necessary power adapters and cabling needed to obtain power from the power distribution assembly shall be provided and secured.

As noted above, the Contractor shall also supply the one (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.

All VOTR's 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: The quantity of Shelf Mounted VOTR's with Cable will be measured for payment per each delivered, complete and operational, and successfully tested.

The quantity of rack mounted VOTR's with cable will be measured for payment per each delivered, complete and operational, and successfully tested.

The quantity of nineteen (19) inch rack mounted card cage will be measured for payment per each delivered, complete and operational, and successfully tested.

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.

The equipment delivered will be tentatively accepted pending testing by the FAST Manager 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: The accepted quantity of Shelf Mounted VOTR's with cable delivered complete will be paid for at the contract unit price bid per each, which price shall be full compensation for the VOTR(s), SMFO cable, housing(s), four (4) fiber optic jumper cables per video transceiver, hardware, one (1) simplex fiber optic jumper cable per video transceiver, warranty, and delivery to the FAST Manager or designee.

The accepted quantity of rack mounted VOTR's with cable delivered complete will be paid for at the contract unit price bid per each, which price shall be full compensation for the VOTR(s), SMFO cable, four (4) fiber optic jumper cables per video transceiver, hardware, one (1) simplex fiber optic jumper cable per video transceiver, warranty, and delivery to the FAST Manager or designee.

The accepted quantity of nineteen (19) inch rack mounted card cage delivered complete will be paid for at the ccontract unit price bid per each, which price shall be full compensation for the rack mounted card cage, hardware, warranty, and delivery to the FAST Manager or designee.

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
Nineteen (19) Inch Rack Mounted Card Cage	Each

SECTION 684

FIELD-HARDENED ETHERNET SWITCH

DESCRIPTION

684.01.01 GENERAL: 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.

The Field Switch shall comply with the requirements stated within this specification so as to operate within the Freeway and Arterial System of Transportation (FAST) Arterial Management System (AMS) and Freeway Management System (FMS).

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. The agency Project Manager shall be notified prior to the delivery to the TMC. No partial shipments will be accepted. All equipment supplied on this project will be delivered during a single delivery, and shall be labeled clearly with the project and location designation.

All equipment shall be approved prior to purchase by the FAST Manager or designee.

MATERIALS/EQUIPMENT

684.02.01 FUNCTIONAL REQUIREMENTS: The field switch shall comply with the following standards:

(a) Institute of Electrical and Electronic Engineers (IEEE) 802.IQ Local and Metropolitan Area Networks – Virtual Bridged Local Area Networks

(b) IEEE 802.1P: Traffic Class Expediting and Dynamic Multicast Filtering – Draft Eight (8)

(c) IEEE 802.3X: IEEE Standards for Local and Metropolitan Area Networks; Specifications for 802.3 Full Duplex Operation

(d) IEEE 802.1W: IEEE Standards for Local and Metropolitan Area Networks – Common Specifications – Part Three (3); Media Access Control (MAC) Bridges – Amendment Two (2) Rapid Configuration

(e) Federal Communications Commission (FCC) Rules and Regulations Vol. II, Part Fifteen (15) for Class A Equipment Electronic Compatibility and Susceptibility (Product electromagnetic compatibility is required)

(f) National Electronics Manufacturers Association (NEMA) TS- One (1) Section Two (2) – Traffic Control System. The following clauses apply:

(1) 2.1.2: Voltage

(2) 2.1.3: Frequency Range

(3) 2.1.4: Power Interruption

(4) 2.1.5 : Temperature and Humidity, as modified herein

(5) 2.1.6: Transients, Power Service

(6) 2.1.7: Transients, Input-output terminals

(7) 2.1.8: Nondestruct Transient Immunity

(8) 2.1.12: Vibration

(9) 2.1.13: Shock

(g) Underwriters Laboratory (UL) 60950 Safety Requirements for Information Technology (IT) Equipment (applicable to equipment safety)

(h) International Electrotechnical Commission IEC 61850-3 Communications Networks and Systems in Substations (applicable to Electro Magnetic Interference (EMI) immunity, Section 5.7 applies)

(i) Military Handbook MIL-HDBK-217F-2 Military Handbook for "Reliability Prediction of Electronic Equipment", Notice 2

Detailed Requirements:

(j) The field switch shall:

(1) Be twelve (12) port (minimum) 10/100 Base TX RJ-45

(2) Have a minimum of two (2) 100 Base FX fiber optical ports

(3) Operate non-blocking, at full wire speed

(4) Support remote reset and remote management

(5) Support IGMP snooping

(6) Support IP Multicast filtering

(7) Support remote turn on/off Base TX ports.

(k) The field switch shall also meet the following functionality and requirements.

(1) 10/100 Base TX port shall connect via RJ-45 connector. The ports shall operate as half-duplex or full-duplex (IEEE 802.3x) over one hundred (100) m segment lengths and provide auto-negotiation and Medium Dependent Interface/ Medium Dependent Interface, Crossover (MDI/MDIX) capability.

(2) Each 100 Base Fiber Transmission (FX) port shall connect vial fiber connectors and 9/125um single-mode fiber. Fiber connectors shall be available as Straight Tip (ST). The ports shall operate as full duplex (IEEE 802.3x) over fifteen (15) km segment lengths. The minimum link loss budget (OPB = Rx (min) – LED aging) shall be greater than or equal to fifteen (15) dB.

(3) The field switch shall provide the following advanced Layer 2 functions: IEEE 802.1Q VLAN with support for a minimum of one hundred twenty-eight (128) Virtual Local Area Networks (VLAN), IEEE 802.1P priority queuing, IEEE 802.1W rapid spanning tree (required), IEEE 802.3X flow control greater than or equal to one thousand twenty-eight (1,028), support automatic address learning of a minimum four thousand ninety-six (4,096) Medium Access Control (MAC) addresses and greater than or equal to one thousand twenty-eight (1,028) static MAC address.

(4) The field switch shall provide the following port security function: ability to configure static MAC addresses, ability to disable automatic address learning per ports; known

hereafter as secure port, secure ports only forward statically configured MAC addresses, trap and alarm upon any unauthorized MAC address and shutdown for programmable duration. Port shutdown requires administrator to manually reset the port before communications are allowed, all the above activities are done remotely.

(5) The field switch shall provide the following network management functions: SNMPv3 (RFC 2273), RMON (RFC 1757), Port Mirroring (RFC 1757), Spanning Tree (IEEE 802.1D), Rapid Spanning Tree (IEEE 802.1W)

(6) The field switch shall support telnet, Trivial File Transfer Protocol (TFTP) or File Transfer Protocol (FTP), Command Line Interface (CLI) and Simple Network Management Protocol (SNMP).

(l) The field switch shall have an integrated web interface. Reset/Reboot and firmware shall be supported via all methods listed above. All parameters and settings (network management, security, Layer 2 features, etc) shall be user configurable through the maintenance port, web interface Telnet and all other supported remote management tools.

(m) The field switch shall allow for stand-alone shelf mounting unit and DIN rail mounting.

(n) The field switch shall support the following:

(1) Power: nominal one hundred twenty (120) VAC, sixty (60) Hz. The unit shall be provided with all power conversion and regulation necessary to support electronics operation. The power input circuitry shall be designed to protect the electronics from damage by a power surge or under-voltage condition. Power consumption shall not exceed twenty (20) Watts.

(o) The field switch shall include a power status indicator.

(p) Physical Characteristics:

(1) Twelve (12)-Port

(2) The field switch shall not exceed three (3) inches high X seventeen and one quarter (17.25) inches wide or ten (10) inches deep (3" X 17.25 X 10)

(3) The weight shall not exceed six (6) pounds

(q) Environmental: The field switch shall conform to functional and performance specifications as defined herein when operated in the following environment.

(1) Temperature: -20°C. to 74°C.

(2) Humidity: Five (5) to ninety-five (95) percent relative humidity, non-condensing

(r) Cooling shall be by convection with case acting as heat sink. No cooling fan shall be used.

(s) The field switch shall have the following minimum indicators:

(1) Power: On, Off

(2) Network status per port: transmit, receive, link, speed

(t) Status indicators shall be Light Emitting Diode (LED).

(u) 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.

(v) The field switch shall have a minimum average time between failures of forty thousand (40,000) hours.

(w) Each unit shall have a unique MAC address, MAC address shall be derived from an address space of ten thousand (10,000) sequential addresses.

(x) Documentation: Upon delivery, the following minimum documentation shall be provided by the vendor with each field switch provided:

(1) Initial configuration (This document shall provide both hardware and software settings)

(2) Setup and configuration manual

(3) Users manual.

(z) Warranty: The field switch shall be warranted for a minimum of three (3) years. The warranty shall guarantee the field switch to be free from defects from assembly, fabrication and materials. The warranty will begin upon acceptance by the contracting agency.

METHOD OF MEASUREMENT

684.03.01 MEASUREMENT: The field switch shall be measured per each. The mounting hardware and cabling and network management software are considered incidental and will not be measured or paid separately to the unit.

BASIS OF PAYMENT

684.04.01 PAYMENT: The accepted quantity of field switch(s) will be paid at the contract unit price per each. The unit will include furnishing and configuration, and all labor, material and equipment required for facilitating an operational field switch.

Payment will be made under:

PAY ITEM:	**PAY UNIT**
Field-Hardened Ethernet Switch	Each

SECTION 685

VIDEO ENCODER

DESCRIPTION

685.01.01 GENERAL: 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) two (2) / MPEG four (4) video encoder. 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. The Video encoder shall be fully supported by Barco© ARGUS controller using Apollo version 1.6 used for the video wall equipment to include decoding of encoded video by Barco©.

The video encoder shall comply with the requirements stated within this specification so as to operate within the FAST Arterial Management System (AMS) and Freeway Management System (FMS).

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. The agency Project Manager shall be notified prior to the delivery to the TMC. No partial shipments will be accepted. All equipment supplied on this project will be delivered during a single delivery, and shall be labeled clearly with the project and location designation.

All equipment shall be approved prior to purchase by the FAST Manager or designee.

MATERIALS

685.02.01 FUNCTIONAL REQUIREMENTS: The video encoder shall comply with the following standards:

(1) National Electronics Manufacturers Association (NEMA) TS-one (1) Section two (2) – Traffic Control System. The following clauses apply:

(1) 2.1.2: Voltage
(2) 2.1.3: Frequency Range
(3) 2.1.4.1: Power Interruption
(4) 2.1.5: Temperature and Humidity, as modified herein
(5) 2.1.6: Transients, Power Service
(6) 2.1.7: Transients, Input-output terminals
(7) 2.1.8: Nondestruct Transient Immunity
(8) 2.1.12: Vibration
(9) 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 three (3) CSMA/CD Access Method and Physical Layer Specifications.

(4) Federal Communications Commission (FCC) Rules and Regulations Vol. II, Part Fifteen (15) for Class A Equipment Electronic Compatibility and Susceptibility (Product electromagnetic compatibility is required).

(5) Underwriters Laboratory (UL) 60950 Safety Requirements for IT Equipment (Applicable to equipment safety).

(6) Military Handbook MIL-HDBK-217F-2 Military Handbook for "Reliability Prediction of Electronic Equipment", Notice two (2).

Detailed Requirements

(a) The video encoder shall support the following video features:

(1) Signal format: Thirty (30) fps, NTSC color

(2) Resolution: 720 x 480 (full Resolution)

(3) Video Settings (contrast, saturation, brightness and hue)

(b) The video encoder shall support bi-directional serial communications over Ethernet via the following methods:

(1) Encoder serial port to decoder serial port data stream

(2) Internet Protocol (IP) socket to encoder serial port

(3) The video encoder shall support full-duplexed serial interface and data rates up to 57.6 bps. The baud rate, stop bits, data bits and flow control shall be user configurable. 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).

(c) The video encoder shall support the following:

(1) Encoding Formats: The unit shall be capable of being soft configured to perform MPEG-2 ISO/13818-2 video compression.

(2) The encoder shall be capable of being soft configured to produce elementary, or transport stream.

(3) Bandwidth: One and one half (1.5) Mbps – ten (10) Mbps for MPEG two (2) and sixty-four (64) Kbps to five (5) Mbps for MPEG four (4) (The data rate shall be defined as the maximum committed bandwidth to be utilized, which includes bursting). The default bandwidth for the video encoder shall be set to five (5) Mbps for MPEG two (2) and one (1) Mbps for MPEG four (4).

(4) Latency: The end-to-end latency between the video encoder and the video decoders shall be no more than two hundred fifty (250) ms while operating at a rate of five (5) Mbps.

(d) The video encoder shall support the following network features:

(1) Ethernet Interface (10/100 Mbps, Full-Duplex, Auto Negotiate (802.3), (RJ-45)

(2) Static IP Addressing (Class A, B and C)

(3) SNMP (MIB2)

(4) Unicast and Multicast (IGMP V2)

(5) Gateway Configuration

(6) Adjustable Packet Payload Size

(e) The video encoder shall support:

(1) Command Line Interface (CLI)

(2) Telnet

(3) Trivial File Transfer Protocol (TFTP) or FTP (new firmware download)

(4) The video encoder shall have an integrated web interface, which provides remote configuration.

(5) Reset/Reboot and firmware upload shall be supported via all methods listed above.

(6) All video (i.e. resolution, contrast, etc.), data (i.e. baud rate, parity, etc.), encoder (i.e. bandwidth, etc) and network (i.e. IP, subnet mask, gateway, etc.) parameters and settings shall be user configurable through the maintenance port, web interface, Telnet and all other supported remote management tools.

(7) All configurations and settings shall be downloadable / exportable in a document form. As a minimum, the exported settings shall include video, network, and data settings.

Failure and Reset Recovery: The recovery time of a hard or soft reset shall be less than forty-five (45) seconds.

Electrical:

(a) The video encoder shall support the following:

(1) Power: Nominal input voltage of one hundred twenty (120) VAC sixty (60) Hz. The unit shall contain all power conversion and regulation necessary to support electronics operation.

(2) Power consumption: Shall not exceed seventy (70) Watts.

(3) All supplied video encoders shall have the same power connectors. Each unit shall be provided with a power cable that is at least five (5) feet (1.5 meters) in length and terminated with a male, three (3) prong UL-listed power connector for interface with the previously stated power system.

Ports:

(a) 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: Two Electronics Industry Association (EIA)-RS232/422/485, DB-9* (Female) I/F. These ports shall provide data pass thru for serial control (i.e. PTZ camera control). If EIA RS422 is not provided natively by the port, an EIA RS232 to 422 converter meeting all encoder environmental requirements shall be supplied.

(4) Data: One (1) EIA-232 DB-9* (Female) I/F. This port shall provide maintenance interface for local configuration.

