

**UNIFORM STANDARD SPECIFICATIONS
CLARK COUNTY AREA**

**REVISION SET II
1999 Release**

<u>SPECIFICATION NUMBER AND TITLE</u>	<u>PAGE NUMBER(S)</u>	<u>NATURE OF CHANGE</u>	<u>RTC DATE OF APPROVAL</u>
623 Traffic Signals and Streetlighting	623-(42-46)	Revision to Subsection 623T.02.12 to provide for the use of data- encoded preemption equipment for traffic signals which can record vehicle identification information.	7/10/97
208 Trench Excavation and Backfill	208-7	Revision to reference Uniform Standard Drawings for work zone traffic control and/or the MUTCD.	8/21/97
623 Traffic Signals and Streetlighting	623-8	"	"
625 Construction Signs	625-1	"	"
627 Permanent Signs	627-1	"	"
628 Painting Traffic Striping...	628-3	"	"
704 Base Aggregates	704-3	Revision to specify dry preparation method for plasticity test specimens.	11/13/97
705 Aggregates for Bituminous Courses	705-2	Revision to specify dry preparation method for plasticity test specimens. Fractured faces requirement for Type II increased to 70%.	"
627 Permanent Signs	627-2	Revision to delete requirement for overhead signs to be porcelain enamel.	4/9/98
716 Sign Materials	716-(2-3)	Revision to require Class 5 Fluorescent Orange sheeting for work zone signs and establish a phase-in period.	5/14/98

<u>SPECIFICATION NUMBER AND TITLE</u>	<u>PAGE NUMBER(S)</u>	<u>NATURE OF CHANGE</u>	<u>RTC DATE OF APPROVAL</u>
610 Slope and Channel Protection	610-2	Revision to table in Subsection 610.02.04 to correct ASTM Designation for percent of wear of stone.	11/12/98
408 Pavement Surface Treatments	408-(1-11)	Section renamed and revised to provide specifications for slurry seals and micro-surfacing.	"
703 Bituminous Materials	703-2,8,9,10	Section revised to include material requirements for slurry seals and micro-surfacing.	"
705 Aggregates for Bituminous Courses	705-(1-6)	Section revised to include material requirements for slurry seals and micro-surfacing.	"
627 Permanent Signs	627-(1-2)	Revision to require Class 6 retroreflective sheeting to be used on overhead, non-internally illuminated signs.	1/14/99
631 Street Name Signs	631-2	Revision to Subsection 631.03.01 to clarify material requirement.	"
716 Sign Materials	716-1, 4, 7	Revision to clarify the material requirements for street name signs.	"
709 Metal and Thermoplastic Pipe	709-3	Revision to Subsection 709.03.09(e) to add ASTM F 679 requirement.	3/11/99
716 Sign Materials	716-4	Revision to Subsection 716.03.01 to add fluorescent yellow-green to Class 6 sheeting per MUTCD.	4/8/99
633 Pavement Markers	633-1,3	Revision to adhesive requirements.	"
728 Epoxy	728-5	Addition of epoxies for markers.	"
208 Trench Excavation and Backfill	208-(8-9)	Revision to trench patching requirements, Subsection 208.03.05 (e), (f) and (g).	5/13/99

<u>SPECIFICATION NUMBER AND TITLE</u>	<u>PAGE NUMBER(S)</u>	<u>NATURE OF CHANGE</u>	<u>RTC DATE OF APPROVAL</u>
208 Trench Excavation and Backfill	208-(2,4,5)	Revision to delete use of crushed rock unless specifically approved for pipe bedding and pipe zone.	5/13/99
106 Control of Materials	106-(4-5)	Revision to Subsection 106.04 to allow sampling at production plant.	"
501 Portland Cement Concrete	501-9	Revision to 501.03.06 relocating requirements for batch to beginning of subsection for clarification.	"
623 Traffic Signals and Streetlighting	623-8	Revision to 623G.03.06 to address time frame for mounting arms on standards.	"
502 Concrete Structures	502-17	Revision to 502.03.19 to address time frame for mounting arms on standards.	"
633 Pavement Markers	633-(2-4)	Revision to reflective pavement marker requirements in order to conform with ASTM.	"
701 Portland Cement	701-1	Revision to Subsection 701.01.01 to delete cement categories for soluble sulfate content of 1.5% or less.	6/10/99
207 Structure Backfill	207-2	Revision to Subsection 207.02.02 to change No. 200 Sieve requirements.	9/9/99
208 Trench Excavation and Backfill	208-1	Revision to Subsection 208.02.03 to change No. 200 Sieve requirements	"
208 Trench Excavation and Backfill	208-3	Revision to add Subsection 208.02.08 for Type III Aggregate.	"
625 Construction Signs	625-2	Revision to Subsection 625.03.02 & .03 to require temporary stop signs to be embedded in ground when no flagger is present.	10/14/99

<u>SPECIFICATION NUMBER AND TITLE</u>	<u>PAGE NUMBER(S)</u>	<u>NATURE OF CHANGE</u>	<u>RTC DATE OF APPROVAL</u>
633 Pavement Markers	633-(1-2)	Revision to Subsection 633.02.01 to update requirements for non-reflective pavement markers.	10/14/99
709 Metal and Thermoplastic Pipe	709-3	Revision to Subsection 709.03.09 b) & c) to allow corrugated polyethylene pipe sizes to 60 inches.	"

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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

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processing of whatever nature and extent required, shall be considered as included in the price paid for the contract item of work involving such material and no additional compensation will be allowed therefor.

106.04 SAMPLES AND TESTS: Except as provided in Subsection 106.05, "Certificates of Compliance," all materials will be inspected, tested, and accepted by the Engineer before incorporation in the work. Any work in which untested and unaccepted materials are used without approval or written permission of the Engineer shall be treated as provided in Subsection 105.12.

It is the intent of these specifications that the Contractor shall produce materials at the plant that conform in all respects to the requirements of the specifications; however, blending on the roadbed to correct for minor deficiencies in grading, sand equivalent, or excess plasticity will be allowed under the following conditions:

- (a) All blending material added on roadway and all work involved in processing such material will be at the expense of the Contractor.
- (b) Processing of the material will continue until a homogeneous mixture is obtained. Uniform gradation shall be obtained to the degree that sieve analysis tests show less than ten (10) percent difference, in the amount of material passing the No. 16 sieve, determined by comparing sieve analysis tests on two samples of processed and blended material. Samples for tests, taken for the above conditions, shall be confined within a distance of five hundred (500) feet (152 meters) of each other and also taken in the same continuous windrow.

When the Engineer elects to take samples at a production plant, the plant shall be provided with a mechanical means for obtaining samples. Samples of the finished product of the plant shall be obtained prior to or as the material leaves the conveyor belt for the bin or stockpile. The sampling device shall be so constructed that small representative samples may be taken frequently and these small samples combined to form the complete sample.

The samples shall be delivered by mechanical means to a point on the ground or other safe and accessible spot satisfactory to the Engineer. Test results run from samples taken will be furnished to the Contractor's representative at his request. The results of such tests shall not be the basis for final acceptance of the material.

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

- (a) Types I and II aggregate base courses will be sampled from the roadbed just prior to the first pass of the roller, or in the case of trench backfill the point of acceptance will be in the trench.
- (b) Aggregate for cement or lime treated bases will be sampled as follows:
 - (1) Where the material is being mixed at a stationary plant, samples will be taken from the conveyors just prior to delivery to the mixer and prior to adding lime or cement.
 - (2) Where material is being mixed on the roadbed, samples will be taken after the material has been placed on the roadbed and processed and prior to adding cement or lime.
- (c) 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.
- (d) 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.

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

Two samples shall be taken from each railroad tank car or truck transport of material by the Contractor or his designated representative under the observation of and in a manner approved by the Engineer. Where delivery is made in smaller hauling units than those cited above such as a distributor, or where the contents of a storage tank are sampled, the required two samples shall be taken to represent a maximum of 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.

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

- (1) In accordance with the provisions of Test Method No. ASTM D 140;
- (2) By bleeding through a drain-cock in the transfer line during the unloading of the approximate middle third of the load; or
- (3) By means of a sampling device inserted to a level of approximately the middle third of the load or tank.

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

It shall be understood and agreed that samples obtained by any one of the above designated methods are deemed to be acceptable and are truly representative of the material delivered for incorporation in the work.

All sampling devices and sample containers will be furnished by the Contracting Agency. 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 Contracting Agency's laboratory for testing and the other sample retained by the Engineer to be later submitted to the laboratory for confirming tests in the event the first sample tested should fail to comply with requirements. If the first sample tested complies with requirements, the second 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 25 tons of asphalt delivered to the project.

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- (h) 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.

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, and will be furnished to interested persons upon request.

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.

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

Should the Contractor remove 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 so as to cause no obstruction to flow of streams; or otherwise impair the efficiency or appearance of the structure. It shall be disposed of in such 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.

206.03.02 INSPECTION: After each excavation is completed, the Contractor shall notify the Engineer, and no masonry shall be placed until the Engineer has approved the depth of excavation and the character of the foundation material.

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 culverts; and other backfill specifically designated in the contract documents as structure backfill. This item does not include backfilling pipes within a trench or minor miscellaneous structure excavations outside the limits of the roadway.

MATERIALS

207.02.01 SELECTED BACKFILL: Selected backfill shall be of a quality acceptable to the Engineer and may consist of suitable material from excavation. It shall be free from sod, frozen earth, organic materials, rubbish, or debris. The backfill material shall have a sufficient amount of fine material to fill the voids between the coarser aggregate. In addition thereto, the material shall conform to the following requirements:

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

Percentage by Weight Passing No. 200 Sieve	Plasticity Index Maximum
0-10.0	15
10.1-20.0	12
20.1-50.0	10
50.1-80.0	8
80.1-100.0	6

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 thereto, the material shall conform to the following requirements:

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 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 secured 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.

Unless otherwise permitted by the Engineer, foundation materials for structures shall be compacted to not less than ninety (90) percent of the maximum density.