*RJ-45 may be provided in place of DB-9. For each RJ-45 port, a RJ-45 to DB-9 converter shall be supplied.

Status Indicators:

(a) The video encoder shall have the following minimum indicators:

(1) Activity

(2) Power

(3) Video Loss

(4) Transmit

(5) Receive

(b) Status indicators shall be LED.

Physical Characteristics:

(a) The video encoder shall not exceed two and one half (2 ½) inches high X twelve (12) inches wide X thirteen (13) inches deep (2 ½" X 12" X 13".)

(b) The weight shall not exceed ten (10) pounds.

External Markings:

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.

Environmental:

(a) The video encoder shall conform to the performance specification when operated in the following environment:

(1) Temperature: -20°Celsius to +70°Celsius (-4 degrees F. to 165 degrees F.)

(2) Humidity: Five (5) to ninety-five (95) percent relative humidity, non-condensing

(3) The video encoder shall be conformal coated to prevent damage from blowing sand and dust

(b) The video encoder shall have a minimum mean time between failures (MTBF) of sixty thousand (60,000) hours.

MAC Address:

Each unit shall have a unique MAC address, MAC address shall be derived from an address space of ten thousand (10,000) sequential addresses.

Network Management Software:

All custom Management Information Base (MIB's) required for network management shall be provided for use with third party network management software.

IP Addressing:

Each unit shall support and be delivered with two (2) user settable IP addresses, one (1) for command and control, and one (1) for video multicasting.

685.03.01 SUBMITTALS: The following shall be submitted by the Vendor to the contracting agency:

(a) Acceptance Test Procedures (stand-alone and operational)

(b) Training Syllabus

(c) Users Manual

(d) Parts List

(e) Description of MAC address scheme/space

(f) Certifications/Statement of: conformance to all standards listed in this section of the Uniform Standard Specifications. Testing for compliance will be performed by an independent party.

TESTING

685.04.01 TESTING: Prior to acceptance by the contracting agency the video encoder shall require testing as described below. The supplier 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. Prior to acceptance of any video encoder the following tests shall be performed:

(a) Stand Alone Acceptance Test (SAT): Using the FAST approved vendor-supplied test procedures, FAST will perform the SAT in a test area provided by FAST. A vendor representative may be present during the SAT. The Vendor will be provided with a schedule of the test, including time and place.

(b) The SAT will be performed as follows:

(1) The video encoder will be assembled and connected to power in a stand-alone configuration.

(2) The video encoder will be powered up and allowed to initialize, boot and run self-diagnostic tests as defined in the FASTapproved test procedures.

(3) After the video encoder has started and initialized, any additional test procedures will be executed.

(4) After the test procedures have been executed, the video encoder will be allowed to run, uninterrupted, for a burn-in period of seventy-two (72) hours.

(5) At the end of the burn-in period, the unit will be restarted and configuration verified.

(6) Upon completion of all test procedures, the Vendor will be notified of SAT acceptance or failure.

(c) Operational Test: After successful completion of the SAT, FAST will configure and connect the video encoder to the FAST test network. A FAST provided CCTV assembly will be connected (video and data) to the video encoder. Along with the video encoder, the network will also have a video decoder unit with a video monitor, and a Personal Computer (PC) operating the video decoder software and camera control application provided by the County. 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

(d) While connected to the network, the video encoder shall not, in any way compromise the function or functions or any other connected network device(s).

(e) Upon completion of all the tests, the Vendor will be notified of operational test acceptance or failure. If the unit fails the test, the Vendor shall supply a new unit and the test shall be restarted.

685.05.01 WARRANTY: The video encoder shall be warranted for a minimum of three (3) years. The warranty shall guarantee the video encoder to be free from defect from assembly, fabrication, and materials. The FAST and contracting agency may exercise the option of purchasing an extended warranty for an additional two (2) years utilizing the video encoder, extended two (2) year warranty item as indicated in Section 685.07.01 "Payment."

The warranty shall be provided in writing. If the normal manufacturers warranty extends for a longer period, the video encoder shall be warranted for that period.

The warranty shall be measured from the date of receipt by the contracting agency. The manufacturer shall be responsible for maintaining a list of equipment supplied and warranty information during the period of the warranty contract. A report shall be submitted to FAST annually which details the status of equipment warranties.

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.

The manufacturer shall also provide technical support coverage for all equipment and software furnished. This support shall as a minimum include the following:

(a) Software and firmware upgrades

(b) Software patches

METHOD OF MEASUREMENT

685.06.01 MEASUREMENT: The video encoder shall be measured per each. The unit will include furnishing all material required for facilitating an operational video encoder including all necessary jumpers. The video encoder, extended two (2) year warranty shall be measured by lump sum.

BASIS OF PAYMENT

685.07.01 PAYMENT: The accepted quantity of video encoder will be paid at the contract unit price per each. The unit will include furnishing and configuration, and all labor, material and equipment required for facilitating an operational video encoder. The lump sum price for video encoder, extended two (2) year warranty shall be full compensation for the extended warranty.

Payment will be made under:

PAY ITEM:	PAY UNIT
Video Encoder	Each
Video Encoder, extended two (2) year warranty	Lump sum

SECTION 686 - BLANK

SECTION 687

VIDEO DECODER

DESCRIPTION

687.01.01 GENERAL: 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) two (2) / (MPEG) four (4) video decoder. 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.

The video decoder shall be of the same manufacturer as and fully compatible with the video encoder provided under Specification 685 "Video Encoder".

The video decoder shall comply with the requirements stated within this specification so as to operate within the FAST Arterial Management System (AMS) and Freeway Management System (FMS).

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. The agency Project Manager shall be notified prior to the delivery to the TMC. No partial shipments will be accepted. All equipment supplied on this project will be delivered during a single delivery, and shall be labeled clearly with the project and location designation.

All equipment shall be approved prior to purchase by the FAST Manager or designee.

MATERIALS/EQUIPMENT

687.02.01 FUNCTIONAL REQUIREMENTS: The video decoder shall comply with the following standards:

(a) International Organization for Standardization: (ISO) 9001 Quality Assurance, MPEG-2 ISO/13818-2 Video Compression.

(b) Institute of Electrical and Electronic Engineers (IEEE) 802.3: Part Three (3): CSMA/CD Access Method and Physical Layer Specifications.

(c) (Federal Communications Commission (FCC) Rules and Regulations Vol. II, Part Fifteen (15) for Class A Equipment Electronic Compatibility and Susceptibility (Product electromagnetic compatibility is required).

(d) Underwriters Laboratory (UL) 60960 Safety Requirements for IT Equipment (Applicable to equipment safety).

(e) Military Handbook MIL-HDBK-217F-2 Military Handbook for "Reliability Prediction of Electronic Equipment", Notice 2.

Detailed Requirements:

(a) The video decoder shall inter-operate with the video encoders, as defined in Section 685 "Video Encoder."

(b) The video decoder shall support the following video features:

(1) The unit shall be capable of being soft configured to perform MPEG-two (2) ISO/13818-2 video decoding.

(2) The unit shall be capable of being soft configured to produce elementary or transport stream.

(3) Video stream of up to ten (10) Mbps, auto-detecting.

(4) Video frame rate up to thirty (30) fps and resolution of 720x480 pixels.

(5) Thirty (30) fps NTSC color video output.

(6) The end-to-end latency between the video encoder and the video decoders shall be no more than two hundred fifty (250) ms while operating at a rate of five (5) Mbps.

(c) The video decoder shall support the following network features:

(1) Ethernet Interface (10/100 Mbps, Half/Full-Duplex, Auto Negotiate (802.3), (RJ-45).

(2) Static Internet Protocol (IP) Addressing (Class A, B and C).

(3) Simple Network Management Protocol (SNMP) (M1B1, MIB2).

(4) Unicast and Multicast (IGMP V2).

(5) Gateway Configuration.

(d) The video decoder shall support:

(1) Command Line Interface (CLI).

(2) Telnet.

(3) Trivial File Transfer Protocol (TFTP) or FTP (new firmware download).

(4) The video decoder shall have an integrated web interface, which provides remote configuration and management features.

(5) Reset/Reboot and firmware upload shall be supported via all methods listed above.

(6) All video (i.e. resolution, contrast, etc.), data (i.e. baud rate, parity, etc), encoder (i.e. bandwidth, etc) and network (i.e. IP, subnet mask, gateway, etc.) parameters and settings shall be user configurable through the maintenance port, web interface, Telnet and all other supported remote management tools.

(7) All configurations and settings shall be downloadable / exportable in a document form. As a minimum, the exported settings shall include video, network, and data settings.

Failure and Reset Recovery:

- The recovery time of a hard or soft reset shall be less than forty-five (45) seconds.

Electrical:

(a) The video decoder shall support the following:

(1) Power: Nominal input voltage of one hundred twenty (120) VAC sixty (60) Hz. The unit shall contain all power conversion and regulation necessary to support electronics operation.

(2) Power consumption: Shall not exceed seventy (70) Watts.

(3) All supplied video decoders shall have the same power connectors. Each unit shall be provided with a power cable that is at least five (5) feet (1.5 meters) in length and terminated with a male, three prong UL-listed power connector for interface with the previously stated power system.

Ports:

(a) The video decoder shall have the following ports:

(1) Network: 10/100 Mbps RJ-45.

(2) Video: Composite Bayonet Neill-Concelman (BNC) and S-Video.

(3) Data: Two (2) Electronics Industry Association (EIA)-RS232/422/485, DB-9* (Female) I/F (supporting up to 57.6 kbps). These ports shall provide data pass thru for serial control (i.e. PTZ camera control).

(4) Data: One (1) EIA-232 DB-9* (Female) I/F. This port shall provide maintenance interface for local configuration.

*RJ-45 may be provided in place of DB-9. For each RJ-45 port, a RJ-45 to DB-9 converter shall be supplied.

Status Indicators:

(a) The video decoder shall have the following minimum indicators:

(1) Activity

(2) Power

(3) Video Loss

(4) Transmit

(5) Receive

(b) Status indicators shall be (Light Emitting Diode) LED.

Physical Characteristics:

(a) The video decoder shall not exceed two and one half (2 ½) inches high X twelve (12) inches wide X thirteen (13) inches deep (2 ½" X 12" X 13").

(b) The weight shall not exceed ten (10) pounds.

External Markings:

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.

Environmental:

(a) The video decoder shall conform to the performance specification when operated in the following environment:

(1) Temperature: Zero (0) degrees Celsius (+32 degrees F.)to forty (+40) degrees Celsius. (104 degrees F.).

(2) Humidity: Five (5) to ninety-five (95) percent relative humidity, non-condensing.

(b) The video decoder shall have a minimum mean time between failures (MTBF) of sixty-thousand (60,000) hours.

MAC Address:

Each unit shall have a unique MAC address, MAC address shall be derived from an address space of ten thousand (10,000) sequential addresses.

Network Management Software:

All custom Management Information Base (MIB's) required for network management shall be provided for use with third party network management software.

IP Addressing:

Each unit shall support and be delivered with two (2) user settable IP addresses, one (1) for command and control, and one (1) for video multicasting.

687.03.01 SUBMITTALS: The following shall be submitted by the Vendor to the contracting agency:

(a) Acceptance Test Procedures (stand-alone and operational)

(b) Training Syllabus

(c) Users Manual

(d) Parts List

(e) Description(s) of MAC address scheme / space

(f) Certifications / Statement of: Conformance to all standards listed in the standard specification. Testing for compliance will be performed by an independent party.

687.04.01 TESTING: Prior to acceptance by the contracting agency, the video decoder shall require testing as described below. The vendor shall absorb all costs associated with the testing including and not limited to shipping and handling, all material and equipment and any labor. Prior to acceptance of any video decoder the following tests shall be performed:

(a) Stand Alone Acceptance Test (SAT): Using the FAST approved vendor-supplied test procedures, FAST will perform the SAT in a test area provided by FAST. A vendor representative may be present during the SAT. The Vendor will be provided with a schedule of the test, including time and place.

(b) The SAT will be performed as follows:

(1) The video decoder will be assembled and connected to power in a stand-alone configuration.

(2) 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.

(3) After the video decoder has started and initialized, any additional test procedures will be executed.

(4) After the test procedures have been executed, the video decoder will be allowed to run, uninterrupted, for a burn-in period of seventy-two (72) hours.

(5) At the end of the burn-in period, the unit will be restarted and configuration verified.

(6) Upon completion of all test procedures, the Vendor will be notified of SAT acceptance or failure. If the unit fails the test the Vendor shall supply a new unit and the test shall restart.

(c) Operational Test: After successful completion of the SAT, FAST will configure and connect the video decoder to the FAST Test Network. Along with the video decoder, the network will also have a video encoder unit as specified in section six hundred eighty-five (685) and a Personal Computer (PC) operating the video decoder software, as specified by FAST, and the camera control application provided by FAST.

(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.

(e) While connected to the network, the video decoder shall not, in any way compromise the function or functions or any other connected network device(s).

(f) Upon completion of all the tests, the Vendor will be notified of operational test acceptance or failure. If the unit fails the test, the Vendor shall be disqualified and the Agency will proceed with the next low qualified bidder.

687.05.01 WARRANTY: The video decoder shall be warranted for a minimum of three (3) years. The warranty shall guarantee the video decoder to be free from defect from assembly, fabrication, and materials. The FAST and contracting agency may exercise the option of purchasing an extended warranty for an additional two (2) years utilizing the item number as indicated in Section 687.07.01, "Payment."

The warranty shall be provided in writing. If the normal manufacturers warranty extends for a longer period, the video decoder shall be warranted for that period.

The warranty shall be measured from the date of receipt by the contracting agency. The manufacturer shall be responsible for maintaining a list of equipment supplied and warranty information during the period of the warranty contract. A report shall be submitted to FAST annually which details the status of equipment warranties.

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.

The manufacturer shall also provide technical support coverage for all equipment and software furnished. This support shall as a minimum include the following:

(a) Software and firmware upgrades.

(b) Software patches.

METHOD OF MEASUREMENT

687.06.01 MEASUREMENT: The video decoder shall be measured per each. The unit will include furnishing all material required for facilitating an operational video encoder including all necessary jumpers. The video decoder, extended two (2) year warranty shall be measured by lump sum.

BASIS OF PAYMENT

687.07.01 PAYMENT: The accepted quantity of video decoder will be paid at the contract unit price per each. The unit will include furnishing and configuration, and all labor, material and equipment required for facilitating an operational video decoder. The lump sum price for video decoder, extended two (2) year warranty shall be full compensation for the extended warranty.