Backfill material shall be placed in uniform horizontal layers and shall be brought up uniformly on all sides of the structure or improvement. Each layer of backfill shall be moistened as necessary and thoroughly compacted until ninety (90) percent of the maximum density is achieved, except that each layer of backfill so placed within the limits shown on the plans for selected borrow embankments for approaches to bridges shall be thoroughly compacted until ninety-five (95) percent of the maximum density is achieved. Test method shall be as specified in Section 111, "Soils and Aggregate Tests."

Compaction of structure backfill by jetting will be permitted when, as determined by the Engineer, the following conditions are met:

- 1) The backfill material contains no more than 10% passing the No. 200 sieve.
- 2) The adjacent material and foundation materials will not soften or be otherwise damaged by the applied water.
- 3) The structure will not be damaged as a result of hydrostatic pressure.

Compaction of structure backfill by ponding will be permitted when, as determined by the Engineer, the above conditions are met, and in addition, the gradation of the backfill material is such that not more than five (5) percent passes the No. 200 sieve. The backfill material shall be leveled prior to compaction by ponding.

As used in these specifications, jetting shall be defined as compaction by the use of a jet pipe to which is supplied a continuous flow of water under pressure, and ponding shall be defined as the inundation of backfill with water.

When the character of the backfill and surrounding material is such that jetting, or ponding methods of compaction are permitted, and the Contractor elects to use one of these methods, compaction of the backfill shall be accomplished in a manner such that the water will thoroughly saturate the thickness of the lift being compacted, and cause it to settle and densify. When using the jetting method, the jet pipe shall penetrate the full depth of the

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lift being compacted at intervals not to exceed five (5) feet (1.5 meters) in both a longitudinal and transverse direction. Supplemental vibratory or other compaction equipment shall be used when necessary to obtain the required compaction.

The thickness of each lift of backfill to be compacted by jetting or ponding shall not exceed four (4) feet (1.2 meters).

The upper sixteen (16) inches (400 millimeters) below finish grade shall be compacted by mechanical means only.

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 as structure backfill 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 an age of twenty-eight (28) days or the concrete has developed 100 percent of the design strength in compression as determined by Test Method ASTM C 39 using cylinders cured per ASTM Test Method C 31.

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

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

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

Existing slopes which are shaped so as 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 eight (8) inches (200 millimeters) in depth (loose measurements) before compaction when hand-directed compaction equipment is used, unless otherwise approved by the Engineer. Each layer shall be wetted as required and thoroughly compacted to the density requirements as set forth in Subsection 207.03.01, "General." Jetting or ponding methods of compaction will not be permitted for backfilling around corrugated metal pipe culverts or thermoplastic pipe.

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.

BASIS OF PAYMENT

207.04.01 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.

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.

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."

MATERIALS

208.02.01 SELECTED BACKFILL: Selected backfill shall be as specified in Subsection 207.02.01, "Selected Backfill."

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

208.02.03 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:

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% by dry weight of soil.

208.02.04 TYPE II AGGREGATE BASE BACKFILL: Type II aggregate base backfill shall be as specified in Subsection 704.03.04, "Type II Aggregate Base". The soluble sulfate content shall not exceed 0.3% by dry weight of soil.

208.02.05 DRAIN BACKFILL: Drain backfill shall be as specified in Subsection 704.03.01, "Drain Backfill." The type shall be as shown on the plans or approved by the Engineer.

208.02.06 FLOWABLE BACKFILL: Flowable backfill 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 of 50 to 150 psi at 28 days when tested in accordance with ASTM D 4832.

The mix shall result in a product having a slump in the range of 7 to 10 inches at the time of placement. The 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 compliance with the 28 day compressive strength requirements.

Flowable backfill will be proportioned using materials that meet the requirements specified below.

Cement shall meet the requirements of Section 701, "Portland Cement". Other types of cement may be used if prior testing indicates acceptable results.

Fly ash shall meet the requirements of Section 729, "Fly Ash". Fly ash not meeting the requirements of Section 729 may be used if prior testing indicates acceptable results.

Aggregates shall meet the requirements of Section 706, "Aggregates for Portland Cement Products". When coarse aggregate is used, 100% shall pass the one (1) inch sieve, and it shall comprise not more than 40% of the total aggregate content. Other aggregate products such as Type II aggregate base, crushed rock, pea gravel, or reject sand which has no more than 20% passing the #200 sieve and is free of organic material and other deleterious substances, may be used if a flowable, workable mix can be produced without segregation of the aggregate.

Water shall meet the requirements of Section 722, "Water".

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 flowable backfill may be used.

All materials shall be proportioned and mixed in accordance with the requirements of Section 501, "Portland Concrete."

Flowable backfill should be discharged directly from the truck into the space to be filled, or by other methods approved by the Engineer. The mix may be placed part depth or full depth as conditions at the site dictate. When used as backfill in the pipe zone, care should be taken to prevent flotation or misalignment of the pipe by means of straps, soil anchors or other approved means of restraint. Material may be placed in stages with initially lesser flowability, to prevent movement or flotation of pipe.

Placement of pavement materials or vehicle traffic shall not be allowed until the flowable backfill has achieved a penetration resistance of at least 600 psi using a hand-held penetrometer, in accordance with ASTM C 403. This penetration resistance shall be considered achieved when a person weighing at least 150 pounds, by use of their body weight as an axial load, cannot penetrate the flowable backfill with the square cut end of a No. 4 steel reinforcing bar.

208.02.07 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:

Sieve Sizes	Percentage of Weight Passing
3/8"	100
No. 4	20-80
No. 200	0-15

The percentage of wear (500 revolutions) in accordance with ASTM C 131 shall not exceed 45%.

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208.02.08 TYPE III AGGREGATE: The soluble sulfate content shall not exceed 0.3% by dry weight of soil. 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 gradation requirements of Type II aggregate base as per Subsection 704.03.04 with the following property testing:

Project Control Test	Test Method	Requirements
Sieve Analysis	AASHTO	704.03.04
Sampling Aggregate	ASTM D 75	n/a
Plasticity Index	ASTM D 4318	Section 207.02.01
Liquid Limit	ASTM D 4318	35% Maximum

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 and 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 obtain 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 waste water 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 waste water on account 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.

- (a) 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. The bottom of the trench shall have a maximum width equal to the outside diameter of the pipe plus 24 inches (600 millimeters) or as shown on the plans. If the maximum trench width is exceeded, the Contractor shall provide either additional bedding, another type of bedding, or a higher strength of pipe if required by the Engineer, with no additional payment therefor. Trench widths greater than the outside diameter of the pipe plus 24 inches (600 millimeters) may be required by the Engineer for flexible pipe to compensate for low stability soils, with payment for the additional work to be paid for in accordance with Subsection 104.03, "Extra Work."

Except when otherwise specified or ordered by the Engineer, the bottom of the trench shall be excavated uniformly to the grade or depth indicated on the drawings. The maximum amount of open trench permitted in any one location shall be 500 feet (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 finish surface. 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 legal limit 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.

- (b) **Trench Overexcavation.** 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 208.03.02.

Trench overexcavation 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. If no price is included in the contract, the work may be paid for according to the provisions of Subsection 104.03, "Extra Work."

Trench overexcavation and backfill to control groundwater or to facilitate ponding or jetting shall be at the option and expense of the Contractor.

- (c) **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."
- (d) **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."

208.03.02 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 four (4) inches (100 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, and backfilled to the required grade of the bottom of the pipe with "Type II Aggregate Base Backfill" or "Sand Backfill." "Crushed Rock" shall not be used unless specifically pre-approved by the governing agency. When "Crushed Rock" is used in the presence of groundwater, the Contractor shall follow the same procedures described later in this subsection when "drain backfill" is used to control groundwater.

The bedding shall be compacted to at least 90% of maximum density. Pipe bedding shall be placed and prepared in such a manner that there will be a firm, continuous support along the entire length of the pipe barrel.

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Bell holes in the bedding shall provide at least two (2) inches (50 millimeters) clearance beneath pipe joints.

Unless otherwise specified, laying pipe on mounds of the approved bedding material compacted firmly in place will be allowed whenever pipe eighteen (18) inches in diameter or smaller is being used, excepting sanitary sewer pipe and storm drain pipe; when "Type II Aggregate Base Backfill" or "Sand Backfill" is used for bedding material; and when the character of the bedding material and adjacent native material is such that ponding or jetting will be used for compaction. The mounds shall be a minimum of six (6) inches (150 millimeters) along the length of the pipe and of adequate size to hold the pipe in alignment and to maintain a two (2) inch (50 millimeter) minimum clearance from the bottom of the coupling to the trench bottom. Each pipe shall be laid on two mounds with the center of each mound placed approximately one-fifth of the pipe length from each end. The clearance between the trench bottom and the bottom of the coupling and/or pipe barrel shall be properly backfilled utilizing "Type II Aggregate Base Backfill" or "Sand Backfill" and the material shall be compacted utilizing appropriate methods and equipment to provide a firm and uniform bedding throughout the entire length of the pipe.

In the event that "Drain Backfill" is used to control groundwater, the Contractor shall at his expense, construct dams within the drain rock bedding material at maximum intervals of 600 feet (180 meters). The dams shall be constructed to the top of the pipe or the level of groundwater, whichever is greater, with Class "B" Portland cement concrete conforming to the requirements of Section 501, and shall have a minimum thickness of six (6) inches (150 millimeters). All pipe shall be placed directly on the drain rock bedding material unless otherwise required or approved by the Engineer.

If groundwater is present or anticipated to be present, a filter material as specified in Subsection 207.03.01, "General," may be required by the Engineer.

208.03.03 TRENCH BACKFILL: Except as otherwise provided or approved by the Engineer, after the pipe or conduit is laid, trenches shall be backfilled with "Sand Backfill," "Type II Aggregate Base Backfill," or with "Flowable Backfill" in the pipe zone as defined in the following table:

Pipe or Conduit	Pipe Zone
2 inch (50 millimeters) or less diameter	Subgrade to 6 inches (150 millimeters) above the top of the pipe
Greater than 2 inch (50 millimeters) diameter, except vitrified clay pipe	Subgrade to 12 inches (300 millimeters) above the top of the pipe
Vitrified clay pipe	Subgrade to 24 inches (600 millimeters) above the top of the pipe

"Crushed Rock" shall not be used to backfill in the pipe zone unless specifically pre-approved by the governing agency.