Payment will be made under:

PAY ITEM:	PAY UNIT
Video Decoder	Each
Video Decoder, extended two (2) year warranty	Lump sum

SECTION 688

REMOTE DATA RADIO COMMUNICATION SYSTEM

DESCRIPTION

688.01.01 GENERAL: The data radio unit for installation at remote intersection traffic signal control shall be of solid state design. It 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. The remote station data radio unit shall be Microwave Data System (MDS) – MDS 9710A (or approved equal) and shall meet the following requirements:

The remote data radio unit shall be configurable as a master station or remote radio. They shall be capable of operating as a half-duplex or simplex radio and shall support all splits in duplex frequencies. Full network diagnosis shall be available when operating as a master station. The units shall provide high system performance and data integrity through digital signal processing. The data radio units shall have the ability to communicate with any asynchronous protocol without extra software or programming.

MATERIALS / EQUIPMENT

688.02.01 FUNCTIONAL REQUIREMENTS: The remote data radio units shall conform to the following general requirements:

(a) Supply Voltage: (10.5) VDC to (16.5) VDC.

(b) Tx Current: Two (2) amps typical at five (5) watts.

(c) Rx Current: Less than one hundred twenty five (125) milliamps.

(d) Sleep Mode: Fifteen (15) milliamps nominal Humidity: ninety-five (95) percent at forty (40) degrees Centigrade, non-condensing.

(e) Temperature Range: Negative thirty (-30) to sixty (+60) degrees Centigrade.

(f) Data Rate: Ninety-six thousand (9,600) bps (rf).

(g) Port Speed: Three hundred (300) to ninety-six thousand (9,600) bps (rf and data) at (12.5) kHz Channel spacing.

(h) Bit error rate: BER x .000001.

(i) Casing: Die cast aluminum.

(j) Dimensions: Two (2) inches by six (6) inches by eight (8) inches maximum.

(k) Weight: Two and a one half (2.5) pounds maximum.

(l) Operational Modes: Async. – Simplex, half-duplex.

(m) Data Interface: RS-232, DB-25 Female connector supports: TXD, RXD, RTS, CTS, DCD, RUS, AUX 14. POWER, DSR, and GND.

(n) Synthesizer Range: Four hundred (400) kHz sliding window, manually tunable.

(o) Current Consumption:

(1) RF Unit Rx/Standby: Seventy (70) milliamps maximum.

(2) RF Unit Tx: (1.6) amps nominal.

(p) TX to RX Transition Time: Three (3) milliseconds RSSI Squelch.

Modem/Diagnostics: The remote data radio units shall conform to the following:

(a) Modulation: Digital / CPFSK.

(b) CTS Delay: Zero (0) to two hundred fifty-five (255) millisecond, programmable in one (1) millisecond increments.

(c) PTT Delay: Zero (0) to two hundred fifty-five (255) millisecond, programmable in one (1) millisecond increments.

Radio Receiver: The radio receiver shall conform to the following:

(a) Type: Double conversion superheterdyne

(b) Frequency Stability: ± fifteen (0.00015) percent (1.5 ppm).

(c) Adjacent Channel: Sixty (60) dB nominal.

(d) Sensitivity twelve (12) dB Sinad: Negative one hundred seventeen (-117) dBm nominal.

(e) Spurious Rejection: Eighty (80) dB.

(f) Desensitization: Sixty-five (65) dB at twelve and one half (12.5) kHz and seventy (70) dB at twenty-five (25) kHz nominal.

(g) IF Selectivity: One hundred (100) dB at adjacent channel.

(h) Electronic Industry Association (EIA) Inter-modulation: Sixty-five (65) dB.

(i) RSSI: Negative one hundred and twelve (-112) dBm to negative fifty-four (-54) dBm.

(j) Squelch Opening Time: One and one half (1.5) milliseconds.

(k) Audio Outputs:

(1) Filtered: Negative ten (-10) dB, Six hundred (600) ohm unbalanced, adjustable.

(2) Unfiltered: Forty (40) mV RMS at two (2) kHz Dev.

(l) Harmonic Distortion: Three (3) percent maximum.

Radio Transmitter: The radio transmitter shall conform to the following:

(a) RF Power: Adjustable between (0.5) w and (5) w at (13.6) VDC.

(b) Duty Cycle: Continuous.

(c) Time Out Timer: Programmable between one (1) second and two hundred fifty-five (255) seconds, or OFF.

(d) Spurious and Harmonics: Negative fifty-five (-55) dBc maximum.

(e) Hum and Noise: Negative forty (-40) dB between three hundred (300) and three thousand 3,000 Hz.

(f) Audio Inputs:

(1) Filtered: Negative ten (-10) dBm six hundred (600) ohms unbalanced, adjusted, at two (2) kHz Dev.

(2) Unfiltered: Two hundred forty-five (245) mV RMS at two and one half (2.5) kHz Dev.

(g) Audio Response:

(1) Filtered: Between one (1) dB and negative three (-3) dB from five (5) Hz to three thousand (3,000) Hz,

(2) Unfiltered: One (1) dB and negative three (-3) dB from five (5) Hz to four thousand (4,000) Hz.

(h) Frequency Stability: ±0.00015 percent (1.5 ppm).

(i) Transmitter Attack Time: Less than one (1) millisecond to within one hundred (100) Hz.

(j) Carrier Power: Programmable from one-tenth (0.1) to five (5) watts.

(k) Carrier Power Accuracy: Normal plus or minus one and one half (1.5) dB.

(l) Output Impedance: Fifty (50) ohms.

Connectors and Harnesses: 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. The remote data radio unit is for with the FAST system.

Power Requirements: The remote data radio units shall meet all specified requirements when the input power is one hundred twenty (120) VAC plus or minus ten (10) VAC, and fifty-five (55) Hz plus or minus five (5) Hz.

Antennae Requirements: A Yagi type antennae with nine (9) dB gain shall be provided with each unit. The antennae shall be capable of operation within the nine hundred forty (940) to nine hundred sixty (960) MHz bandwidth.

Software Requirements: All software necessary for the units to be fully functional shall be down-loaded into the devices at the factory before shipment.

Compliance to FAST: All equipment supplied shall conform to the requirements of FAST.

METHOD OF MEASUREMENT

688.03.01 MEASUREMENT: The quantity of remote data station radio unit shall be measured per each. This item shall include providing and installing the radio unit as shown on the plans.

METHOD OF PAYMENT

688.04.01 PAYMENT: The accepted quantity of remote data station radio unit(s) will be paid at the contract unit price bid per each which shall be full compensation for the equipment, measured as provided under "Method of Measurement," as specified and shown on the drawings.

Payment will be made under:

PAY ITEM:	PAY UNIT
Remote Data Station 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

PORTLAND CEMENT

SCOPE

701.01.01 MATERIALS COVERED: This specification covers the five types of Portland cement as required under pertinent sections of these specifications and Type I-P. Unless otherwise provided, the cement to be used for all Portland cement concrete, mortar, cement-treated base, and cement-treated subgrade shall be in accordance with the following table:

Type of Cement Permitted	Minimum Sacks of Cement Per Per Cubic Yard	Maximum Water (Plus Cement Fly Ash) Ratio
Type II & Fly Ash	6.5[1,2]	0.45
Type 1-P (MS)	6.5	0.45
Type V	6.5 [2]	0.45
Type V & Fly Ash	6.0[1,3]	0.45

Note: [1] - Sacks per cubic yard before replacement with fly ash.
[2] - 6.0 sacks per cubic yard for precast products, pipe and box, with zero slump mix design.
[3] - 5.5 sacks per cubic yard for precast products, pipe and box, with zero slump mix design.

MATERIALS

701.02.01 GENERAL: Unless otherwise specified the type of cement used is to 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.

Portland cement concrete shall be subject to the requirements of Section 501, Table 1, except as herein noted.

Cement to be removed and replaced with fly ash shall be 13% to 20% of the weight of cement. Fly ash added at the mixer shall be in a proportion of 1.2 minimum to the weight of cement removed.

Class F fly ash conforming to the requirements of Section 729, "Fly Ash," shall be used.

702.03.05 HYDRATED LIME: Hydrated lime shall conform to the requirements of ASTM C 207, Type N.

702.03.06 SUBMITTAL: Curing compounds and admixtures shall be tested and certified per the Table 1 frequency. 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. A test certificate shall be included with the certifying document.

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.

The **Statute of Limitations** duration for the record storage shall be as required by the Nevada Revised Statutes.

Table 1. Submittal Requirements

ITEM	REQUIREMENT	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: 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: Bituminous material failing the requirements (including tolerances) of the tests hereinafter prescribed shall be subject to the provisions of Subsection 109.02, "Scope of Payment," and attention is directed thereto.

703.02.02 MATERIAL SOURCE RESPONSIBILITY: Bituminous materials supplied under these specifications shall be provided from a source authorized by the Entity Engineer and/or IQAC. The process for authorization maybe obtained from the Entity Public Works Construction Management Division.

703.02.03 SHIPPING NOTICE: Shipping notices shall be mailed upon making shipment and shall contain the following information:

(a) Consignee and destination

(b) Agency contract number

(c) Delivery point

(d) Date shipped

(e) Car initials or number of truck transport delivery ticket number

(f) Type and grade of material

(g) Quantity loaded

(h) Loading temperature

(i) Net quantity

(j) Signature of shipper or authorized representative

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 by, or observed by a NAQTC certified technician.

Three copies of the shipping notice shall be mailed to the Contracting Agency.

PHYSICAL PROPERTIES AND TESTS

703.03.01 REFINERY TEST REPORT: Refinery test reports shall be mailed to the Engineer as soon as tests have been completed, and the report shall contain the following data:

(a) Date of shipment

(b) Car initials or number of truck transport delivery ticket number

(c) Destination and consignee

(d) Contracting Agency contract number (or purchase order number, if applicable)

(e) Type and grade of material

(f) Certificate of grade (certify that material conforms to these specifications, and itemize results on tests performed and date of test)

(g) Signature of refinery's authorized representative

The certificate of compliance shall be used as a basis 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: Asphalt cement shall be prepared by the distillation of crude petroleum. This asphalt shall be homogeneous, free from water, and shall not foam when heated to three hundred forty-seven (347) degrees Fahrenheit (175°C).

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 for the Southern Nevada region as listed in Table 1, 2, 2A, and 2B. The Performance Grades are to be used only when required in the Agency Contract special provisions for Capital Improvements or Agency 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 PG64-22*
Mountain Roads at / and above 6,000 feet elevation	PG 64 -34CC

* Sixty (60') right of way or less

The various grades set forth above shall conform to the requirements and the methods of testing shown in Tables 2, 2A, and 2B. Performance grade (PG) material must have been prepared from crude petroleum product. The asphalt cements shall be homogenous, free from water and shall not foam when heated to three hundred forty-seven (347) degrees Fahrenheit (175°C). Blending of asphalt cements to produce a specified performance grade shall result in a uniform, homogenous blend with no separation. Modified binders shall be blended at the source of supply and delivered as a completed mixture to the job site. It shall not be transported via railroad car. 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: Liquid asphalts shall consist of materials conforming to the following classifications. Rapid curing products designated by the letters RC, shall consist of paving asphalt with a penetration of approximately eighty five (85) to one hundred (100) fluxed or blended with a naphtha solvent. Medium curing products, designated by the letters MC, shall consist of paving asphalt fluxed or blended with a kerosene solvent. Slow curing products, designated by the letter SC, shall consist of natural crude oils or residual oils from crude asphaltic petroleum. When tested in accordance with the standard methods of AASHTO and ASTM, the grades of liquid asphalt shall conform to the requirements specified in Tables 2, 3, and 4.

703.03.04 EMULSIFIED ASPHALT: 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: 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 MICRO-SURFACING: The micro-surfacing 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: 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. (60°C.)

(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. (60° C.), poise	T 202	200-300	400-600	800-1200	1600-2400	2400-3600	3200-4800
Viscosity at 275° F. (135° C.), cs, min.	T 201	125	175	250	300	350	400
Penetration at 77°F. (25°C.), 100 g/5 sec., min.	T 49	220	140	80	60	50	40
Flash point (C.O.C., °F. min.)	T 48	325	350	425	450	450	450
Solubility in Trichloroethylene (percent, min.)	T 44	99	99	99	99	99	99
Ductility at 39°F. (4°C.), 1 cm./min., cm. min.	T 51	50	25	15	5	---	---
Tests On Residue From RTFC:							
Loss on heating, percent max.	T 240	---	1	0.5	0.5	0.5	0.5
Viscosity at 140°F. (60° C.), poise max.	T 202	1000	2000	4000	8000	12000	16000

Table 2A – PERFORMANCE GRADE FOR ORIGINAL MATERIALS

Characteristics	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. (4°C.) 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				
Characteristics	**Test Method**	**PG 76-22CC Modified**	**PG 64-34CC Modified**	**PG 64-22**
Ductility at 39.2°F. (4°C.) 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 R 28	100	100	100
Dynamic Shear G*/sin ä = Max 5,000 kPa @ 10 rad/s Test Temp. in °C.	AASHTO T 315	31	19	25
BBR - Creep Stiffness S = 300 Mpa Maximum m-value = 0.30 Minimum @ 60s Test Temp. in °C.	AASHTO T 313	-12	-24	-12
Direct Tension Failure Strain = 1.0% Minimum @ 1.0 mm/min Test Temp. in °C.	AASHTO T 314	-12	-24	-12

TABLE 3

UNIFORM PACIFIC COAST SPECIFICATIONS FOR RAPID-CURING (RC) LIQUID ASPHALTS

Characteristics	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. (60°C.), cs.		D 2170	70	140	250	500	800	1600	3000	6000
Flash Point (Open Tag),° F.	T 79	D 1310	---	---	80	---	80	---	80	---
Distillation										
Distillate percent of total distillate to 680°F. (360°C.)			10		---		---		---	
to 437°F. (225°C.)	T 78	D 402	50		30		15		---	
to 500°F. (260°C.)			70		60		45		25	
to 600°F. (316°C.)			85		80		75		70	
Residue from distillation to 680°F. (360°C.), volume percent by difference			55		65		75		80	
Test on Reside from Distillation										
Penetration, 77°F. (25°C.), 100g/5 sec.	T 49	D 5	80	120	80	120	80	120	80	120
Ductillity, 77°F. (25°C.), cms.**	T 51	D 113	100	---	100	---	100	---	100	---
Solubility in Trichloroethylene, %	T 44	D 2042	99.5	---	99.5	---	99.5	---	99.5	---
Water, %	T 55	D 95	---	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.

TABLE 4

UNIFORM PACIFIC COAST SPECIFICATIONS FOR MEDIUM-CURING (MC) LIQUID ASPHALTS

Characteristics	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. (60°C.), cs.	T 201	D 2170	70	140	250	500	800	1600	3000	6000
Flash Point (Open Tag),° F.	T 79	D 1310	100	---	150	---	150	---	150	---
Distillation										
Distillate (percent of total distillate to 680°F.) (360°C.)										
to 437°F.) (225°C.)			---	20	---	10	---	---	---	---
to 500°F.) (260°C.)	T 78	D 402	20	60	15	55	---	35	---	15
to 600°F.) (316°C.)			65	90	60	87	45	80	15	75
Residue from distillation to 680°F										
(360°C.) volume percent by difference			55	---	67	---	75	---	80	---
Test on Reside from Distillation										
Penetration,77°F. (25°C.), 100g/5 sec.	T 49	D 5	120	250	120	250	120	250	120	250
Ductility, 77°F. (25°C.), cms.**	T 51	D 113	100	---	100	---	100	---	100	---
Solubility in Trichloroethylene, %	T 44	D 2042	99.5	---	99.5	---	99.5	---	99.5	---
Water, %	T 55	D 95	---	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

* Flash Point by Cleveland Open Cup may be used for products having a flash point greater than 175°F. (79°C.)

** If penetration of residue is more than two hundred (200) and it ductility at 77°F. (25°C.) is less than one hundred (100, the material will be acceptable if its ductility at 60 °F. (15.6°C.) is 100+

TABLE 5

UNIFORM PACIFIC COAST SPECIFICATIONS FOR SLOW-CURING (SC) LIQUID ASPHALTS

Characteristics	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. (60°C.), cs.	T 201	D 2170	70	140	250	500	800	1600	3000	6000
Flash Point (Open Tag),° F.	T 48	D 1310	150	---	175	---	200	---	250	---
Distillation										
Total Distillate to 680°F.										
(360°C.), % by volume	T 78	D 402	10	30	4	20	2	12	---	5
Kinematic Viscosity of Distillation										
Residue at 140°F. (60°C.), Strokes	T 201	D 2170	4	70	8	85	20	140	40	350
Asphalt Residue of 100										
Penetration, %,	T 56	D 243	50	---	60	---	70	---	80	---
Ductility of 100 penetration Asphalt										
Residue at 77°F. (25°C.), cms.	T 51	D 113	100	---	100	---	100	---	100	---
Solubility in Trichloroethylene, %	T 44	D 2042	99.5	---	99.5	---	99.5	---	99.5	---
Water, %	T 55	D 95	---	0.5	---	0.5	---	0.5	---	0.5

TABLE 6
UNIFORM PACIFIC COAST SPECIFICATIONS FOR ANIONIC EMULSIFIED ASPHALTS

Type			Rapid Setting				Slow Setting			
			RS - 1		RS - 2		SS - 1		SS - 1h	
Grade	AASHTO Test Method	ASTM Test Method	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Test on Emulsions:										
Viscosity SSF @ 77°F.										
(25°C.), sec.	T 72	D 88	20	100	---	---	20	100	20	100
Viscosity SSF @ 122°F.										
(50°C.), sec.	T 72	D 88	---	---	75	400	---	---	---	---
Settlement, 5 days, %*	T 59	D 244	---	5	---	5	---	5	---	5
Storage Stability, 1 day**	T 59	D 244	---	1	---	1	---	1	---	1
Demulsibility, 35 ml .02N	T 59	D 244								
Calcium Chloride***	T 59	D 244	60	---	60	---				
Cement Mixing Test %	T 59	D 244					---	2.0	---	2.0
Sieve Test, %	T 59	D 244	---	0.10	---	0.10	---	0.10	---	0.10
Residue by distilliation, %	T 59	D 244	55	---	63	---	57	---	57	---
Test on Residue from										
Distillation Test:			(4)	(4)	(4)	(4)				
Penetration @ 77°F. (25°C)	T 49	D 5	100	200	100	200	100	200	40	90
Ductility 77°F. (25°C)										
5 cm/min., cm.	T 51	D 113	40	---	40	---	40	---	40	---
Solubility in trichloroethylene, %	T 44	D 2042	97.5	---	97.5	---	97.5	---	97.5	---

* The test requirement for settlement may be waived when the emulsified asphalt is used in less than five (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 five (5) days.

** The twenty-four (24) hours one (1 day) storage stability test may be used instead of the five (5) day settlement test.

*** The demulsibility test shall be made within thirty (30) days from 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 ASPHALT

Type			Rapid Setting				Medium Setting						Slow Setting				Quick Setting (6)	
Grade	AASHTO Test Method	ASTM Test Method	CRS-1		CRS-2		CMS-2S		CMS-2		CMS-2h		CSS-1		CSS-1h		CQS-1h	
			Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Tests on Emulsions:																		
Viscosity SSF 77°F. (25°C.) sec.	T 72	D 88	---	---	---	---	---	---	---	---	---	---	20	100	20	100	20	100
Viscosity SSF 122°F. (50°C.) sec.	T 72	D 88	20	100	100	400	50	450	50	450	50	450	---	---	---	---	---	---
Settlement 5 days, %*	T 59	D 244	---	5	---	5	---	5	---	5	---	5	---	5	---	5	---	5
Storage Stability Test one (1) day**	T 59	D 244	---	1	---	1	---	1	---	1	---	1	---	1	---	1	---	1
Demulsibility, 35 ml 0.8% sodium																		
dioctyl sulfosuccinate, %***	T 59	D 244	40	---	40	---	---	---	---	---	---	---	---	---	---	---	---	---
Coating Ability/Water Resistance	T 59	D 244																
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	T 59	D 244	POSITIVE		POSITIVE		POSITIVE		POSITIVE		POSITIVE		POSITIVE[5]		POSITIVE[5]		POSITIVE	
Sieve Test, %	T 59	D 244	---	0.10	---	0.10	---	0.10	---	0.10	---	0.10	---	0.10	---	0.10	---	0.10
Cement Mixing Text, %	T 59	D 244	---	---	---	---	---	---	---	---	---	---	---	2.0	---	2.0		
Distillation:																		
Oil Distillate by volume of																		
emulsion, %	T 59	D 244	---	3	---	3	---	20	---	12	---	12	---	---	---	---	---	---
Residue, %	T 59	D 244	60	---	65	---	60	---	65	---	65	---	57	---	57	---	60	---
Tests on Residue from Distillate Test:			(4)	(4)														
Penetration 77°F. (25°C.)	T 49	D 5	100	250	100	250	100	250	100	250	40	90	100	250	40	90	45	60
Ductility 77°F. (25°C.)	T 51	D 113	40	---	40	---	40	---	40	---	40	---	40	---	40	---	40	---
Solubility in Trichloroethylene, %	T 44	D 2042	97.5	---	97.5	---	97.5	---	97.5	---	97.5	---	97.5	---	97.5	---	97.5	---

* The test requirement for settlement may be waived when the emulsified asphalt is used in less than five (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 five (5) days.

** The twenty-four (24) hour one (1 day) storage stability test may be used instead of the five (5) day settlement test.

***The demulsibility test shall be made within thirty (30) days from 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 E 70) 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
60 minute set	ISSA T139	20 - 21 kg/cm
Set Time, 30 minutes	ASTM D3910	negative
Excess Asphalt by LWT & 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 D-3910/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
60 minute set	ISSA T139	20 kg/cm
Excess Asphalt by LWT & 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 (25°), 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]			
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, the 'Residue by Distillation' is preferred and shall be used as the reference procedure.
[3] Note 3: ASTM D5546, "Test Method for Solubility of Polymer-Modified Asphalt Materials in 1,1,1-Trichloroethane" 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: This specification covers the quality and size of mineral materials used in base courses., trench backfill , or other construction locations.

The term Source shall mean any of the following:

a) A permanent commercial location,

b) Contractor manufactured material either commercial or onsite.

704.01.02 REFERENCE CODES AND STANDARDS:

a) Uniform Standard Specifications for Public Works' Construction Off-site Improvements, Clark County Area Nevada that will henceforth be referred to as "USS" Specifications and Drawings

b) Contract Special Provisions and Drawings and Agency Policies and Procedures

c) NRS. 338.176, NAC 625.550

d) Most current ASTM, AASHTO, ACI or NDOT test & inspection procedures

e) Related Interagency Quality Assurance Committee (IQAC) procedures at www.accessclarkcounty.com/pubworks/iqac/IQAC.htm

REQUIREMENTS

704.02.01 GENERAL: 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:

(a) The character of the material is such, in the opinion of the Engineer, as to make improbable the furnishing of aggregates conforming to the requirements of these specifications.

(b) The character of the material is such, in the opinion of the Engineer, that undue additional costs may be accrued by the Contracting Agency.

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: For expediting of material source and type approvals, and at the opinion of the Source, a website was established for the posting of qualified materials at:

www.accessclarkcounty.com/pubworks/iqac/IQAC.htm

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 the US specifications.

The IQAC posted materials as indicated in Table 1 are subject to re-approval as prescribed in Subsection 704.04.033, "Source Deficiencies," continued posting on the Interagency Quality Assurance Committee (IQAC) website. The procedure is annotated in Subsection 704.04.02, "Source Quality Control Testing Requirements".

Table 1 – IQAC Materials That Require Annual Qualification

Type II Aggregate Base
Type II Controlled Low Strength Material (CLSM)

Table 2 – Materials That Require Six Month Qualification

Type II blended with recycled Portland Cement Concrete

704.02.02 DEFICIENCIES: If the product of a deposit is deficient in material passing the No. 16 sieve, filler from other approved deposits may be added at the crushing and screening plants. This is not to be construed as a waiver of any of the requirements contained herein.

PHYSICAL PROPERTIES AND TESTS

704.03.01 PLASTIC LIMITS: 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: This aggregate shall conform to one of the following grading requirement:

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	0-100	0-55	70-100
No. 4	--	0-25	0-70
No. 8	0-5	0-15	--
No. 200	0-3	0-3	0-3

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: This aggregate shall conform to one of 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 T 27	Table 7
Sampling Aggregate from Calibrated Conveyor stream or belt cut[1]	AASHTO T 2	----------
Plasticity Index	AASHTO T 90[2]	Table 1
Liquid Limit	AASHTO T 89	35 Maximum
Resistance (R Value)	ASTM D 2844	60 Minimum
Percentage of Wear (500 Rev.)	AASHTO T 96	45% Maximum

704.03.04 TYPE II AGGREGATE BASE: 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

Table 9 – Type II Acceptance Limits

Quality Control Test	Test Method	Requirements
Sieve Analysis	AASHTO T 27	Table 7
Sampling Aggregate from Calibrated Conveyor stream or belt cut[3]	AASHTO T 2	----------
Fractured Faces	Nev. T 230	70% Minimum
Plasticity Index	AASHTO T 90[4]	Table 1
Liquid Limit	AASHTO T 89	35 Maximum
Resistance (R Value) or	ASTM D 2844	78 Minimum for road base
Resilient Modulus	AASHTO T 307	35,000 psi minimum for road base
Percentage of Wear (500 Rev.)	AASHTO T 96	45% Maximum
Total Available Water Soluble Sulfates[5]	AWWA 3500-NaD AWWA 4550 E	Less than 0.3% by dry weight of soil.

[1] Sampling from a stockpile permitted only after approval of the Engineer; the conveyor device shall be calibrated every three (3) months and recent attached to sample document.
[2] Test specimens shall be prepared following the dry preparation procedure AASHTO T 87
[3] Sampling from a stockpile permitted only after approval of the Engineer; the conveyor device shall be calibrated every three (3) months and recent attached to sample document.
[4] Test specimens shall be prepared following the dry preparation procedure AASHTO T 87

Type II Plantmix Aggregate as specified in Subsection 705.03.01 may be used in lieu of Type II Base Aggregate as specified above.

704.03.05 TYPE III AGGREGATE: 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 as per Subsection 704.03.04 with the following property testing.

Table 10 – Type III Acceptance Limits

Quality Control Test	Test Method	Requirements
Sieve Analysis	AASHTO T 27	704.03.05
Sampling Aggregate From Calibrated Conveyor stream of belt cut[6]	AASHTO T 2	----------
Plasticity Index	AASHTO T 90[7]	Table 1
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: Crushed rock shall be the product from approved aggregate deposits and shall only be used as directed by the governing agency. The mineral aggregate shall be clean, hard, 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"	100
No. 4	20-80
No. 200	0-15

[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 T 87
[8] Required only for placement around waterline pipe

Table 12 – Crushed Rock Acceptance Limits

Quality Control Test	Test Method	Requirements
Sieve Analysis	AASHTO T 27	704.03.05
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 1
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): CLSM shall consist of a low-strength, self-leveling concrete material composed of various combinations of cement, fly ash, aggregate, water, and chemical admixtures. It shall have a design compressive strength at an age of twenty eight (28) days within the ranges required in the table below for the specified class:

a) **Class I - (50 to 150 psi (345 kPa to 1.03 MPa)):** 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.

b) **Class II – (100 to 300 psi (1.03 Mpa to 2.07 Mpa)):** Specified where the minimum strength is of primary concern for pipe support.

c) **Class Special (as shown in project specifications or drawings):** Specified where project unique criteria, such as erosion control, are the primary concern.

d) **Class I and II CLSM:** The mix shall result in a product having a slump in the range of six (6) to ten (10) inches (150 to 250mm) at the time of placement. The Source of Contractor shall submit a mix design for approval by the engineer prior to placement. The mix design shall be supported by laboratory test data verifying the potential of the mix to comply with the requirements for these specifications.

CLSM will proportioned in general compliance with the methods outlined in ACI 211.1-91 Re-approved 1997, Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete. The following materials shall be used:

(a) Cement shall meet the requirements of Section 701, "Portland Cement". Type V cement shall be used unless otherwise specified.

[9] Sampling from a stockpile permitted only after approval of the Engineer; the conveyor device shall be calibrated every three (3) months and record attached to sample document.
[10] Test specimens shall be prepared following the dry preparation procedure AASHTO T 87
[11] Required only for placement around waterline pipe

(b) 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.

(c) Water shall meet the requirements of Section 722, "Water".

(d) Aggregates shall have one hundred (100) percent by total weight of the aggregate passing the one (1) inch (25 mm) screen and fifthteen (15) percent or less passing the No. 200 sieve. The aggregate shall meet the plastic limits requirements of Subsection 704.02.03, "Plastic Limits"

(e) Chemical admixtures shall meet the requirements of Subsection 702.03.03, "Air-Entraining Admixtures", and Subsection 702.03.04, "Admixtures Other Than Air-Entraining." Other admixtures specifically approved for CLSM may be used. All materials proportions shall be measured and the CLSM mixed in accordance with the requirements of Section 501, "Portland Concrete." Other proportion measuring and CLSM mixing systems are acceptable, if control can be demonstrated to be satisfactory to the Engineer. These other methods include continuous feed, volumetric measurement of proportions, and pug mill and continuous mixing plants.