The partially backfilled trench shall be compacted to not less than 90% of maximum density except when "Flowable Backfill" is used. Jetting or ponding methods of compaction performed in accordance with the provisions of Subsection 207.03.01 will be permitted in the pipe zone, except for corrugated metal pipe and thermoplastic pipe.

- (a) In unpaved areas and areas outside the existing or proposed street right-of-way, the remaining backfill shall be "Flowable Backfill," "Granular Backfill," or "Selected Backfill," except that no stones or lumps

greater than three (3) inches will be permitted if "Selected Backfill" is used in trenches two (2) feet (600 millimeters) or less in width. Except when "Flowable Backfill" is used, the material shall be compacted to not less than 85% of maximum density, except for the top twelve (12) inches (300 millimeters) which shall be compacted to 90% of maximum density unless otherwise approved by the Engineer. Compaction of backfill by ponding or jetting methods will be permitted when performed in accordance with the provisions described in Subsection 207.03.01, but shall not be restricted by the amount of material passing the No. 200 sieve.

The upper twelve (12) inches (300 millimeters) below the existing grade in the traveled portion of an unpaved road shall be by mechanical means only.

- (b) In paved areas and areas within the existing or proposed street right-of-way, the remaining backfill shall consist of one of the following types as determined by the Engineer.

- (1) **Granular or Selected Backfill.** Backfill material from the pipe zone to a plane which is a minimum of 16 inches (400 millimeters) below the bottom of pavement shall be "Granular Backfill," or "Selected Backfill."

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. The material shall be compacted to not less than 90% of maximum density.

Trench backfill may be compacted by ponding or jetting methods performed in accordance with the requirements of Subsection 207.03.01, "General" when the character of the backfill material and adjacent native materials are as specified in Subsection 207.03.01, "General," except ponding or jetting methods will not be permitted in the trench sixteen (16) inches (400 millimeters) below the bottom of an existing pavement.

Backfill material for the minimum of 16 inches (400 millimeters) beneath the pavement shall consist of "Type II Aggregate Base" conforming to the requirements of Subsection 704.03.04. The material shall be mechanically compacted to not less than 95% of maximum density.

- (2) **Flowable Backfill.** "Flowable Backfill" shall be placed from the top of the pipe zone to the bottom of the pavement. In deep trenches, backfill material from the pipe zone to a plane which is a minimum of 24 inches (600 mm) below the bottom of the pavement may be "Selected Backfill," "Granular Backfill," or "Flowable Backfill."

If ponding or jetting is used to compact the backfill, the Contractor shall take all necessary precautions to prevent the pipe from floating including the filling or partially filling of the pipe with water if necessary. Adequate sumps and pumping shall be provided, as determined by the Engineer, for removing excess water from the trench. Any free standing water in a partially backfilled trench shall be allowed to completely drain away before the remaining backfill is placed.

Ponding or jetting methods shall be supplemented by the use of vibratory or other mechanical compaction equipment when necessary to obtain the required compaction.

Compaction not accomplished by ponding and jetting shall be done 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, but not exceeding eight (8) inches (200 millimeters) in loose thickness before compaction when hand-directed compaction equipment is used unless otherwise approved by the Engineer. Each layer shall be evenly spread, moistened, and tamped or rolled until the specified relative compaction has been attained.

208.03.04 SOILS TESTS: Where backfill is required to be compacted to a specified density, field tests for compliance may be made by the Contracting Agency using the test procedure prescribed in Section 111, "Soils and Aggregate Tests." For density determination tests the Contractor shall excavate at his expense in accordance with Subsection 208.03.01 any trench horizon the Contracting Agency may request. Where tests reveal non-compliance with the requirements of the contract, the Contractor shall bear the costs of subsequent recompaction and retesting until the required density is obtained.

208.03.05 CUTTING AND RESTORING STREET SURFACING:

- (a) Prior to beginning work within any public right-of-way, or cutting any street surfacing therein, an encroachment permit and barricade plan approval shall be obtained from the governmental entity or agency having jurisdiction over that right-of-way.
Permit fees and construction restrictions shall be in accordance with the rules, regulations, and ordinances of the entity or agency having jurisdiction.
- (b) 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.

- (c) 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. "Flowable Backfill" shall be used in the following cases:
 - (1) All trenches eight (8) inches (200 millimeters) or less in width for installation of conduit (full depth to bottom of asphalt surface).
 - (2) Trenches for service laterals on developed major streets (greater than 60 feet of planned right-of-way) as determined by the Engineer.
- (d) 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 the short duration as 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 three-fourths (3/4) inch (20 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.

- (e) Prior to placing the permanent patch, the existing pavement shall be sawcut to a neat line and to a minimum width as follows:
 - (1) For transverse trenches, sufficient width (four (4) feet (1.2 meters) minimum) to accommodate mechanical placement, rolling and compaction in compliance with Subsection 401.03.11, "Rolling and Compaction."
 - (2) 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, 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.
 - (3) 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, 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.

- (f) 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.

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- (g) Completion of the permanent patch in areas where an opengraded surface course exists, which is less than 5 years in age, shall include placement of a surface course to match the existing surface texture.
- (h) Existing asphalt pavement or concrete shall be replaced with like material. 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. When a straightedge twelve (12) feet (4 meters) long 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 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.

- (j) Any concrete improvements disturbed or damaged during construction shall be replaced prior to placement of the permanent pavement patch. Damaged sections of concrete sidewalk shall be removed and replaced to the nearest expansion joint or score line. Damaged concrete curb and gutter shall be removed and replaced to the nearest expansion joint, or as approved by the Engineer. Replacement of less than a ten (10) foot length of curb and gutter will not be permitted. Under no circumstances will sawcutting of concrete valley gutters be allowed. Valley gutters shall be replaced in their entirety.
- (k) 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.

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.

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

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SECTION 209

DRAIN BACKFILL

DESCRIPTION

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

MATERIALS

209.02.01 GENERAL: Material shall conform to the requirements as set forth in Subsection 704.03.01, "Drain Backfill."

CONSTRUCTION

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

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

Compacting by ponding or jetting will not be permitted.

METHOD OF MEASUREMENT

209.04.01 MEASUREMENT: The quantity of drain backfill to be measured for payment will be the number of cubic yards (cubic meters) measured in accordance with the dimensions shown on the plans or established by the Engineer complete and in place.

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

BASIS OF PAYMENT

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

The accepted quantities of drain backfill measured as provided in Subsection 209.04.01, "Measurement," will be paid for at the contract unit price bid per cubic yard (cubic meters) of drain backfill.

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

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

SECTION 408

PAVEMENT SURFACE TREATMENTS

408-1 CHIP SEAL

DESCRIPTION

408-1.01 GENERAL: This work shall consist of an application of bituminous material and cover of screenings applied on a previously compacted and bonded bituminous surface, in accordance with these specifications and in conformity with the lines shown on the plans or established by the Engineer.

MATERIAL

408-1.02.01 BITUMINOUS MATERIAL: The type and grade of bituminous material will be specified in the contract. The grade may be changed by the Engineer during construction.

The bituminous material shall meet the applicable requirements of Section 703, "Bituminous Materials." The bituminous material may be conditionally accepted at the source.

408-1.02.02 SCREENINGS: Screenings shall meet the requirements of Subsection 705.03.05, "Screenings" for the size specified. Attention is directed to Subsection 106.04, "Samples and Tests."

CONSTRUCTION

408-1.03.01 DISTRIBUTORS: The distributor shall meet the requirements of Subsection 405.03.01, "Equipment."

408-1.03.02 AGGREGATE SPREADER: The aggregate spreader shall be self-propelled and supported by at least four (4) wheels equipped with pneumatic tires on two (2) axles. The aggregate spreader shall be equipped with positive control so that the required amount of material will be deposited uniformly over the full width of the bituminous material.

408-1.03.03 ROLLING AND COMPACTION: There shall be operating with each aggregate spreader at least one pneumatic-tired roller.

Rollers shall meet the following requirements: They shall be pneumatic-tired rollers and shall consist of not less than nine (9) wheels equipped with pneumatic tires of equal size and diameter mounted on two axles attached to a rigid frame equipped with a loading platform or body suitable for ballast loading, so that the total weight of the roller can be varied to produce an operating weight per tire of between one thousand (1,000) and two thousand (2,000) pounds (450 and 900 kilograms). The tire treads, rear tire spacing, tire inflation and tire size shall be presented to and approved by the Engineer.

Rolling with a pneumatic-tired roller shall begin immediately after the distribution of the screenings, and

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continue until the aggregate is properly sealed in the binder. As soon as the asphalt has achieved a definite set, rolling should be discontinued unless otherwise directed by the Engineer. Rollers shall begin at the outer edge of the treatment and proceed in a longitudinal direction, working toward the center of the road. Each pass shall overlap the previous pass by about one-half the width of the front wheels. All rollers shall be in good condition, and the reversing mechanism so maintained that the roller is capable of changing directions smoothly.

408-1.03.04 WEATHER LIMITATIONS: Bituminous material shall not be spread when weather conditions are unsuitable, or when the atmospheric temperature is below sixty-five (65) degrees F. (18 degrees C.) or the pavement temperature is below eighty (80) degrees F. (27 degrees C.).

408-1.03.05 MAINTAINING TRAFFIC: Where public traffic is being routed over a surface upon which a surface treatment is to be applied, the surface treatment shall not be applied to more than one-half the width of the traveled way at a time, and the remaining half width shall be kept free of obstructions and open for use by public traffic at all times until the surface treatment first applied is ready for use by traffic.

Traffic will not be allowed on the newly placed bituminous material and screenings until, in the opinion of the Engineer, the screenings and bituminous material have sufficiently set and bonded to prevent displacement by such traffic.