If the CLSM mix does not produce a flowable consistency or exhibits excessive bleeding, the mix shall be adjusted. 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. Mix adjustments shall include, but not be limited to: aggregate gradation, cementitious material content, admixtures, water content, or a combination of adjustments.

The testing for approval by IQAC or contract special provision requirements, the material Source, which may be the Contractor, shall cast one set of six each four-inch diameter by eight (8) inch high (600 millimeter by 1200 millimeter) specimens in split cylinders. No rodding method shall be used for the placement of the CLSM into the cylinders. All field curing and environmental protection shall conform to the AASHTO T23 Test Methods for Making and Curing Concrete Test Specimens in the Field. The cast specimens shall then be laboratory-cured in one hundred (100) percent humidity, temperature-controlled concrete cure room (cure tanks shall not be used). Compressive strength testing shall be performed in accordance with AASHTO T22 and T23 with samples from each set at the ages of seven (7), twenty-eight (28), and ninety (90) days. A report of the results shall be submitted to the Engineer.

Class Special: the compressive strength testing procedures shall be as specified in the project specifications or on the project drawings.

Bonded Aggregate Fill (BAF): This material is a crushed rock-cement slurry consistency. BAF may be used only with the prior approval of the Engineer. The material Source have it designed under the responsible charge of a Nevada PE which shall consist of a gap graded one half (½) inch maximum nominal size crushed gravel bounded by a one (1) sack minimum Type V cement and water slurry. The material shall be plant mixed and placed from a truck. 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 at each manhole as specified in Subsection 208.03.01, "Trench Excavation, General". This procedure does not require concrete cylinder break testing however does require a visual inspection and documented in a report to the Engineer as follows:

After the first batch is placed and initially cured, excavate to the bottom of the pipe or structure. If a self-supporting vertical face is maintained, the material is functioning properly.

704.03.08 AGGREGATE FOR PORTLAND CEMENT TREATED BASE: 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 T 27	Table 14
Sampling Aggregate from Calibrated Conveyor stream or belt cut[12]	AASHTO T 2	1/1000 Tons per day or portion thereof
Percentage of Wear (500 Rev.)	AASHTO T 96	45% Maximum

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

(a) 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.

(b) 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.

704.04 SOURCE QUALITY CONTROL TESTING: There are two (2) testing aspects to Source material acceptance.

(a) Testing by the Source for annual posting on the IQAC web page of qualified materials.

(b) Contractor project quality control Source testing for non-qualified materials.

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.

Any laboratory submitting to an agency shall be R-18 AASHTO accredited in the appropriate test method

[12] Sampling from a stockpile permitted only after approval of the Engineer. The conveyor device shall be calibrated every three (3) months and record attached to sample document.

per Table 13, 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, however must have responsible charge of the testing and/or inspection.

704.04.01 IQAC ANNUAL MATERIAL PREQUALIFICATION: 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 per the Table 13 "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 web page next to the Source material at:

http://www.accessclarkcounty.com/pubworks/iqac/IQAC.htm

Test data shall be included with the certifying document.

The maximum qualification period is one (1) year or six (6) months for aggregate blended with crushed concrete. The entire qualification process must be completed, in accordance with the sections above, prior to the first day of April. For aggregates blended with crushed concrete, the first day of April and the first day of October for each year. This includes, but is not limited to, submittal, agency review, all required retesting, and qualification from the IQAC member.

704.04.02 NON-PREQUALIFIED MATERIALS: 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 to the above noted specification and must have been tested within sixty (60) days of the intended use.

704.04.03: SUBMITTAL: All tests specified in this section shall be performed. 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. The most current ASTM, AASHTO, NDOT, and AWWA methods shall be used when performing the tests.

All samples shall be "cut" from the "belt". When circumstances do not allow for sampling during production, the source must coordinate with the Engineer to identify an alternative plan for sampling.

<u>IQAC Annual Submittal</u>

For the purposes for the IQAC submittal, the Engineer is the IQAC reviewing agency as noted on the IQAC web page. 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. The Engineer shall be notified a minimum of forty eight (48) hours prior to obtaining the sample. If the Engineer is not present during the sampling of the material, the results for that sample will not be accepted. Sampling must be performed during normal working hours for the Engineer. If the Source laboratory results are in compliance with the standard specifications, Source shall submit the test report to the Engineer within twenty one (21) days of sampling requesting the review and approval of the materials for the proposed use of the material.

Notification by the Source of samples not in compliance with the standard specifications is requested but not required. Samples without notification or a qualification submittal within the twenty one (21) day period will be assumed by the IQAC to be outside the standard specifications.

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.

<u>Non-prequalified materials (materials not posted on the IQAC list)</u>

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. The Engineer shall be notified a minimum of forty eight (48) hours prior to obtaining the sample. If the Engineer is not present during the sampling of the material, the results for that sample will not be accepted. Sampling must be performed during normal working hours for the Engineer. If the Source laboratory results are in compliance with the standard specifications, the Source shall submit the test report to the Engineer within twenty one (21) days of sampling with a letter requesting the review and approval of the materials report for the proposed use of the material.

Notification by the Source of samples not in compliance with the standard specifications is requested but not required. Samples without notification or a qualification submittal within the twenty one (21) day period will be assumed by the IQAC to be outside the standard specifications. The Source shall submit to the Engineer, within between sixty (60) to fourteen (14) days prior to use, the material test report

The qualification is for one project only.

704.04.04 REPORT FORMAT: The report must be prepared by 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:

(a) Recommendation by the Source Professional Engineer

(b) The testing results per the appropriate Table 13 test methods reporting requirements along with any graphs and chart.

When "no exceptions" are taken, a conditional posting on the web site will be provided by the IQAC within ten (10) days of the receipt of the submittal.

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 ten (10) days of receipt of the qualification submittal.

704.04.05 SAMPLING AND TESTING: It is the intent of these specifications that with respect to soils and aggregates, the Contractor or Material Sources conform in all respects to the requirements of the specifications

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. If a mechanical means is not provided, a belt cut from a stopped conveyor will be required. 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 his representative. The sampling device shall be so constructed to provide for simultaneous "cutting" of the entire section of material being discharge or conveyed, and so constructed that small representative samples may be taken frequently and these samples combined to form the complete sample. The reference method for the mechanical procedure shall be a "belt cut" sample taken from a stopped conveyor belt. 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.

Test results run from samples taken will be furnished to the Engineer as required in the USS by the Contractor's representative. The results of such tests shall not be the basis for final acceptance of the material.

Sampling for final acceptance of materials will be as required in the appropriate USS sections and in general must comply with the AASHTO requirements, where applicable and with any exception to the

[13] The form is on the IQAC web site at http://www.accessclarkcounty.com/pubworks/iqac/IQAC.htm or use an Agency approved form

method(s) listed on the Clark County web page at:
http://www.accessclarkcounty.com/pubworks/iqac/QA.htm under testing.

Table 15 Source Quality Control Testing Requirements[14]

SPEC SECTION	DISCRIPTION	ITEM	REFERENCE SPECIFICATION AND/OR TEST PROCEDURE	FREQUENCY
704.03.02, 03, 04, 08	Drain Rock, Type I, Type II Aggregate Cement treated base	Submittal	IQAC and/or Agency Requirements	Annually for IQAC Source Approval OR per project
		Sampling from Calibrated conveyor stream or belt cut	AASHTO T 2	1/day at plant
		Sieve Analysis	AASHTO T 11 & T 27	1/day at plant
		Percentage of Wear (500 Rev.)	AASHTO T96	Annually for Source Approval OR per project
704.03.04, 05, 06	Drain rock, Type II, and III aggregate around water pipe	Total Available Water Soluble Sulfates[15]	AWWA 3500-NaD AWWA 4550 E	1/month at plant
704.03.03, 04	Type I and Type II Aggregate	Plasticity Index	AASHTO T 90[16]	1/day at plant
		Liquid Limit	AASHTO T 89	1/day at plant
		Resistance (R Value) Or	ASTM D 2844	Annually for IQAC Source Qualification OR per project
		Resilient Modulus	AASHTO T 307	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 208.02.06 & AASHTO T 22, T 23	Annually for IQAC Source Qualification OR per project
	CLSM-BAF	Visual Inspection Report	RTC 208.02.06 Split cylinders	Annually for IQAC Source Qualification OR per project

[14] Review the Clark County website for any exceptions to the listed test methods at www.accessclarkcounty.com/pubworks/iqac/qa.htm
[15] Required only for placement around waterline pipe
[16] Test specimens shall be prepared following the dry preparation procedure AASHO T 87

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ISSA, TYPE I GRADATION

Sieve Size	Mix Design Range (Percentage By Weight Passing Each Sieve)	Stockpile Tolerance
3/8"	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%

ISSA, TYPE II GRADATION

Sieve Size	Mix Design Range (Percentage By Weight Passing Each Sieve)	Stockpile Tolerance
3/8"	100	0
No. 4	90 - 100	±5%
No. 8	65 - 90	±5%
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%

ISSA, TYPE III GRADATION

Sieve Size	Mix Design Range (Percentage By Weight Passing Each Sieve)	Stockpile Tolerance
3/8"	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: 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: The Ultrathin Asphalt Concrete Surface (UTACS) shall use one of the gradation types listed below as required by the Engineer.

Table 1 - 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

Coarse aggregate testing shall comply with Table 2. Coarse aggregate is defined as aggregate that is retained on and above the No. 4 (4.75 Minimum) sieve.

Table 2 UTACS Coarse Aggregate Specifications

Tests	Method	Limit
Los Angeles abrasion value, % loss	AASHTO T 96-94	35 max
Soundness, % loss	AASHTO T 104-94	18 max
Magnesium Sulfate or Sodium Sulfate	AASHTO T 104-94	12 max
Flat & Elongated Ratio, % @ 3:1	ASTM D 4791	25 max
% Crushed, single face	ASTM D 5821	95 min
% Crushed, Two or more Mechanically crushed faces	ASTM D 5821	85 min
Micro-Deval, % loss	AASHTO TP58-99	18 max

For the Los Angeles abrasion value, the value shown for these tests are targets for aggregate selection purposes. The results of these tests should not be the sole basis for rejection.

Fine aggregate testing shall comply with Table 3.

Table 3 - UTACS Fine Aggregate Specifications

Tests	Method	Limit
Sand Equivalent	AASHTO T 176-86	45 min
Methylene Blue (on materials passing 200)	AASHTO TP 57-99	10 max
Un-compacted Void Content	AASHTO T 304-96	40 min

Values for sand equivalent shown for these tests are targets for aggregate selection purposes. If the finished bituminous mixture passes the AASHTO - T - 283 requirement in the Mix Design section, the sand equivalent and methylene blue requirements may be waived.

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SECTION 708

CONCRETE AND CLAY PIPE AND DRAINS

SCOPE

708.01.01 MATERIALS COVERED: This specification covers the quality of clay pipe, non-reinforced concrete pipe, and reinforced concrete pipe used for culverts, siphons, pressure conduits, and storm drains. Also the quality of perforated pipe used in underdrains. The quality of pipe used for sanitary sewers shall be as specified in Section 630, "Sanitary Sewers". Quality control testing and inspection requirements are described in Subsection 708.04, "Production Quality Control Testing and Inspection".

Beginning January 2007, Concrete pipe that is precast shall be manufactured in an annually certified plant. Certification shall be by the American Concrete Pipe Association (ACPA). The quality program from the certification process and this specification shall be initially submitted to the Regional Transportation Specification Subcommittee for approval. 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.

Design in accordance with AASHTO LRFD Bridge Design Specifications Section 12, and to withstand a backfill dead load of one hundred and twenty (120) lb/ft^3 (1,900 kg/m^3) 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.

The design shall consider any flotation affects with the use of controlled low strength material for backfill.

For storm drain application, the design shall consider the abrasion affects of parameters outline in the Regional Flood Control design manual or Federal Highway Administration (FHWA) publication FHWA-DF-88-003 Federal Highways Project Development and design Manual.

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.

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 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.

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.

The design shall include definition of either rigid or flexible pipe as defined by the South African Standard SABS 0102 as outline on the Clark County QAQC web page:

http://www.accessclarkcounty.com/pubworks/iqac/QA.htm

The minimum design life before first maintenance on all pipes shall be fifty (50) years. The definition of first maintenance is as follows:

Rigid Pipe or Box - Reinforced Concrete:	Point of exposed reinforcement from normal designed use
Rigid Pipe – Non-reinforced:	The least value of the thickness from designed use by a reduction of twenty five (25) percent or one inch

Joints shall be specified per 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: Unless otherwise specified or designated by the Engineer, pipe shall be accepted based on manufacture tests and inspection as indicated in Table 1 in Subsection 708.04 "Production Quality Control Inspection and Testing".

The manufacturer must supply the purchaser with a Certificate of Compliance for each type of pipe furnished, in accordance with the provisions of Subsection 106.05, "Certificates of Compliance," and these Specifications. Said certificate shall certify that the pipe complies with the requirements of the specifications, and shall include the pipe classification, diameter and the date of manufacture. The certificate shall also have attached the batch test results of each of the material lot delivered to the project.

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PHYSICAL PROPERTIES AND TESTS

708.03.01 REINFORCED CONCRETE PIPE: Reinforced concrete pipe shall conform to the following requirements:

Circular Pipe: ASTM C 76, ASTM C 1417

Elliptical Pipe: ASTM C 507

The aforementioned ASTM and AASHTO specifications are clarified and amended as follows:

a) Reinforced Concrete Pipe (RCP) ASTM C 76, 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.

b) Reinforced Concrete Arch Pipe (RCAP) ASTM C 507, 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.

Materials:

a) **Cement:** Unless otherwise specified, cement shall be Type V, Type IP, or Type V and fly ash conforming to the requirements of Section 701, "Portland Cement." Fly ash shall be Class F and conform to the requirements of Section 729 of these specifications, "Fly Ash."

b) **Concrete:** Unless otherwise specified, Portland cement concrete shall be as specified in Section 501, "Portland Cement Concrete."

c) **Synthetic Fibers:** Polypropylene fibers may be used, with the approval of the Engineer, as a nonstructural manufacturing material. Only Type III synthetic fibers designed and manufactured specifically for use in concrete and conforming to the requirements of ASTM C 1116 shall be accepted.

d) **Admixtures:** Unless otherwise specified or approved by the Engineer, admixtures conforming to USS Section 702, "Concrete Curing Materials and Admixtures" shall be acceptable for use.

All D-load and/or compressive strength requirements shall be met prior to shipment.

708.03.02 NONREINFORCED CONCRETE PIPE: This pipe shall conform to the requirements of ASTM C 14 for the specified diameters and strength classes.