When the newly completed surface treatment is open to traffic, the traffic shall be controlled by use of flagmen and a pilot car for a period of six (6) hours or for such time as deemed necessary by the Engineer as follows:

- (a) A flagman shall be stationed at the beginning of each newly completed section open to traffic, to stop oncoming traffic preparatory to piloting operations and shall be kept on duty during the entire control period.
- (b) Traffic control as described above shall be moved ahead progressively as the newly completed surface is open to traffic.

408-1.03.06 PREPARATION OF SURFACE: Immediately before applying the bituminous material, the surface to be treated shall be thoroughly cleaned of all dirt and loose material by sweeping with power brooms supplemented by hand brooms if necessary. The process of cleaning shall continue until the surfacing is exposed and all dirt and loose material is removed from the entire width of surfacing.

408-1.03.07 APPLICATION OF BITUMINOUS MATERIAL: Bituminous material shall be applied by means of a pressure distributor in a uniform, continuous spread over the section to be treated. The temperature of the bituminous material shall conform to the applicable requirements of Subsection 406.03.04, of Section 406, "Prime Coat." The quantity of bituminous material to be used per square yard shall be as directed. If the texture of the surface is such that bituminous material penetrates too rapidly, a preliminary application of from 0.05 to 0.10 gallon per square yard (0.25 to 0.50 liter per square meter) of surface may be required. A strip of building paper at least three (3) feet (1 meter) in width and with a length equal to that of the spray bar of the distributor plus one (1) foot (300 millimeters) shall be used at the beginning of each spread. If the cutoff is not positive, the use of paper may be required at the end of each spread. The paper shall be removed and disposed of in a satisfactory manner.

The distributor shall be moving forward at proper application speed at the time the spray bar is opened. Any skipped areas or deficiencies shall be corrected. Junctions of spread shall be carefully made to assure a smooth riding surface.

The length of spread of bituminous material shall not be in excess of that which trucks loaded with screenings can immediately cover.

The spread of bituminous material shall not be more than six (6) inches (150 millimeters) wider than the width covered by the screenings from the spreading device. Under no circumstances shall operations proceed in such manner that bituminous material will be allowed to chill, set up, dry, or otherwise impair retention of the screenings.

The distributor, when not spreading, shall be parked so that the spray bar or mechanism will not drip bituminous materials on the surface of the traveled way.

408-1.03.08 APPLICATION OF SCREENINGS: Immediately following the application of the bituminous material, screenings shall be spread at the required rate per square yard (square meter).

In order to avoid building a longitudinal joint, when spreading screenings on the first width of bituminous material, no screenings shall be applied within six (6) inches (150 millimeters) of the edge adjacent to the next application of bituminous material.

In order to eliminate dust film, screenings shall be moistened with water before applied. In spreading the screenings, the equipment used shall be so operated that the fresh bituminous material will be covered before equipment wheels come upon it.

Asphaltic emulsion applied to the road surface shall be covered with screenings before setting or breaking occurs.

After the screenings have been spread upon the bituminous material, any piles, ridges, or uneven distribution shall be carefully removed with flat bottom shovels, or other approved methods to insure against permanent ridges or bumps in the completed surface. Additional screenings shall be spread by hand in whatever quantities required to prevent picking up by the rollers or traffic.

After the application of the screenings, the surface, where specified, shall be lightly broomed or otherwise maintained as directed for a period of four (4) days or as directed. Maintenance of the surface shall include the distribution of screenings over the surface to absorb any free bituminous material and cover any area deficient in screenings. The maintenance shall be conducted so as not to displace embedded material. Excess material shall be swept off and removed at the time determined by the Engineer.

METHOD OF MEASUREMENT

408-1.04.01 MEASUREMENT: The quantity of bituminous material to be measured for payment will be the number of tons (metric tons) or the number of square yards (square meters) conforming to all the requirements in the completed work. The quantity of screenings measured for payment will be the number of tons (metric tons) or square yards (square meters) conforming to all the requirements in the completed work.

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

BASIS OF PAYMENT

408-1.05.01 PAYMENT: The accepted quantity of materials measured as provided in Subsection 408.04.01, "Measurement" will be paid for at the contract unit price bid per ton (metric ton) or square yards (square meters) for bituminous material and per ton (metric ton), or square yards (square meters) for screenings.

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The above prices shall be full compensation for furnishing the material, mixing, loading, hauling, placing, rolling, sweeping, and incidentals necessary for doing all the work involved in placing bituminous material and screenings, as shown on the plans or established by the Engineer.

The Contracting Agency reserves the right to increase or to omit all or any part of the estimated amount of screening or bituminous material to be used and no adjustment in unit price shall be allowed by reason of such increase or decrease.

Flagmen and pilot cars will be paid for in accordance with Section 624, "Accommodations for Public Traffic."

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

Payment will be made under:

PAY ITEM	PAY UNIT
Emulsified Asphalt (Type)	Ton (Metric Ton) Square Yard (Square Meter)
Screenings	Ton (Metric Ton) Square Yard (Square Meter)

408-2 SLURRY SEAL/MICRO-SURFACING

DESCRIPTION

408-2.01.01 GENERAL: This work shall consist of an application of a mixture of mineral aggregate, emulsified asphalt, water and additives applied on a previously compacted and bonded bituminous surface, in accordance with these specifications and in conformity with the lines shown on the plans or established by the Engineer.

MATERIALS

408-2.02.01 ASPHALT EMULSION: The asphalt emulsion shall be CQS-1h. Each shipment of emulsified asphalt shall be accompanied with a certificate of analysis/compliance from the manufacturer. When the daily high ambient temperature is below eighty (80) degrees F. (27 degrees C.), the Contractor shall chemically modify the emulsion to accelerate the break and set times. The emulsion modifier shall be adjusted at the emulsion manufacturer's facility. The asphalt emulsion shall meet all applicable requirements of Section 703 "Bituminous Materials."

408-2.02.02 POLYMER MODIFIERS: The polymer modifier shall be either a solid synthetic rubber or latex material. The polymer modifier shall be combined with the base asphalt emulsion at a minimum rate of 3% polymer solids by weight of asphalt and prior to loading at the manufacturing plant. If the contract includes quantities for conventional slurry seal, the polymer modified emulsion shall be compatible with the mix design developed for the conventional slurry seal.

408-2.02.03 COMMERCIAL MINERAL FILLER: The mineral filler shall be considered a part of the mineral aggregate and shall conform to the requirements of Section 705 "Aggregates for Bituminous Courses". The quantity

of filler shall be determined by the job mix design. It shall be used for one or more of the following reasons only: to improve the gradation of the aggregate; to provide improved stability and workability of the slurry, or to increase the durability of the cured slurry.

408-2.02.04 CARBON BLACK: If specified, carbon black shall be added to the slurry seal mixture at a minimum 2% to maximum 3% based on the weight of the emulsion. The product shall be Mono-Chem perma-black 115A, 2847A or equal as approved by the Engineer.

Specifications	Tolerances
Total Solids	40-44
Percent Black by Weight	35-37
Type Black	Medium furnace color

408-2.02.05 SET CONTROL ADDITIVE: The set control additive shall be aluminum sulfate or Portland Type I/II cement, or other approved additive previously included in the mix design. The quantity of set control additive shall be field adjusted to provide the specified mix properties.

408-2.02.06 WATER: Water for the slurry mixture shall conform to Section 722 and be clear, potable, free from harmful soluble salts, and compatible with the slurry mixture.

408-2.02.07 MINERAL AGGREGATE: The mineral aggregate shall conform to the specified contract gradations for either ISSA Type I, Type II, or Type III. It shall be 100% manufactured crushed stone that is free from dirt, organic matter, clay balls, adherent films of clay, dust or other objectionable matter. The parent rock used in the manufacturing shall have a normal size greater than one-half ($\frac{1}{2}$) inch (13 millimeters) and shall meet all applicable requirements of Section 705 "Aggregates for Bituminous Courses." Aggregate sources may be required to be evaluated for use based upon petrographic examination in accordance with ASTM C-295. Such tests shall be at the expense of the Contractor

CONSTRUCTION

408-2.03.01 SLURRY SEAL/MICRO - SURFACING MIXTURES: The slurry seal shall consist of a mixture of emulsified asphalt; mineral aggregate; mineral filler and carbon black, if required; set control additive and water, conforming to ISSA Type I, Type II, and Type III gradations. The mix shall be per this section, and in accordance with Section 703 "Bituminous Materials", Section 705 "Aggregates for Bituminous Courses" and Section 722, "Water." The mixture shall be proportioned, mixed, and spread evenly on a prepared surface in accordance with these specifications or as directed by the Engineer. The completed slurry seal shall leave a homogeneous mat, adhere firmly to the prepared surface, and have a friction resistant surface texture throughout its service life.

Micro-surfacing mixtures shall be capable of being spread in varying cross sections (wedges, wheel path depressions, leveling courses and surfaces) which, after curing and initial traffic consolidation, resist compaction throughout the entire design tolerance range of bitumen content and the various thicknesses encountered. The blended mixture shall have proper workability during lay down and will permit traffic loading within one hour after placement, without the occurrence of bleeding, raveling, separation, or other distresses.

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Prior to the start of work, the Contractor will be required to place two test sections of at least fifteen hundred (1,500) square yards (1,250 square meters) each, for each mix to be used, in an area designated by the Engineer. The test section will be placed using the same equipment, methods, and mixes as scheduled for use on the Contract. At these test sections, the Contractor must also satisfactorily demonstrate the equipment and procedure intended for the removal of oil deposits from the pavement surface. If a test section proves to be unsatisfactory, the necessary adjustments to the mix design, equipment and/or placement methods shall be made. Additional test sections, as required, shall be constructed and evaluated for conformance to the specifications. The two initial test sections, if acceptable, will be paid for at the contract unit price.

When the test sections do not conform to the specification requirements, the slurry seal shall be removed at the Contractor's expense. No compensation will be made for reapplication or additional test sections required due to unsatisfactory work or material. Initiation of work on the project streets, shall not begin without the Engineer's approval of test sections.

The equipment, tools, and machines needed in the performance of the work shall be provided by the Contractor, shall be subject to the approval of the Engineer, and shall be maintained in a satisfactory working condition at all times.

- (a) **Job Mix Design.** No slurry or micro-surfacing mixture shall be placed until mix design(s) submitted by the Contractor have been approved by the Engineer. Sources of all materials shall be selected prior to the time when the mix design is prepared and the materials are required to be used in the work. The exact proportions used in the preparation of the slurry seal or micro-surfacing shall be determined by a testing laboratory experienced in slurry seal and micro-surfacing mix design procedures and approved by the Engineer. Mix design preparation shall conform to Section 703 "Bituminous Materials" and shall be at the expense of the Contractor.

The approved mixture shall be homogenous, sufficiently stable during the entire mixing/spreading period so that the emulsion does not break prematurely, there is no segregation of the fines from the courser aggregate, and the liquid portion of the mix does not float to the surface. The amount and type of asphalt emulsion to be blended with aggregate shall be determined by the laboratory mix design. The set control additive shall be introduced into the slurry mix by an approved method that will assure uniform distribution and proper control. The exact amount shall be determined by conditions in the field and indicated in the mix design. A minimum amount of water, added as specified by the Engineer, shall be used as necessary to obtain a workable and homogeneous mixture. The slurry mixture shall show no signs of uncoated aggregate or premature breaking of emulsion when applied to the pavement surface.

- (b) **Sampling and Testing.** Suitable sized samples of aggregate, bituminous material, and mineral filler shall be submitted, when required by the Engineer, for approval not less than ten days before the work starts. All samples of materials shall be supplied by the Contractor at his expense. All tests deemed necessary by the Owner to determine conformance with requirements specified shall be performed without cost to the Contractor. Additional samples of materials shall be furnished as directed by the Engineer during progress of the work.

The aggregate manufacturer shall produce and stockpile each specified gradation of aggregate in 500 ton (450 metric ton) lots. The first lot of material shall be sampled and tested by the Owner. Certification of Lot 1 shall be based upon the averaged test values from five samples. The approved gradation of Lot 1 shall be

the "job target gradation". The stockpile tolerance identified in subsection 705.03.07 shall be applied to this "job target gradation". Each successive lot of 500 tons (450 metric tons) shall be sampled and tested once. When the "job-target gradation" has been tested and accepted, the Contractor shall continuously manufacture the aggregate until the total estimated quantity is produced, tested, and accepted. The contractor shall not receive compensation for unused aggregate. The approved lots of aggregate shall be stockpiled in a secured area, protected from contamination and reserved for use on this contract.

If it is established that a satisfactory mixture meeting the requirements specified herein cannot be produced from the materials furnished, the materials shall be rejected and the Contractor shall submit new samples.

408-2.03.02 PREPARATION OF SURFACE: At least two weeks prior to cleaning and slurry sealing the streets, an application of Pramitol 25E herbicide as distributed by Universal Cooperatives, Inc. Minneapolis, MN 55440, or an equal product as approved by the Engineer shall be applied to all vegetation within the limits of curb flow line to curb flow line. At the direction of the Engineer, multiple applications of herbicide may be required to ensure complete kill of vegetation. No additional compensation will be made for multiple applications of herbicide. Extreme care shall be used when placing the herbicide to insure that it is not allowed to go beyond the intended limits, the Contractor shall be responsible for any necessary licenses required or damage to any plant or animal which is caused by the Contractor's operations.

Immediately prior to applying the slurry seal, the existing pavement surface shall be cleaned of all silt deposits, oil spots, vegetation, and all loose or objectionable material.

Loose material in cracks shall be removed by the use of compressed air ninety (90) pounds per square inch (620 kilopascals) at the nozzle immediately before sweeping or vacuuming operations. In urban areas, the surface shall be cleaned with a self-propelled pick-up sweeper. In rural areas, power brooms may be used. Water flushing will be permitted by approval of the Engineer when normal sweeping will not adequately remove debris from the surface. If water flushing is approved the pavement will be dry before the slurry seal is applied.

Areas impregnated with grease, oil, or fuel shall be cleaned by grinding. Traffic paint not tightly bonded to the surface and any thermoplastic markings shall also be removed. The grinding machine used to remove the existing bituminous surface, paint, and pavement markings shall be a hydrostatically powered mandrel type device. The mandrel shall be studded with a minimum of 72 cutter bits to provide a pavement texture acceptable to the Engineer. Bits shall have tungsten carbide tips in forged steel holders and conical in shape. The mandrel device shall have a minimum cutting width of twenty-four (24) inches (600 millimeters) and a variable cutting depth of zero to four (0-4) inches (0-100 millimeters). Areas inaccessible to the grinder will be treated and prepared with an alternate method approved by the Engineer. The debris produced by the grinding machine or other method shall be immediately removed from the pavement surface and disposed of at an acceptable location. It shall be the responsibility of the Contractor to protect existing facilities (i.e. concrete, valve boxes, manholes, etc.). Damaged facilities shall be replaced at the Contractor's expense at the direction of the Engineer.

The Engineer shall give final approval that the surface has been properly prepared, prior to the application of the slurry, this approval shall not relieve the Contractor from responsibility as outlined above.

Prior to application of the slurry or micro-surfacing, manholes, valve boxes, drop inlets and other service entrances shall be protected by covering with paper, plastic or other suitable material approved by the Engineer. The paper shall be held in place with spray glue or tape and removed within twenty-four hours after slurry seal has cured.

Raised pavement markers not scheduled for reinstallation shall be covered or protected from the slurry by a method approved by the Engineer.

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408-2.03.03 MIXING UNIT: The slurry seal or micro-surfacing shall be mixed and applied with a machine designed and manufactured to lay the mixture. Self-loading mixing units shall not be used on roadway right-of-way widths of sixty (60) feet (18 meters) or less. The mixing machine shall be a continuous flow mixing unit, automatically sequenced and capable of delivering accurately predetermined proportions of aggregate, water and asphalt emulsion to a revolving multi-blade, double shafted, spiraled mixer tank, and of discharging the thoroughly mixed product on a continuous basis. The machine shall be equipped with a hydraulically controlled steel pugmill gate for positive discharge operations. Discharge from the pugmill shall be controlled by a chute or other suitable mechanical device. The mixing unit shall be equipped with a metering system to accurately meter all liquids by volume by the use of flow meters reading gallons per minute (liters per second). The flow of the liquids shall be consistent and precise and feed into the pugmill in the proportions outlined in the mix design. The machine shall be equipped with a temperature indicating device installed in the emulsion tank at the emulsion pump suction line level. The mixing unit shall be capable of thoroughly blending all ingredients together without violent action. The mixing machine shall be equipped with an approved fines feeder that provides an accurate metering device or method of introducing a predetermined proportion of mineral filler into the mixer as the aggregate is fed in. The fines feeder shall be used when mineral filler is part of the aggregate blend. The mixing machine shall be equipped with a water pressure system and fog type spray-bar. The machine shall be capable of mixing materials at pre-set proportions regardless of the speed of machine and without changing machine settings.

Each mixing unit to be used in performance of the work shall be calibrated prior to construction. Previous calibration documentation covering the exact materials to be used may be accepted provided they were made during the current calendar year. The documentation shall include an individual calibration of each material of various settings which can be related to the machine metering device(s).

The Contractor shall ensure that all equipment used to transport materials and mixing units on public roadways are in conformance with Nevada Revised Statutes Sections 484.764 through 484.771. If special use permits are required, the Contractor shall provide the Owner with copies.

Attached to the mixing machine shall be a mechanical type squeegee distributor, having a rubber-like material in contact with the surface to prevent unwanted egress of slurry. It shall prevent loss of slurry on varying grades and crown by adjustments to assure uniform spread. An appropriate mechanical device for a flexible strike-off and a burlap or other approved drag. The spreader box shall be adjustable to various widths from eight (8) feet (2.5 meters) upward. The box shall be kept clean. Cured slurry seal shall not be allowed to collect in the spreader box.

Spreader boxes twelve (12) feet (3.8 meters) or greater in width shall be used for the placement of full width micro-surfacing and shall include baffles and reversible motor driven augers. Six (6) feet (1.8 meters) long spreader box skids shall be maintained in such a manner as to prevent transverse chatter (washboarding) in the finished mat. Rear flexible strike-off blades shall make close contact with the pavement, and shall be capable of being adjusted to the various crown shapes of the pavement. A secondary flexible strike-off blade shall also be required.

408-2.03.04 MIX PREPARATION: The Contractor shall ensure that all oversized aggregate particles and other objectionable matter is removed from the mineral aggregate utilized in the slurry mix. At the direction of the Engineer, the aggregate shall be screened prior to loading into the mixing unit. Type I and II gradations shall be screened through a three-eighths (3/8) inch (10 millimeter) screen. Type III gradation shall be screened through a one-half (1/2) inch (13 millimeter) screen. With the approval of the Engineer, temporary use of screens attached to the distributor box will be permitted. The aggregate shall be moistened immediately prior to mixing with the emulsion.

408-2.03.05 WATER FOG: Immediately prior to application of the slurry seal, the surface of the pavement and all crack faces shall be moistened with a fog spray of water, applied at the rate of 0.02 to 0.05 gallon per square yard (0.09 to 0.25 liter per square meter) from the spray-bar on the slurry seal machine. No free water shall be on the surface of the pavement following the fog spray. Rate of application of the fog spray shall be adjusted during the day to suit pavement temperatures, surface texture, humidity, and dryness of pavement surface.

408-2.03.06 APPLICATION: Sufficient quantities of the slurry seal or micro-surfacing mixture shall be fed into the spreader box such that uniform and complete coverage of the pavement is obtained. The mixing machine shall be operated at such a speed that the mixture in the spreader box shall not exceed a total mixing time of four (4) minutes and the volume shall remain essentially constant. The slurry seal shall be placed at a rate of eight to twelve (8-12) pounds per square yard (3.6 to 5.5 kilograms per square meter) of Type I aggregate, and fourteen to twenty (14-20) pounds per square yard (6.4 to 9 kilograms per square meter) for Type II aggregate, and eighteen to thirty (18-30) pounds per square yard (8.2 to 14 kilograms per square meter) for Type III aggregate.