708.03.03 PERFORATED CONCRETE PIPE: This pipe shall conform to the requirements of ASTM C 444 for the specified diameters and strength classes.

708.03.04 CLAY PIPE: This pipe shall conform to the requirements of AASHTO M 65 for pipe with full circular cross section, for the specified diameter and strength class. When specified, the bell shall have integral spacer lugs to provide for an annular opening and self-centering feature.

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708.03.09 REINFORCED CONCRETE PRESSURE PIPE: This pipe shall conform to the requirements of AWWA C 300, C 301, C 302 and ASTM C 361.

TESTING AND INSPECTION

708.04.01 PRODUCTION QUALITY CONTROL INSECTION AND TESTING: Material shall be tested, inspected and certified per the Table 2 frequency.

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. Any structural integrity test shall be reviewed and stamped by a Nevada Professional Engineer who has responsible charge of the work. Chemical testing does not require a Professional Engineer review and stamp

Table 2 – Inspection and Testing[1]

Spec Subsection	Description	Test or Inspection Per Batch	Referenced Specification or Test Procedure	Frequency
General	Submittal	Plant QC Program	Certified Annually by American Concrete Pipe Association (ACPA)	One per new plant or revision
708.03	Submittal for design	Acceptance of design RCP	ASTM C 76, ASTM C 1417	One per type
		Acceptance of design RCEP	ASTM C 507 Section 5.1.1 AND C 655 SECTION 9	
		Acceptance of design non-reinforced	AASHTO M 315 and ASTM C 14	
		Acceptance of design perforated pipe	ASTM C 444	
		Acceptance of design pressure water pipe	AWWA C 300, C 301, and C 302	
708.03.01 b) & c)	Submittal	Basis of Manufactured Lot Acceptance	ASTM C 76 Section 5.1.2	See appropriate references and below
708.03.02			ASTM C 14	
708.03.03			ASTM C 444	
708.03.05			AWWA C 300, C 301, and C 302	
	Cement	Certificate with test of Batch lot	RTCSN 701 "Portland Cement"	One per batch or heat lot
	Cure Compound & Admixtures		RTCSN 702 "Concrete Curing Materials and Admixtures"	
	Fly Ash		RTCSN 729 "Fly Ash"	
	Steel Wire Steel Welded Wire Steel Wire Welded Deformed Steel Wire Welded Wire Deformed		RTCSN 713 "Reinforcement"	
	Aggregates Coarse and Fine	Sieve Analysis	AASHTO M 6 & M 80	One per day for QA of External Source
	Submittal	Concrete Design	RTCSN 501 "Portland Cement Concrete"	One per new design and renewal each year.
	Concrete	Compressive Strength	AASHTO T-22	1 set per production day per design
	Pipe	D-Load testing	ASTM C 655	annually per size and class
	Inspection	Diameter, Wall thickness, Steel area, Product Marking (size & Length), Length	Per previous referenced , AWWA and ASTM methods	Each piece
	Pressure Pipe Joint	Hydrostatic Test	ASTM C 497 and C 443	One per setup or change

[1] Review the Clark County web site for any exceptions to the listed test methods at http://www.accessclarkcounty.com/pubworks/iqac/QA.htm

SECTION 709

METAL AND THERMOPLASTIC PIPE

SCOPE

709.01.01 MATERIAL COVERED: 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. The quality of pipe for the sanitary sewer shall be per Section 630, "Sanitary Sewers," or Responsible Agency specifications.

Beginning January 2007, plastic pipe shall be manufactured in an annually certified plant. Certification shall be by the Plastic Pipe Institute (PPI) or other Agency approved program. The quality program from the certification process and this specification shall be initially submitted to the Regional Transportation Specification Subcommittee for approval. 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.

Beginning January 2007, the metal pipe manufacturer shall be authorized and be annually certified by a procedure approved by the Regional Transportation Specification Subcommittee. The Quality Program used for the certification and this specification shall be submitted prior to construction activities. 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. All pipes shall be clearly marked with certification program identification.

Design in accordance with AASHTO LRFD Bridge Design Specification Section 12, and to withstand a backfill dead load of one hundred and twenty (120) lb/ft^3 (1,900 kg/m^3) (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.

The design shall consider any flotation affects with the use of controlled low strength material for backfill.

For storm drain application, the design shall consider the abrasion affects of parameters outline in the Regional Flood Control design manual or Federal Highway Administration (FHWA) publication FHWA-DF-88-003 Federal Highways Project Development and design Manual.

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.

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 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.

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.

The design shall include definition of either rigid or flexible pipe as defined by the South African Standard SABS 0102 as outline on the Clark County QAQC web page:

http://www.accessclarkcounty.com/pubworks/iqac/QA.htm

The minimum design life before first maintenance on all pipes shall be fifty (50) years. The definition of first maintenance is as follows:

Flexible Pipe: Point of first perforation from designed use

Joints shall be specified per the following:

Table 1- Joint Types

Pipe Type	Joint Type	Description	Test Pressure1	Application
Non-pressure	Silt Tight	Rubber Gasketed	2.0 psi	Storm
Pressure	Water Tight (pressure)	Rubber Gasketed	10.8 psi	Storm

709.01.02 Basis of Manufactured Lot Acceptance: Unless otherwise specified or designated by the Engineer, pipe shall be accepted based on manufacture tests and inspection as indicated in:

a) **Plastic Pipe:** Table 4 in Subsection 709.04, "Quality Control Testing and Inspection".

b) **PVC Pipe:** Table 5 in Subsection 709.04, "Quality Control Testing and Inspection".

c) **ABS Pipe:** Table 6 in Subsection 709.04, "Quality Control Testing and Inspection".

d) **Metal Pipe:** Table 7 in Subsection 709.04, "Quality Control Testing and Inspection".

The manufacturer must supply the purchaser with a Certificate of Compliance for each type of pipe furnished, in accordance with the provisions of Subsection 106.05, "Certificates of Compliance," and these Specifications. Said certificate shall certify that the pipe complies with the requirements of the specifications, and shall include the pipe classification, diameter and the date of manufacture. The certificate shall also have attached the batch test results of each of the material lot delivered to the project.

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PHYSICAL PROPERTIES AND TESTS

709.03.01 CORRUGATED METAL PIPE AND PIPE ARCHES: These conduits and the coupling bands shall conform to the requirements of AASHTO M 36 for the specified sectional dimensions and coating.

Special Sections, such as elbows, tees and wyes for these conduits shall be of the same gage as the conduit to which they are joined, and shall conform to applicable requirements of AASHTO M 36.

When metal end sections are required, the following requirements shall pertain:

(a) Metal end sections shall be of the gage shown on the plans.

(b) The end of the pipe shall be 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.

(c) Where connector sections are used the connector section shall be helical or annular as required to match the type of pipe used.

Gages of conduits shall conform to the requirements shown on the plans.

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[1] The amount of corrugation coverage for the joint shall be fully engaged as per the banding requirements for the pipe being testing.

Connecting bands may be two (2) gages lighter than that used for pipe but not more than twelve (12) gage or less than eighteen (18) gage. Unless otherwise approved by the Engineer, two-piece bands shall be required for pipe greater than forty-eight (48) inches (1.2 meters) in diameter.

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 fifty (50) years to first perforation.

The electrical resistivity of the soil shall be determined by California Test Method 643, "Method for Estimating the Service Life of Steel Culverts." Test Method 643 will also be used to determine the anticipated service life for galvanized pipe. 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: These conduits and the coupling bands shall conform to the requirements of AASHTO M 36 for the specified sectional dimensions and gages, and to AASHTO M 190 for the type of bituminous coating. Coupling bands shall be fully coated with bituminous material. Shop-formed elliptical pipe and shop strutted pipe shall be furnished where specified.

Special sections, such as elbows and flared end sections, for these conduits shall be of the same gage as the conduit to which they are joined, and shall conform to the applicable requirements of AASHTO M 190. Coating and invert paving shall be of the type specified.

709.03.03 ALUMINIZED TYPE II COATED CORRUGATED STEEL PIPE: This pipe shall conform to the requirements of AASHTO M 36 and more specifically to the metallic coating specification AASHTO M 274. In addition, the use of Aluminized Type II Coated Corrugated Steel Pipe shall be limited by the following conditions:

(a) Minimum Resistivity $R > 1500$ for $5 < pH < 9$

(b) Minimum Resistivity $R > 1000$ for $6.1 < pH$ 8.2

709.03.04 CORRUGATED ALUMINUM PIPE: This pipe shall conform to the requirements of AASHTO M196. In addition, the use of corrugated aluminum pipe shall be limited by the following condition:

Minimum Resistivity $R > 500$ ohm-cm and $4 < pH < 9$[2]

709.03.05 POLYMER COATED CORRUGATED STEEL PIPE: This pipe shall conform to the requirements of AASHTO M 36 and more specifically to the coating specification AASHTO M 245. In addition, the use of Polymer Coated Corrugated Steel Pipe shall be limited by the following condition:
Minimum: Resistivity $R > 250$ ohm-cm and $3 < pH < 12$

709.03.06 CONCRETE LINED CORRUGATED STEEL PIPE: This pipe shall conform to the requirements of Section 709.03.03 for pipe and to ASTM A 849 except as modified by the following concrete lining specifications:

(a) **Composition.** Concrete for the lining shall be composed of cement, fine aggregate and water that are well mixed and of such consistency as to produce a dense, homogeneous, non-segregated lining.

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[2] Federal Lands Highway Project Development and Design Manual Publication FHWA-DF-88-003

(b) **Mixture.** The aggregates shall be sized, graded, proportioned and thoroughly mixed with such proportions of cement and water as will produce a homogeneous concrete mixture of such quality that the pipe will conform to the design requirements of this specification. In no case, however, shall the concrete mixture be less than a six-sack mix in accordance with Section 701, "Portland Cement."

The lining shall have a minimum thickness of one-eight (1/8) of an inch (3.2 millimeters) above the crest of the corrugations and shall be applied so as to produce a homogeneous non-segregated lining throughout. The lining shall be applied in a two-course application, and shall be mechanically trowelled.

709.03.07 CORRUGATED METAL PIPES FOR DOWNDRAINS: Downdrain flumes and pipe shall conform to the requirements of AASHTO M 36. Type III inlets shall conform to the requirements of AASHTO M 36. Type I and Type II inlets shall conform to the requirements of ASTM A 525 except 2.00 ounce (57 grams) coating shall be required. When specified, pipe, flumes, and inlets shall be bituminous coated conforming to the requirements of AASHTO M 190. All anchor assemblies, hardware and accessories shall conform to the requirements of ASTM A 153 and ASTM A 123.

709.03.08 CORRUGATED METAL PIPE FOR UNDERDRAINS: This pipe shall conform to the requirements of AASHTO M 36, Type III for the specified diameters. Unless otherwise specified, any one of the first three classes shown may be furnished.

709.03.09 BITUMINOUS COATED CORRUGATED METAL PIPE FOR UNDERDRAINS: This pipe shall conform to the requirements of AASHTO M 36 and shall be coated with the bituminous material to meet requirements of AASHTO M 190, Type A coating, except that minimum coating thickness shall be 0.03 inch (8 millimeters). Coupling bands shall be full coated. The specified minimum diameter for perforations shall apply after coating.

709.03.10 THERMOPLASTIC, PLASTIC PIPE CULVERTS AND DRAINS: Plastics are composed of thermoplastic and thermosetting resins such as acrylonitile butadiene styrene (ABS), polyethylene (PE), poly vinyl chloride (PVC), fiber-reinforced (CCFRPM or FRP), or saturated-fibers (CIPP). For this specification, the applicable plastic is PE and PVC and are generally identified by cell classification per AASHTO M 294 and M304. The cell classification is a series of numbers and letters that correspond to the ranges of properties in the plastic compound. The pipe strength is expressed as pipe stiffness as psi per lineal inch (Mpa-m^2 per lineal m), the product of the initial flexural modulus and pipe wall cross section moment of inertia.

Polyethylene pipe shall conform to the requirements of AASHTO M 252 and M 294 and Poly (Vinyl Chloride) pipe shall conform to AASHTO M 278 and M 304.

Thermoplastic pipe shall be fabricated as per Section 709, "Metal and Thermoplastic Pipe".

Thermoplastic pipe or end sections greater than a thirty (30) inch diameter shall not be allowed within a minimum of eight (8) feet of an open outfall.

The material properties shall comply with Section 709 "Metal and Thermoplastic Pipe".

Joints shall be specified per the following Table 2.

Table 2- Joint Types

Pipe Type	Joint Type	Description	Test Pressure	Application
Corrugated HDPE (D), (S)	Silt Tight	Bell/Spig. O-Ring	2.0 psi	Storm
Ribbed HDPE, Ribbed PVC, Spiral Wound PVC, Corrugated HDPE Corrugated PVC	Water Tight (pressure)	Bell/Spig. O-Ring	10.8 psi	Storm

Reference specifications:

a) **Corrugated Polyethylene Pipe, Type S:** Type S corrugated polyethylene pipe shall be manufactured from high density polyethylene (HDPE) virgin compounds with the exception that up to three (3) percent grindings from original pipe trimming may be re-introduced. The pipe shall conform to AASHTO M 252 for pipe sizes four (4) inches (102 mm) to ten (10) inches (254 mm) and, AASHTO M 294 for pipe sizes twelve (12) inches (305 mm) to sixty (60) inches (1500 mm), unless otherwise specified herein or in the special provisions. The pipe wall shall be corrugated exterior construction with a smooth inner liner.

b) **Corrugated Polyethylene Pipe, Type D:** Type D corrugated polyethylene pipe shall be manufactured from high-density polyethylene (HDPE) virgin compounds with the exception that up to three (3) percent grindings from original pipe trimming may be re-introduced. Nominal sizes of forty two (42) inches (1050 mm) through sixty (60) inches (1500 mm) shall conform to AASHTO M-294, unless otherwise specified herein or in the Special Provisions.