If uniform thickness cannot be met with one application due to irregularities in pavement surface, multiple applications shall be made. Where multiple applications are required, as determined by the Engineer, each application shall be thoroughly cured before another application is placed. Any additional applications will be paid at the unit price bid.

No streaks caused by oversized aggregate particles or buildup of slurry mix on squeegees shall be left in the finished surface.

408-2.03.07 JOINTS: The longitudinal joint between adjacent lanes shall have no visible lap, pinholes, or uncovered areas. Thick spots caused by overlapping shall be smoothed immediately with hand squeegees before the emulsion breaks. Overlaps which occur at transverse joints shall also be smoothed before the emulsion breaks, so that a uniform surface is obtained which contains no discontinuities.

408-2.03.08 PRODUCTION: The Contractor shall average a minimum of twenty thousand (20,000) square yards (17,000 square meters) of material, in place, per working day for work within the public right of way. Parking lot applications and areas not feasible to close the entire area are excluded from the required production rate.

408-2.03.09 LINES: Care shall be taken to insure straight lines along curbs and shoulders. No runoff on these areas will be permitted. Lines at intersections shall be kept straight to provide a good appearance.

408-2.03.10 HANDWORK: Approved hand squeegees, with burlap drags, shall be used to spread slurry in areas not accessible to the slurry spreader box. Care shall be exercised in leaving no unsightly appearance from handwork.

408-2.03.11 CURING: Areas receiving slurry seal will be allowed to cure from four (4) to twenty-four (24) hours or until the treated pavement will not be damaged by traffic. Areas receiving micro-surfacing shall be sufficiently cured to be open to traffic within one (1) hour. The Contractor will protect the area for the full curing period with suitable barricades or markers. Areas which are damaged within twenty-four (24) hours of application of slurry or prior to moving to new work locations shall be repaired by the Contractor at his expense.

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408-2.03.12 ROLLING: Slurry seal placed on parking lots, alleys or low traffic volume areas as determined by the Engineer shall be compacted with a pneumatic tire roller, with a minimum weight of four (4) tons (3.6 metric tons).

Rolling shall start when the slurry seal has set sufficiently to prevent any pick-up of material and rolled a minimum of three coverages by the roller until a uniform surface is obtained.

408-2.03.13 WEATHER LIMITATIONS: Slurry seal or micro-surfacing shall be applied only when the atmospheric temperature is sixty-five (65) degrees F. (18 degrees C.) and rising and when the temperature is not expected to fall below sixty (60) degrees F. (16 degrees C.) during working hours. Application of slurry seal or micro-surfacing when the atmospheric temperatures are expected to exceed one hundred five (105) degrees F. (40 degrees C.) will not be allowed. The maximum and minimum temperatures may be adjusted by the Engineer. High relative humidity or overcast conditions causing prolonged cure times or undesirable color shall be cause for stopping the work.

408-2.03.14 MAINTAINING TRAFFIC: The seal coat shall be applied to alternating streets to provide sufficient public parking for those residents living on streets which have been closed. Traffic will not be allowed on the newly placed bituminous material until, in the opinion of the Engineer, the bituminous material has sufficiently set and bonded to prevent damage by vehicular traffic. Areas which are subject to an increased rate of sharp turning vehicles may require additional time to allow for a more complete cure of the slurry seal mat to prevent damage. Street closures shall be opened as soon as the material has sufficiently set and bonded.

408-2.03.15 TRAFFIC MARKINGS: Prior to removal of street closure barricading, all raised pavement markers shall be exposed. Temporary reflective polyurethane plastic marker tabs shall be installed prior to the application of slurry seal on streets where permanent markings are scheduled for replacement.

408-2.03.16 STORAGE OF EQUIPMENT AND MATERIALS: Materials shall be stored in an area to prevent water saturation and contamination of stockpiled aggregates. Written authorization to use private property to store equipment and materials shall be obtained from the property owner and submitted prior to mobilization and use. The Contractor shall also submit a letter of indemnification to the Owner and the property owner.

408-2.03.17 CLEANUP: All material swept or blown onto the sidewalks, all trash, all discarded slurry seal material, or other refuse shall be collected on a daily basis, removed from the site and disposed of to a site approved by the Engineer.

All applied slurry seal surfaces shall be swept by an approved sweeper to remove any excess raveled material which becomes dislodged from the street surface after five (5) days. Dislodged material from the street shall be disposed of to a site approved by the Engineer.

408-2.03.18 CONTRACTORS RESPONSIBILITY TO THE PUBLIC: The Contractor is responsible to answer and resolve any conflicts that may arise between a homeowner or business owner and himself during the construction process.

METHOD OF MEASUREMENT

408-2.04.01 MEASUREMENT: The quantity of slurry seal or micro-surfacing measured for payment will be the number of square yards (square meters) of Type I, Type II, or Type III material applied and conforming to all the requirements of the completed work.

Surface preparation prior to the application of slurry seal or micro-surfacing shall be the number of hours spent performing grinding operations.

Ravel sweeping including disposal of excess material, shall be based on the number of hours spent sweeping at the direction of the Engineer.

BASIS OF PAYMENT

408-2.05.01 PAYMENT: Payment at the unit price bid for the accepted quantity of slurry seal or micro-surfacing measured as provided in Subsection 408-2.04.01 "Measurement" shall be full compensation for developing the mix design, furnishing the material, mixing, hauling, loading, placing, rolling, and any incidentals for doing all the work involved in placing the material.

Payment at the unit prices bid for surface preparation and ravel sweeping shall be full compensation for all work involved to complete the items.

Payment at the unit price bid for the addition of carbon black to the slurry seal or micro-surfacing mixture shall be full compensation for all work involved in its use.

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

PAY ITEM	PAY UNIT
Application of Polymer Modified Type I, II, or III Slurry Seal	Square Yard (Square Meter)
Application of Type III Micro-Surfacing	Square Yard (Square Meter)
Surface Grinding	Hour
Ravel Sweeping	Hour
Carbon Black Additive (optional)	Gallon (Liter)

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

(a) and (b) above will not be required when batching for culvert headwalls, manholes, small boxes, sidewalks, etc., and the total quantity of Class A, AA, D, DA, concrete called for on the project does not exceed 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.

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

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

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

- (b) **On-Site Mixed Concrete.** When mixing at the site of the work, the mixers used shall be of the paving or stationary type. The size of batch shall not exceed the rated capacity as determined by the standard requirements of the Associated General Contractors of America, except that in paving mixers when used for Portland cement concrete pavement, concrete slope protection and curbs and sidewalks, the size of 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 either 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) nor more than one hundred (100) revolutions of the drum or blades at the rate of rotation designated by the manufacturer of the equipment as mixing speed. If any additional mixing is done, it shall be at the speed

designated by the manufacturer of the equipment as agitating speed.

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

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

The rate of discharge of mixed concrete from truck mixer-agitators shall be controlled by the speed of 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

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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:

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. Retempering 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.

(0.3 centimeters) shall be filled or tapered back to present a smooth appearance. All holes one-fourth (1/4) inch (0.6 centimeters) or more in largest diameter shall be patched in accordance with Subsection 502.03.15, "Patching."

BONDED GROUT FINISH: This finish shall be an application of grout consisting of sand and other pigments and mineral fillers combined with a suitable binder. The sand shall pass a No. 30 sieve. The binder shall be either an epoxy, acrylic, vinyl or phenolic resin. This mixture may be thinned by not more than twenty-five (25) percent water by volume.

The finish shall be of such consistency and composition that it will provide a uniform appearance in color and texture when applied as specified below, and shall meet the requirements set forth in Section 727.

At least thirty (30) days in advance of placing bonded grout finish, the Contractor shall furnish the Engineer a quart (1 liter) sample or larger, of the complete mixture for testing. The Contractor shall also furnish two certificates, issued by the manufacturer, certifying that the product complies with the specifications. Said certificates shall be delivered to the Engineer at least thirty (30) days in advance of placing the material.

The grout shall be applied by spray, using conventional spray equipment with a one-fourth (1/4) inch (0.6 centimeters) round spray head. Material is supplied by either a surge pump with a 12 to 1 ratio or an auger type pump, with air pressure sufficient to achieve uniform texture. Worn spray heads shall be replaced as required to achieve a uniform finish.

Application shall be at the rate of 25-40 square feet per gallon (0.6 -1.0 square meters per liter).

The finish surface shall present a uniform appearance.

Color of fine surface finish to be applied will be shown on the plans. Where the color of the fine surface finish that is to be applied is not indicated on the plans, it shall conform to Federal Color No. 37875 as shown in Table I of Federal Standard No. 595.

Surfaces of concrete shall be thoroughly cleaned just before applying fine surface finish. This may be accomplished by:

- (1) Application of a ten (10) percent solution of muriatic acid or a twenty-five (25) percent zinc sulfate solution, which shall be applied as to completely remove any oily film and to lightly etch the surface, or
- (2) Thorough cleaning by an approved abrasive as required to remove all oily film.

Following cleaning, the surface shall be thoroughly rinsed with clean water. Surface to be finished need not be completely dry, but may be damp, prior to application of finish.

CAUTION: Do not apply finish unless temperature is at least 40 degrees F. (4 degrees C.) and is rising. Application shall be stopped if temperature is 40 degrees F. (4 degrees C.) and is dropping.

502.03.19 LIVE LOADS: Live loads such as traffic or superimposed earth loads shall not be allowed on the structure until concrete has reached an age of fourteen (14) days and it has reached the twenty-eight (28) day compressive strength required. Live loads may be allowed on the structure, with the approval of the Engineer, when the concrete has reached an age of eight (8) days and/or the twenty-eight (28) day compressive strength required in cases where Type III (high-early strength) cement is used. Approach slabs shall be treated as concrete paving under Section 409.

In the event of cold weather, the above specified time requirement shall be increased one (1) day for every day the curing time is increased as prescribed in the Subsection 501.03.10(b), "Cold Weather -- General."

In case the concrete does not reach the desired strength within the time specified, the Engineer shall determine when the strength is adequate to carry live loads.