The pipe shall consist of an essentially smooth waterway braced circumferentially or spirally with projections or ribs joined to an essentially smooth outer wall. Both walls shall be fused to, or continuous with, the internal supports.

c) **Ribbed Profile Wall or Spiral Wound Polyethylene Pipe:** Ribbed wall polyethylene pipe shall be manufactured from high density polyethylene (HDPE) virgin compounds with the exception that up to three (3) percent grindings from original pipe trimming may be re-introduced. The pipe shall conform to ASTM F 894. The pipe wall shall be of either solid or hollow rib exterior construction with a smooth inner surface.

d) **Ribbed Profile Wall or Spiral Wound Polyvinyl Chloride Pipe:** Ribbed profile wall polyvinyl chloride pipe shall be manufactured from polyvinyl chloride (PVC) virgin compounds and shall conform to AASHTO M 304, unless otherwise specified herein or in the special provisions. The pipe wall shall be of solid rib exterior construction with a smooth inner surface.

e) **Corrugated Polyvinyl Chloride Pipe with a Smooth Interior:** Corrugated profile wall polyvinyl chloride pipe shall be manufactured from polyvinyl chloride (PVC) virgin compounds and shall conform to ASTM F 949, unless otherwise specified herein or in the special provisions. The pipe wall shall be corrugated exterior construction with a smooth inner liner.

f) **Solid Wall Polyvinyl Chloride Pipe:** Solid wall polyvinyl chloride (PVC) pipe and fittings shall be type PSM Poly (vinyl chloride) pipe and fittings in accordance with ASTM D 3034, SDR 35, or ASTM F 679 with a T-1 wall thickness or Class P550 Polyvinyl Chloride Pipe and fittings conforming to the requirements of AASHTO M 278.

Additives and fillers shall not exceed ten (10) parts by weight per one hundred (100) parts of PVC resin in the material compound.

g) **Acrylonitrile-Butadiene-Styrene Composite Pipe:** Acrylonitrile-Butadiene -Styrene composite pipe shall conform to the requirements of AASHTO M 264. Couplings shall be Type SC. The ends of the pipe shall be so formed that, when laid together and jointed, the pipe will form a continuous line with a smooth interior surface. Immediately prior to assemblage of 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.

h) **Special Fittings:** 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.

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: Type CP pipe shall conform to the requirements of AASHTO M 252 for nominal sizes of three (3) inches (76 mm) through ten (10) inches (254 mm), AASHTO M 294 for nominal sizes of twelve (12) inches (305 mm) through sixty (60) inches (1500 mm). Type SP pipe shall conform to the requirements of AASHTO M 252 for nominal sizes of four (4) inches (102 mm) through ten (10) inches (254 mm), AASHTO M 294 for nominal sizes of twelve (12) inches (305 mm) through sixty (60) inches (1500 mm).

709.03.12 STRUCTURAL PLATE PIPE, ARCHES AND PIPE ARCHES: This pipe shall conform to the requirements of AASHTO M 167 (for steel) and AASHTO M 219 (for aluminum).

709.03.13 CAST IRON PIPE: This pipe shall conform to the requirements of ASTM 74, "Sewer Pipe" or AWWA 106, 108 "Water Pipe" as applicable.

709.03.13 STEEL WATER PIPE: This pipe shall conform to the requirements AWWA C 201, C 202.

INSPECTION AND TESTING

709.04.01 PRODUCTION QUALITY CONTROL INSPECTION AND TESTING: Material shall be tested, inspected and certified per the below table frequencies and submitted to the Engineer as required in the approved authorized quality control program. 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. Test and inspection data shall be included with the certifying document. Subsequent submittals and reports are to be reviewed by the Contractor for compliance then transmitted to the Engineer or approval.

The laboratory shall be American Association for Laboratory Accreditation (A2LA) accredited or by another nationally recognized program approved by the Engineer in the appropriate test method, where applicable. Any structural integrity test shall be reviewed and stamped by a Nevada Professional Engineer who has responsible charge of the work. Chemical testing does not require a Professional Engineer review and stamp.

Table 3- QUALITY CONTROL TESTING AND INSPECTION - GENERAL[3]

Spec Subsection	Description	Test or Inspection	Referenced Specification or Test Procedure	Frequency
General	Submittal	Plant QC Program	**For Plastic:** AASHTO M 294 Appendix A and Certified by Annually Plastic Pipe Institute or Other Agency Approved Program **For Metal:** Follows Guidelines in AASHTO M 294 Appendix A and Certified Annually by Agency Arrpoved Program	One Per New Plant or Revision
709.03	Submittal For Design	Acceptance of Design	Per Appropriate Listed AASHTO and/or ASTM Specification	One Per Type

[3] Review the Clark County web site for any exceptions to the listed test methods at http://www.accessclarkcounty.com/pubworks/iqac/QA.htm

Table 4- Plastic PE Pipe

Spec Subsection	Description	Test or Inspection	Referenced Specification or Test Procedure	Frequency
709.03.09 A) and B) & 10 Corrugated Polyethylene Pipe, Type S, and D	Submittal	Basis of Manufactured Lot Acceptance	Per Appropriate Listed AASHTO and/or ASTM Specification: AASHTO M 252, M 294, M 304,	See Below
709.03.09 C) & 10 Ribbed Profile Wall or Spiral Wound Polyethylene Pipe	Submittal	Basis of Manufactured Lot Acceptance	Per Appropriate Listed AASHTO and/or ASTM Specification: ASTM F 894	See Below
	Pipe Raw Material	Resin Test: Density Melt Index SP-NCLS Test ESCR Test 32 HR	ASTM 1505 ASTM D 1238 ASTM F 2136 AASHTO M294	One Per Lot
	Gasket	Gasket Vol & Durability Test	Name of Gasket Manufacturer and Type ASTM F477	One Per Lot
	Pipe	Pipe Stiffness Test Pipe Flattening test Brittleness test Elongation Tensile Modulus of Elasticity Unit Weight	AASHTO M 294 ASTM D 638 ASTM D 790	3/Week or One Per Lot-Whichever Is Greater
	Pipe	NCTL	ASTM D 5397	One Per Lot
		ESCR	AASHTO M 294	
	Pipe Joint	Joint Hydrostatic Test	ASTM D3212	One Per Setup or Change
		Joint Shear Test	AASHTO M294	One Per Setup or Change
	Inspection	Wall Thickness Inside Diameter	AASHTO M 294 and ASTM D 2122 ASTM F 894	Each Piece
	Inspection	Length and Markings	ASTM D 2122 ASTM F 894	Each Piece

Table 5- PVC PIPE

Spec Subsection	Description	Test or Inspection	Referenced Specification or Test Procedure	Frequency
709.03.09 d) Ribbed Profile Wall or Spiral Wound Polyvinyl Chloride Pipe Corrugated PVC	Submittal	Basis of Manufactured Lot Acceptance	Per Appropriate Listed AASHTO and/or ASTM Specification: AASHTO M 304, ASTM F 949 Section 10.E	See Below
709.03.09 e) Solid Wall Polyvinyl Chloride Pipe	Submittal	Basis of Manufactured Lot Acceptance	Per Appropriate Listed AASHTO and/or ASTM Specification: ASTM D 3034, SDR 35, or ASTM F 679	See Below
	Pipe Raw Material	Resin Test: Density Melt Index SP-NCLS test	ASTM 1505 ASTM D 1238 ASTM F 2136	One Per Lot
		ESCR test F 2136 32 hr	AASHTO M 304	One Per Lot
	Gasket	Gasket Vol & Durability Test	Name of Gasket Manufacturer and Type ASTM F477	One Per Lot
	Pipe	Pipe Stiffness Test Pipe Flattening test Brittleness test Elongation Tensile Modulus of Elasticity Unit Weight	AASHTO M 304	3/Week or One Per Lot-Whichever Is Greater
	Pipe	Acetone Immersion	ASTM D 2152	One Per Lot
	Pipe	NCTL	ASTM D 5397	One Per Lot
		ESCR	AASHTO M 264	One Per Lot
	Pipe Joint	Joint Hydrostatic Test	ASTM D3212	One Per Setup of Change
		Soil Tight Joint	AASHTO M 304	One Per Setup of Change
	Inspection	Wall Thickness Inside Diameter	AASHTO M 304 and ASTM D 2122, D 3034, or F 679	Each Piece
	Inspection	Length and Markings	ASTM D 2122, D 3034, or F 679	Each Piece

Table 6-ABS Pipe

Spec Subsection	Description	Test or Inspection	Referenced Specification or Test Procedure	Frequency
709.03.09 f) Acrylonitril Butadiene Styrene Composite Pipe	Submittal	Basis of Manufactured Lot Acceptance	Per Appropriate Listed AASHTO and/or ASTM Specification: AASHTO M 264 (ASTM D 2680)	See Below
	Pipe Raw Material	Resin Test: Density Melt Index SP-NCLS Test	ASTM 1505 ASTM D 1238 ASTM F 2136	One Per Lot
		ESCR Test F 2136 32 HR	ASTM D 1693	One Per Lot
		Extrusion Quality	ASTM D 2152	One Per Lot
	Gasket	Gasket Vol & Durability Test	Name of Gasket Manufacturer and Type ASTM F477	One Per Lot
	Pipe	Pipe Stiffness Test Pipe Flattening Test Brittleness Test Elongation Tensile Modulus of Elasticity Unit Weight	AASHTO M 264 and ASTM D 2412 ASTM D 638 ASTM D 790	3/Week or One Per Lot-Whichever Is Greater
	Pipe	Acetone Immersion	ASTM D 2152	One Per Lot
	Pipe	NCTL	ASTM D 5397	One Per Lot
		ESCR	AASHTO M 264	One Per Lot
	Pipe Joint	Joint Hydrostatic Test	ASTM D3212	One Per Setup or Change
	Inspection	Wall Thickness Inside Diameter	ASTM D 2680 ASTM D 2122	Each Piece
	Inspection	Length and Markings	ASTM D 2680	Each Piece

Table 7-Metal Pipe

Spec Subsection	Description	Test or Inspection	Referenced Specification or Test Procedure	Frequency
709.03.01, 02, 06, 07, 08 Corrugated Metal Pipe and Pipe Arches (and Bituminous Coated)	Submittal	Basis of Manufactured Lot Acceptance	Per Appropriate Listed AASHTO and/or ASTM Specification: AASHTO M 36 or AASHTO M 196,	See Below
	Pipe Coating	Thickness	AASHTO M 218, M 190 AASHTO T 65 or ASTM A 754	Each Piece
	Pipe	Thickness Diameter	AASHTO M 218 ASTM A 924M	Each Piece
709.03.03 Aluminized Type II Coated Corrugated Steel Pipe	Submittal	Basis of Manufactured Lot Acceptance	Per Appropriate Listed AASHTO and/or ASTM Specification: AASHTO M 274 and ASTM A 463 M	See Below
709.03.04 Concrete Lined Corrugated Steel Pipe			Per Appropriate Listed AASHTO and/or ASTM Specification: AASHTO M 274 and ASTM A 849	
709.03.05 Corrugated Aluminum Pipe	Submittal	Basis of Manufactured Lot Acceptance	Per Appropriate Listed AASHTO and/or ASTM Specification: AASHTO M 196, M 197 and ASTM B 209M	
			Corrugated Metal Pipe and Pipe Arches AASHTO M 218 and ASTM A 924 M	
	Pipe Raw Material	Certification of Tension Test and Base Metal Analysis	Aluminized Type II Coated Corrugated Steel Pipe AASHTO M 274 and ASTM A 463M Concrete Lined Corrugated Steel Pipe AASHTO M 218 Corrugated Aluminum Pipe AASHTO M196/197 and ASTM B 209M	One Set Per Lot
	Sheet (coil)	Thickness	AASHTO M 197 or M 218 or M 274	Each Coil
	Corrugation	Profile	AASHTO M 36 Section 7.2	Each Setup
	Band MTLS Lock Seam	Thickness and Width Inspection and Tensile Test	ASSHTO M 36 Section 9 AASHTO T 249	Each Setup Each Day
	Pipe Coating Thickness	Certification by Supplier	AASHTO M 274 AASHTO T 213 or ASTM A 754	Per Lot
	Pipe Inspection	Dimensions	AASHTO M 36 Section 8.1.1	Each Setup Per Shift
	Pipe Inspection	Workmanship	AASHTO M 36 Section 9 AASHTO M 196 Section 10.1	Each Piece

Spec Subsection	Description	Test or Inspection	Referenced Specification or Test Procedure	Frequency
	Pressure Pipe Joint	Hydrostatic Test	ASTM D 3212	One Per Setup or Change
709.03.11 Structural Plate Pipe and Pipe Arches, 709.03.12 Cast Iron Pipe, 709.03.013- Steel Water Pipe				Conform To The Contract Special Provisions

Testing Prestressing Reinforcement and Anchorages. All wire, strand, or bars to be shipped to the site shall be assigned a lot number and tagged for identification purposes. Anchorage assemblies to be shipped shall be likewise identified.

All samples submitted shall be representative of the lot to be furnished, and, in the case of wire or strand, shall be taken from the same master roll.

All of the materials specified for testing shall be furnished free of cost and shall be delivered in time for tests to be made well in advance of anticipated time of use.

The vendor shall furnish for testing the following samples selected from each lot. If ordered by the Engineer, the selection of samples shall be made at the manufacturer's plant by the inspector.

(a) **Pretensioning Method.** For pretensioned strands, samples at lease five (5) feet (1.5 meters) long shall be furnished of each strand size. A sample shall be taken from each end of every coil.

(b) **Post-Tensioning Method.** The following lengths shall be furnished:

(1) For wires requiring heading - five (5) feet (1.5 meters).
(2) For wires not requiring heading - sufficient length to make up one parallel-lay cable five (5) feet (1.5 meters) long consisting of the same number of wires as the cable to be furnished.
(3) For strand to be furnished with fittings - five (5) feet (1.5 meters) between near ends of fittings.
(4) For bars to be furnished with threaded ends and nuts - five (5) feet (1.5 meters) between threads at ends.

(c) **Anchorage Assemblies.** Two anchorage assemblies shall be furnished, complete with distribution plates of each size or type to be used if anchorage assemblies are not attached to reinforcement samples.

713.03.05 COLD-DRAWN STEEL WIRE FOR SPIRAL REINFORCEMENT: This steel shall conform to the requirements of ASTM A 82.

SECTION 714

PAINT AND PAVEMENT MARKINGS

SCOPE

714.01.01 MATERIALS COVERED: This specification covers the quality, color, and number of applications of paint in painting the various materials of construction. Attention is directed to Section 715, "Galvanizing," for galvanized coatings. 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. Subsequent amendments to the specifications quoted shall apply to all raw materials and finished products. No "or equal" substitutions for any specified material shall be made without written consent of the Engineer. State specification numbers referred to are (California State Specifications) unless otherwise noted.

REQUIREMENTS

714.02.01 CERTIFICATES: The Contractor shall furnish the Engineer with written certification that all required tests have been satisfactorily completed and that the materials thereof comply with all of the requirements. Samples will be taken when required by the Engineer.

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 include the manufacturer's name, business address and location of the manufacturing plant. It shall identify the specifications and include one copy. It shall show the quantity of materials supplied for each color, batch number and date of manufacture.

Manufacturer's lab test results must be supplied upon request of the Engineer. No pavement marking material shall be used which is not on the Qualified Products lists established by the Regional Transportation Commission of Southern Nevada.