METHOD OF MEASUREMENT

502.04.01 MEASUREMENT: The estimated quantity shown on the plans, plus or minus quantities covered by approved changes will be the quantity used for payment. The Contractor may however, request a final measurement and calculation. The Contractor's request for final measurement and calculation shall be in writing. Final measurement will be made according to the dimensions shown on the plans plus or minus approved changes and quantities derived therefrom will be the quantity used for payment. Each class of concrete will be considered separately. Furthermore, when the Contractor requests final measurement and calculations and the quantities thus determined are the same or less than the planned quantities plus authorized changes, the Contractor shall reimburse the Contracting Agency for the agency's expenses incurred by such final measurements and calculations.

Such box culverts, bridges, and such other miscellaneous concrete structures that are identified on the plans or in the Special Provisions as major structures will be paid for at the contract unit price bid for "Class _____ Concrete (Major)," or "Class _____ Concrete Modified (Major)" as the case may be.

Such pipe headwalls, endwalls, drop inlets, and such other miscellaneous concrete structures that are identified on the plans or in the Special Provisions as minor structures will be paid for at the contract unit price bid for "Class _____ Concrete (Minor)."

In the event any class of Portland cement concrete is placed and is shown by test to be below any specified twenty-eight (28) day compressive strength, a determination shall be made by the Engineer as to whether the concrete shall be removed and replaced or allowed to remain in place.

This determination shall be based on an evaluation of the durability and other qualities of the concrete necessary to the integrity of the structure. If the concrete is allowed to remain in place, it is agreed by the parties to the contract that the Contracting Agency will deduct from money due, or to become due the Contractor from the Contracting Agency, a percentage of the contract unit bid price. This deduction shall be considered to be liquidated damages and shall be at a rate of five (5) percent of the contract unit bid price for each fifty (50) P.S.I.

Sacks for concrete riprap shall be made of at least 10 ounce (285 gram) burlap, and shall be approximately 19 1/2 x 36 inches (495 x 915 millimeters) measured inside the seams when the sack is laid flat. The capacity of each sack shall be approximately 1.25 cubic feet (35 liters). Sound reclaimed sacks may be used.

610.02.04 STONES FOR RIPRAP: Stones used for riprap shall be hard, durable, angular in shape, resistant to weathering and erosion, and free from spoils, cracks and organic matter. The stone should be crushed (rounded stone should be avoided) with neither width nor thickness of a single stone less than one-third its length. The specific gravity of the riprap shall not be less than 2.45. The nominal stone size shall be as follows:

Riprap

D₁₅ shall be a minimum of 6 inches.

D₅₀ shall be a minimum of 12 inches.

D₈₅ shall be a minimum of 18 inches.

Heavy Riprap

D₁₅ shall be a minimum of 9 inches.

D₅₀ shall be a minimum of 18 inches.

D₈₅ shall be a minimum of 24 inches.

This stone shall conform to the following requirements:

Source Requirements	Test Method	Requirements
Percent of Wear (500 rev)	ASTM C 535	45% Maximum
Bulk Specific Gravity	ASTM C 127	2.5 Minimum

Control of gradation will be by visual inspection. Upon request by the Engineer the Contractor shall provide a sample of stone of at least 5 tons (4.54 metric tons) meeting the gradation for each location riprap is indicated. Each sample shall be located at the construction site near the location where the riprap is to be placed. The sample shall be used as a frequent reference for judging the gradation of the riprap supplied. The sample riprap shall be in place and acceptable to the Engineer before riprap placing work begins. The Contractor shall maintain the placed riprap until the project is completed and any material displaced by any cause shall be repaired to the lines and grades indicated on the plans.

Caliche stone or cementitious materials meeting the requirements of this section may be used as riprap with prior approval of the Engineer. The riprap shall be fully cemented material. Only materials designated as hard (scratches leave only dust, requires many hammer blows to break) or very hard (difficult to scratch or break), shall be utilized. Moderately hard (crumbles with several hammer blows) or partially cemented materials are not acceptable.

The Contractor may be required to provide riprap test results from an approved testing laboratory and a Certificate of Compliance in accordance with Subsection 106.05, "Certificate of Compliance".

610.02.05 STONES FOR GABIONS: Stones for filling the gabions shall be well graded, hard stones, conforming to the requirements specified in Subsection 706.03.05, "Stone for Masonry and Riprap".

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Size and gradation shall be such that the predominant size is between 4 to 8 inches (100 to 200 millimeters), eighty-five percent by weight. Minimum stone dimensions shall be 3 inches (75 millimeters) and maximum stone dimension shall be 8 inches (200 millimeters). For gabion baskets less than 1 foot (0.3 meters) in height, the maximum stone dimension shall be 6 inches (150 millimeters).

610.02.06 FILTER MATERIAL: When filter material is specified or shown on the plans, it shall consist of mineral aggregate that is clean, hard, durable, and free of any deleterious matter or harmful adherent coatings. Gradation of the filter material shall conform to the requirements specified by the Engineer, or as shown in the special provisions.

610.02.07 FILTER FABRIC: When filter fabric is specified or shown on the plans, it shall consist of a geotextile that is made from synthetic fibers. The filter shall conform to the requirements specified by the Engineer or as outlined in the special provisions.

610.02.08 WIRE MESH GABIONS: Wire mesh gabions shall be fabricated from either twisted wire mesh or welded wire mesh. Only one type of wire mesh may be used in any one structure.

Gabion dimensions of width, height, and length shall be as shown on the plans. Each gabion unit shall not vary more than five percent from the dimensions shown on the plans.

Where the length of the gabion basket exceeds its width, the basket shall be equally divided into cells equal to or less than the basket width using diaphragms of the same type and size mesh as the basket panels. Each basket shall be prefabricated with the necessary panels and diaphragms secured to the base in such a manner that no additional tying at this juncture is required.

Fabrication of the wire mesh gabion baskets shall be as follows:

(a) **Twisted Wire Mesh Panels**

Gabion panels of the twisted mesh style shall be manufactured from galvanized steel wire, Class 3, soft temper, conforming to ASTM A641, or from aluminized steel wire, soft temper, conforming to ASTM A809. The wire shall have a minimum tensile strength of 60,000 psi (415 MPa) when tested in accordance with ASTM A370.

The mesh shall be formed with non-raveling double twists by twisting each pair of wires through two 360 degrees turns. The mesh openings shall be hexagonal in shape and uniform in size, with the maximum line dimension of any hexagonal opening not to exceed 5 inches (125 millimeters), and the maximum area of any mesh opening not to exceed 10 square inches (6450 square millimeters).

All perimeter edges of the mesh panels forming the gabion basket shall be securely tied to a selvedge wire so that the selvedge is at least the same strength as the body of the mesh. Selvedge wire shall be the same kind and type of material used for the mesh.

When specified by the Engineer, the galvanized or aluminized wire shall be coated with a polyvinyl chloride (PVC) material. The coating shall be accomplished by using either extruded or extruded and bonded PVC material, and shall be applied prior to twisting the wire into mesh panels.

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."

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

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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 Class A concrete conforming to the applicable requirements of Section 501, "Portland Cement Concrete."

For posts, standards, and pedestals, a topping of four (4) inches (100 millimeters) minimum shall be poured after the post, standard, or pedestal is in proper position. 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.

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.

Conductors shall be joined by the use of a connector approved by the Engineer.

Conductor insulation shall be well penciled, trimmed to conical shape, and roughened before applying splice insulation. Splice insulation shall be designated by the Engineer.

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 no cable is to be installed, Contractor shall install string 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.

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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.

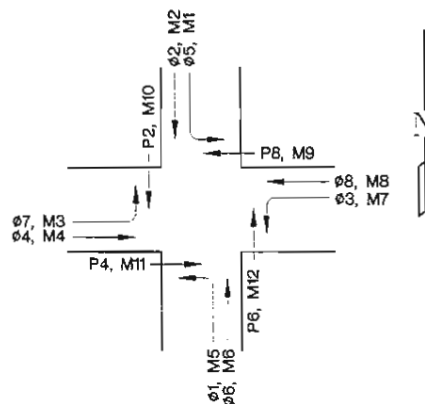
No service point will be considered acceptable unless approved in writing by the serving utility company and the Contracting Agency Engineer or his designee.

TRAFFIC SECTION

MATERIAL

623 T.02.01 CABINETS: The type of cabinet to be furnished shall be as indicated on the traffic signal plans, or as specified in the contract.

- (a) All cabinet harnesses and wiring shall be neat and firm, and laced or bound (with ty-rap) together.
- (b) All terminals shall be numbered and identified in accordance with the cabinet wiring diagram.
- (c) The cabinet shall be equipped with a plastic envelope to house wiring diagrams.
- (d) The cabinet wiring diagrams shall show and identify the connectors for all equipment, switches, terminal blocks, relays, flashers, and signal control bases.
- (e) The cabinet wiring diagram shall have an intersection sketch with signal heads and push-buttons identified as related to the intersection sketch shown below. The cabinet "controller" phasing shall be as indicated below; also refer to Subsection 623T.02.10(g).



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- (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
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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.

- (k) **Interconnect Junction Cabinet.** The Interconnect Junction Cabinet shall be a Tesco Enclosure Class 22-000-NR (43"x20"x11") 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 key and all foundation, anchor bolts and hardware in accordance with instructions of the cabinet manufacturer.
- (l) **Interconnect Cable.** Interconnect cable shall be 22 AWG, twisted pairs with cores filled with petroleum jelly, telephone cable per REA Specification RE-39, dated December, 1979. Splices in the cable are prohibited. The cable shall be terminated in the controller cabinet or in the Interconnect Junction Cabinet.

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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.

623 T.02.12 EMERGENCY VEHICLE PRIORITY CONTROL SYSTEM:

- (a) **System Description.** The system employs data-encoded optical communication to identify the presence of designated priority vehicles, cause the traffic signal controller to advance and/or hold a desired traffic display selected from phases normally available 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, draw-bridge, 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 selection of the desired phase green display for the approaching emergency vehicle. To be wired as shown in table.

	OMIT PHASES	CALL	PULSES
CHANNEL A	134578	MCE & TB14-12	INV. ADV.
CHANNEL B	123567	MCE & TB14-12	INV. ADV.