PHYSICAL PROPERTIES AND TESTS

714.03.01 IRON AND STEEL USE ITEMS:

(a) **Zinc-rich Primer, Organic Vehicle Type (State Spec. 8010-61J-36).**

Description. This specification covers a one-package, thermoplastic organic zinc-rich primer whose mechanism of drying is that of solvent release. It is intended for use only on blast cleaned open steel structures exposed to the air.

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).**

Classification. 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. It 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).**

Classification. 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). 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 one or more applications of each vinyl primer. Either State Specification 8010-61J-23 or 8010-61J-24 may be used for the initial application. This paint is formulated primarily for spray application.

(d) **Aluminum Vehicle (State Spec. 8010-91B-75).**

Classification. This specification covers an aluminum vehicle clear varnish and general all purpose phenolic base spar mixing varnish. 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).**

Classification. This specification covers a phenolic resin varnish base aluminum paint, suitable for use as a finish coat. It is formulated for use on structural steel and interior and underwater surfaces of steel water tanks and similar exposed surfaces.

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).**

Classification. This specification covers a vinyl type aluminum paint for use on properly prepared metal surfaces which have been treated with Pre-Treatment, Vinyl Wash Primer (State Spec. 8010-61J-27), or specified vinyl undercoats. This paint is primarily formulated for spray application.

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).**

Classification. This specification covers a ready-mixed burnt umber tint paint suitable for use as a finish coat on properly prepared structural steel surfaces. This paint may be applied by spray or brush.

(h) **Burnt Sienna Finish Coat (State Spec. 8010-61J-53).**

Classification. This specification covers a ready-mixed burnt sienna paint suitable for use as a finish coat on properly prepared structural steel surfaces. This paint may be applied by spray or brush.

(i) **Green Finish Coat (State Spec. 8010-61J-47).**

Classification. This specification covers a ready-mixed green paint suitable for use as a finish coat on properly prepared structural steel surfaces. This paint may be applied by spray or brush.

(j) **Vinyl Green Finish Coat (State Spec. 8010-61J-40).**

Classification. This specification covers a ready-mixed green 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), or specified vinyl undercoats. This paint is formulated primarily for spray application.

(k) **Vinyl Iridescent Green Finish Coat (State Spec. 8010-91B-43).**

Classification. This specification covers a ready-mixed iridescent green 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), or specified vinyl undercoats. This paint is formulated primarily for spray application.

(l) **Tan Finish Coat (State Spec. 8010-61J-51).**

Classification: This specification covers a ready-mixed tan paint suitable for use as a finish coat on properly prepared structural steel surfaces. This paint may be applied by spray or brush.

(m) **White Tint Base Finish Vinyl Coat (State Spec. 8010-71C-35).**

Classification. 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). This paint is formulated primarily for spray application.

(n) **Enamel; Exterior White, Metal (State Spec. 8010-61J-09).**

Classification. 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.

This paint shall conform to the provisions of Military Specification MIL-E-1115A, and in addition, shall comply with all air pollution control rules and regulations in Clark County Nevada in effect at the time the paint is applied.

(o) **Enamel; Traffic Signal, Lusterless, Black (State Spec. 8010-61J-13).**

Classification. This specification covers a lusterless, black enamel for use in painting traffic signal hoods, shields, and other surfaces. When used on bare aluminum or zinc, Pre-Treatment, Vinyl Wash Primer (State Spec. 8010-61J-27) shall be used first to insure proper bond.

(p) **Enamel; Traffic Signal, Dark Olive Green (State Spec. 8010-41B-A).**

Classification. This specification covers an enamel for use on signal poles and 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).**

Classification. This specification covers high-gloss enamel for use on signal poles and is formulated as a finishing coat to be used over Pre-Treatment, Vinyl Wash Primer (State Spec. 8010-61J-27). 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.**

Classification. This specification covers an enamel for use on signal poles and is formulated as a finishing coat to be used over Pre-Treatment, Vinyl Wash Primer (State Spec. 8010-61J-27). The silver shall conform to Federal Color No. 17178 as shown in Table IX of Federal Standard No. 595a.

714.03.02 TIMBER USE ITEMS:

(a) **Wood Primer Latex Base.**

Classification. This specification covers a ready-mixed priming paint for use on unpainted wood or exterior wood work. It shall comply, in all respects, with Federal Specification TT-P001984, except that it shall dry hard in not more than twelve (12) hours.

(b) **Paint, Latex Base for Exterior Wood, White and Tints.**

Classification. This specification covers a ready-mixed paint for use on wood surfaces subject to outside exposures. This paint shall comply in all respects with Federal Specification TT-P96D.

Unpainted wood shall first be primed with Wood Primer conforming to the requirements in Subsection 714.03.02(a), "Wood Primer, Latex Base."

(c) **Enamel; Sign Post, Black (State Spec. 8010-61J-08).**

Classification. This specification covers a gloss black enamel for use on wood or metal.

714.03.03 CONCRETE USE ITEMS: Concrete end posts, (bridges), raised traffic bars, and miscellaneous concrete specified to receive paint.

Purpose	Number of Coats	Color	General Type	Formulated or Specification
Finish	1	White	Water Thinned	Acrylic Resin or Synthetic Latex Alkyd Emulsion

714.03.04 ALUMINUM USE ITEM: Aluminum bridge railing and posts specified to receive paint shall be prepared for painting with a coat of Pre-Treatment, Vinyl Wash Primer conforming to the requirements of Subsection 714.03.01(b), (California State Spec. 8010-61J-27).

The Contractor may use any of the paint systems specified for use on iron or steel in Subsection 714.03.01 for painting aluminum, and shall submit to the Engineer for approval a letter indicating his choice of system as required for iron or steel.

714.03.05 PAINT FOR TRAFFIC STRIPING, PAVEMENT MARKING, AND CURB MARKING - GENERAL: 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.

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.

Paint shall be homogenous, free of contaminant and of a consistency suitable for use in the capacity for which it is specified. Finished paint shall be well ground and the pigment shall be properly dispersed in the vehicle according to the requirements of the paint. 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. 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. Settled pigment shall be easily redispersed, with minimum resistance to the smooth uniform product of the proper consistency. 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. The paint shall possess satisfactory properties, in all respects which affect its application and curing.

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 I**

Type I pavement marking material shall be a durable retroreflective pavement marking for use of asphalt or concrete pavements transverse markings such as crosswalks and stop bars, and for word/symbol markings, which are subjected to severe wear conditions such as repeated shear action from stop, start, or turn movements. Type I materials are as follows:

1) **Preformed Pavement Marking Tape:** This material shall meet the minimum requirements set forth in ASTM D4505 except as modified below.

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.

Retroreflectance

White preformed marking tape shall have the following initial minimum retroreflectance values as measured in accordance with ASTM D 4061. Retroreflectance values shall be expressed as coefficient of retroreflected luminance (R_L) in millicandelas per square foot per footcandle (mcd/ft^2/fc). The metric equivalent shall be expressed as millicandelas per square meter per lux (mcd/m^2/l).

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

Skid Resistance

The surface of the retroreflective pavement marking tape shall provide an initial minimum average skid resistance value of forty five (45) BPN when tested in accordance to ASTM E 303.

Durability

The durability of the pavement marking material shall be the percentage of the marking material remaining on the pavement surface in satisfactory working condition. The initial value shall always be established at one hundred (100) percent.

Performance Requirements

Type I 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. The material shall be weather resistant and, through normal traffic wear, shall show no fading which will significantly impair the intended use of the marking throughout its useful life. Pavement marking tape shall show no lifting or shrinkage and shall show no significant tearing, roll back or other signs of poor adhesion. Type I pavement marking material shall also meet the performance criteria establish in the table below.

Performance Factor*	Heavy Traffic (greater than 6000 ADT per lane)	Medium and Light Traffic (6000 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.

Installation and Warranty

The markings shall be applied in accordance with the manufacturer's instructions. The manufacturer shall provide governing agency with a written copy of installation instructions and a recommendation for the type of adhesive to be used prior to installation of materials.

The marking material and installation shall have a minimum of one (1) year warranty.

b) **Type II**

Type II 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. The color of the marking material shall be white or yellow and conform to standard highway colors. Type II materials shall be as follows:

1) **Preformed Pavement Marking Tape:** This material shall meet minimum requirements set forth in ASTM D4505 except as modified below:

Retroreflectance

White and yellow preformed marking tape shall have the following initial minimum retroreflectance values as measured in accordance with the testing procedures of ASTM D 4601. Retroflectance values shall be expressed as coefficient of retroreflected luminance (R_L) in millicandelas per square foot per footcandle (mcd/ft^2/fc). The metric equivalent shall be expressed as millicandelas per square meter per lux (mcd/m^2/1).

	White			Yellow		
Entrance Angle	86.0°	86.5°*	88.8°	86.0°	86.5°*	88.8°
Observance Angle	0.2°	1.0°	1.05°	0.2°	1.0°	1.05°
R_L **(mcd/ft^2/fc)**	1100	700	500	800	500	300

Skid Resistance

The surface of the retroreflective pavement marking tape shall provide an initial minimum average skid resistance value of forty five (45) BPN when tested in accordance to ASTM E 303.

2) **Preformed Thermoplastic Tape (Yellow Markings Only):** The preformed retroreflective marking material shall consist of a resilient polymer thermoplastic with uniformly distributed retroreflective beads throughout its entire cross section. The markings shall be fusible to asphalt and portland cement concrete pavements by means of the normal heat of a propane torch as recommended by the manufacturer.

3) **Paint:** Traffic paint used for pavement markings shall conform to materials requirements listed in Subsection 714.03.05, 714.03.07 and 714.03.08. Requirements for retroreflective beads used with the application of this material are listed in Subsection 714.03.09.

4) **Epoxy paint (Yellow Marking Only):** Epoxy paint marking material shall consist of a one hundred (100) percent solid, two part system formulated and designed to provide a simple volumetric mixing ration of two components. Epoxy paint used for pavement markings shall conform to materials requirements listed in Subsection 714.03.08a. Requirements for retroreflective beads used with the application of this material are listed in Subsection 714.03.09.

5) **Polyurea Paint:** Polyurea paint marking shall consist of a one hundred (100) percent solid, two part system formulated and designed to provide a simple volumetric mixing ratio of two components. Polyurea paint used for pavement markings shall conform to materials requirements listed in Subsection 714.03.08a. Requirements for retroreflective beads and reflective elements used with the application of this material are listed in Subsection 714.03.09.

Durability

The durability of the pavement marking material shall be the percentage of the marking material remaining on the pavement surface in satisfactory working condition. The initial value shall always be established at one hundred (100) percent.

Performance Requirements

Type II 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. The material shall be weather resistant and, through normal traffic wear, shall show no fading which will significantly impair the intended use of the marking throughout its useful life. Pavement marking tape shall show no lifting or shrinkage and shall show no significant tearing, roll back or other signs of poor adhesion. Type II 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 & 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.

Installation and Warrant

The markings shall be applied in accordance with the manufacturer's instructions. The manufacturer shall provide governing agency with a written copy of installation instructions and a recommendation for the type of adhesive to be used prior to installation of materials.
The marking material and installation shall have a minimum one (1) year warranty.

Qualified Products List

The Clark County Regional Transportation Commission (RTC) shall maintain a Qualified Products List (QPL) of all products available that satisfy the requirements of these specifications and have proven effective in field tests. All materials, equipment and labor necessary to install and field test a product shall be provided at the cost of the product's manufacturer. All field tests shall be evaluated with regards to the performance standards of these specifications for a period not less than one year. Upon satisfactorily completing the field tests, and after deemed acceptable by the RTC, the RTC shall amend the QPL to include the tested product.

714.03.07 FAST DRY TRAFFIC PAINT: Type I (Heatable) Fast Dry White, Type (Heatable) Fast Dry Yellow, Type II Fast Dry White, and Type II Fast Dry Yellow shall comply with the requirements of any western state specification which is valid at the time of use in addition to meeting the requirements of Subsection 714.03.05. Fast dry traffic paint shall be applied at the film thickness of fifteen (15) mils to twenty (20) mils (0.4 to 0.5 millimeters) and shall dry to "no traffic pickup" within three (3) minutes. The "no traffic pickup" time shall be determined by ASTM D 711.

714.03.07a ALL PURPOSE BLACK TRAFFIC PAINT - PAINT FORMULA 235: All purpose Black Traffic Paint - Paint Formula 235 shall comply with the requirements of any western state specification which is valid at the time of use.

714.03.08 READY-MIXED TRAFFIC STRIPE PAINTS: Where ready-mixed paints are specified, they shall be suitable for use on either asphalt concrete or portland cement concrete.

714.03.08a EPOXY PAINT FOR TRAFFIC MARKINGS: Epoxy traffic paints shall be a two component marking material suitable for use on either asphalt concrete or portland cement concrete. Mixing of two components shall be performed as recommended by the manufacturer. Epoxy paint shall only be

applied if air temperature is a minimum of fifty (50) degrees Fahrenheit (10 degrees Celsius) at the time of marking installation. If the manufacturer of the marking material requires a minimum air temperature different than detailed above, the higher temperature shall be use. If material needs heating prior to application, no fumes shall be exuded which are toxic or injurious to persons or property. Epoxy paint shall dry to "no traffic pickup" within forty-five (45) minutes.

714.03.08b POLYUREA PAINT FOR TRAFFIC MARKINGS: Polyurea traffic paints shall be a two component marking material suitable for use on either asphalt concrete or Portland cement concrete. Mixing of two components shall be performed as recommended by the manufacturer. Polyurea paint shall be applied if air temperature is a minimum of forty (40) degrees Fahrenheit at the time of marking application. If the manufacturer of the marking material requires a minimum air temperature different than detailed above, the higher temperature shall be used. If material needs heating prior to application, no fumes shall be exuded which are toxic or injurious to person or property. Polyurea paint shall be dry to "no traffic pickup" within five (5) minutes.

714.03.09 REFLECTIVE MATERIAL: 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. Special care shall be taken with rapid dry paint and epoxy paint materials.
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. 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.

The Engineer may authorize the use of traffic paint containing pre-mixed retroreflective beads. The type, gradation, quantity and quality of the pre-mixed retroreflective beads shall be approved prior to the manufacture of the traffic paint. In addition to the specified pre-mixed beads, additional beads may need to be mechanically applied when the traffic paint is applied.

714.03.10 AIR POLLUTION: All paint shall meet the requirements of the appropriate Clark County Air Pollution Control Division.

714.03.11 TEST REPORTS AND CERTIFICATION: 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. 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. The test report shall be signed by an authorized representative of the manufacturer. The certified test reports and the testing required in connection therewith shall be at no cost to the Contracting Agency.