All input and output wires of the priority control system to be terminated on a separate panel then wired to the controller back panel.

- (d) Smooth transition to non-priority operation upon passage of the vehicle through the intersection.
 - (e) 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) $14.0359 \text{ Hz} \pm 0.0039 \text{ Hz}$ from a single light source or upon the actuation of a test switch or remote call signal to the phase selector. If a second channel of pre-emption is used it shall respond to a flash rate of (Class I) $9.63855 \text{ Hz} \pm 0.0014 \text{ Hz}$.

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- (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:

MANUAL CONTROL ENABLE (SOLID LOGIC LOW)
 INTERVAL ADVANCE (PULSING LOGIC LOW)
 PHASE OMITS

- (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 fixed 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 two directions (northbound and southbound) or (eastbound and westbound) and provide a single electrical output signal.
 - (e) The unit shall include a design feature to allow aiming of the two optical sensing inputs for skewed approaches or slight curves.
 - (f) The unit shall be responsive to the data-encoded 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.**
- (a) 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).
 - (b) The cable shall have 3 No. 20 AWG (minimum gage) stranded copper conductors and one bare, individually tinned, copper color coded as follows:
 - Orange for delivery of optical detector power (+)
 - Bare for optical detector power return (-)
 - Yellow for optical detector signal
 - Blue for spare 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 two-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 623 T.02.12 (c), "System Operations", via Optical Detectors connected to each channel. The primary function of the Preempt Module is to provide priority emergency vehicle preemption for NEMA traffic signal controllers with or without preempt timing capability. As required by the Engineer 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.

- 2) 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
- 3) Unit shall be capable of three levels of discrimination of data-encoded optical signals as described in 623 T.02.12 (d)(1)(b).
- (c) Circuits to interface with the cabinet controller unit as described in Subsection 623 T.02.12 (c)(2).
- (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.

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 have a finish on all surfaces, both interior and exterior, consisting of a minimum of one shop coat of primer on all surfaces by the manufacturer of the cabinets or boxes and as approved by the Engineer, and unless otherwise shown on the drawings or specified in the Special

Provisions, two coats of white enamel paint on interior surfaces and two coats of white enamel on exterior surfaces. The white enamel shall be that specified in Subsection 714.03.01(o). Aluminum cabinets shall be painted, inside and outside, using white electrostatic powder coating.

- (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 or excessive brush marks.

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.

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- (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 1/2 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 1/2 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

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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 1/2 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 $\pm 10\%$ 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 $\pm 10\%$ 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 $\pm 10\%$ 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 $\pm 10\%$ 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 $\pm 6\%$ will not cause more than a $\pm 8\%$ 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.

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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 metallicity 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.

SECTION 625

CONSTRUCTION SIGNS

DESCRIPTION

625.01.01 GENERAL: This work shall consist of furnishing, erecting, maintaining, relocating and removing work zone traffic control devices, including signs, channelizing devices and lighting devices at locations set forth in the contract documents, or as directed by the Engineer, for the protection of the work, workers, and guidance and safety of the motoring and pedestrian public.

All work zone traffic control devices shall remain the property of the Contractor upon completion of the contract and shall be removed from the project by him.

All work zone traffic control devices shall conform to the requirements of the latest edition of the Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD), published by the U.S. Department of Transportation, Federal Highway Administration, as well as the current edition of the Traffic Control Plans for Highway Work Zones for the Clark County Area, unless otherwise indicated on the plans or by the Special Provisions.

Regulatory signs shall be mounted so that the bottom of the sign will be a minimum of 5 feet above the ground surface or the pavement.

MATERIALS

625.02.01 GENERAL: It is expressly intended that a broad selection of material be granted the Contractor since work zone traffic control devices are in temporary use and new products become commercially available regularly. Sign panels may be constructed of steel, aluminum, wood, or other approved material and be of a sound, durable nature. The materials shall be of such quality to do the job for which they are intended and are subject to approval by the Engineer. Signs and channelizing devices which have become dull, have flaking or peeling paint, are dirty, discolored or are otherwise marred shall be repaired or replaced with acceptable units.

Reflective sheeting for all signs and channelizing devices shall conform to the requirements specified in the following section:

Sign Materials Section 716.03.01

625.02.02 SIGN DIMENSIONS: Sign dimensions shown in the MUTCD are minimum standard. Increases above this minimum are permissible and desirable where investigation has shown a larger sign is needed for adequate emphasis. In the enlarging of signs, standard shapes and colors shall be used, and standard proportions shall be retained so far as practicable.

CONSTRUCTION

625.03.01 GENERAL: Before any detour, temporary route or work zone is opened to traffic or imposed upon existing traffic, all necessary signs shall be in place. Signs required by road conditions or restrictions shall be

removed immediately when those conditions cease to exist or the restrictions are withdrawn. Guide signs directing traffic to and on temporary routes or detours shall be removed when no longer applicable.

Signs and barricades shall be maintained in first-class condition. Care shall be exercised to keep the sign faces free of dust and splashed mud. Any which may become scarred or damaged or destroyed shall be repaired immediately or replaced, at the Contractor's expense, as directed by the Engineer.

The responsibility for the protection of the work, workmen, and public traffic will rest with the Contractor and he shall be liable for damages and injury suffered by reason of the Contractor's operations or any circumstances, conditions, actions, or negligence in connection therewith.

625.03.02 SIGN PLACEMENT: Signs shall be placed in conformance with the latest edition of the Manual of Uniform Traffic Control Devices. All temporary stop signs shall be mounted on a post which is embedded in the ground a minimum of 18 inches (450 millimeters) or to a depth sufficient to prevent overturning by wind loadings and easy removal by vandals as approved by the Engineer with the following possible exceptions:

1. A flagger is used to supplement temporary stop signs. The temporary stop signs must be post-mounted and embedded in the ground when no flagger is present.
2. Temporary stop signs may be used with a moving construction operation with frequent lane shifts only when construction is in progress and the flagger is present. When no construction is in progress and no flagger is present, the temporary stop signs must be post-mounted and embedded in the ground.

625.03.03 SIGN SUPPORTS: Signs, posts, pole mountings, and their foundations shall be so constructed as to hold signs rigidly in a proper and permanent position, and prevent them from swaying in the wind, or from being turned or otherwise displaced by children or irresponsible persons.

A portable or removable type of mounting may be used for signs required intermittently or which are frequently moved. Such a mounting shall be heavy enough not to turn over in the wind, and its base shall not be appreciably wider than the sign.

A portable or removable type of mounting for temporary stop signs may only be used in a moving operation during the time when construction personnel are present. Such a mounting shall be heavy enough not to turn over in the wind. Temporary stop signs shall be post-mounted and embedded in the ground after working hours when no flagger is present.

625.03.04 CHANNELIZING DEVICES: Projects closed to traffic shall be protected by appropriate channelizing devices, as approved by the Engineer, in conjunction with appropriate work zone warning signs. If weighting of channelizing devices is necessary, sand bags may be used as long as a low center of gravity is maintained as approved by the Engineer.

METHOD OF MEASUREMENT

No direct measurement shall be made for work zone signs and channelizing devices unless otherwise specified.

BASIS OF PAYMENT

No direct payment shall be made for work zone signs and channelizing devices unless otherwise specified.

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SECTION 626

FINAL CLEAN UP

DESCRIPTION

626.01.01 GENERAL: Before final acceptance, the Contractor shall remove or obliterate, insofar as feasible, all objects or disturbances of the ground which mar the landscape and were caused by his operations, whether or not part of the improvement. This shall be required on all areas used or occupied by the Contractor within or outside the right-of-way limits.

CONSTRUCTION

626.03.01 FINAL CLEAN UP: Rubbish, excess material, temporary structures, and discarded equipment shall be collected and disposed of as directed by the Engineer. Burning is prohibited. Pits or trenches for equipment setups or camp sites shall be filled and the ground restored, insofar as feasible, to its original conditions, within or outside of the right-of-way limits. Temporary haul roads within the right-of-way limits shall be scarified and bladed to blend with surroundings. Pits from which materials have been obtained shall be dressed and shaped to conform with the surrounding ground. Waste shall be removed from the tops of banks and placed in the bottom of pit. Unless otherwise specified or directed by the Engineer, banks of pits shall be cut to not steeper than two to one (2:1) slopes to blend with the natural contours. Bottoms of pits shall be reasonably smooth. All other disturbances shall be removed or corrected as directed by the Engineer with particular attention to the abatement of any dust hazard.

Working areas and backslopes pertaining to the improvement shall be hand raked and loose objects including rocks and clods in excess of two inches (5 centimeters) in any dimension shall be removed from the site. Pavement, curb and gutter, sidewalks and driveways shall be swept or flushed and presented to the Contracting Agency in condition for maintenance without further work.

METHOD OF MEASUREMENT

626.04.01 MEASUREMENT: The unit of measure for "Final Clean Up" shall be lump sum.

BASIS OF PAYMENT

626.05.01 PAYMENT: The lump sum price paid for "Final Clean Up" shall be lump sum price bid for this item. All payments shall be made in accordance with Subsection 109.02, "Scope of Payment." Payment will be made under:

PAY ITEM	PAY UNIT
Final Clean Up	Lump Sum

SECTION 627

PERMANENT SIGNS

DESCRIPTION

627.01.01 GENERAL: This work shall consist of furnishing, erecting, relocating and installing signs, sign supports and other materials required for highway signs in accordance with the current edition of the Manual on Uniform Traffic Control Devices (MUTCD), these specifications and as shown on the plans and as directed by the Engineer. This item does not include street name signs or construction signs used for traffic control during construction.

The work shall generally consist of:

- (a) Overhead signs, including concrete foundations, steel sign posts and frames, and aluminum sign panels with reflective sheeting.
- (b) Ground mounted signs consisting of concrete foundations, steel sign posts, aluminum sign panels with reflective sheeting, and appurtenances.

This item does not include sign illumination systems.

627.01.02 SHOP DRAWINGS: When overhead sign structures are to be furnished, the Contractor shall submit to the Engineer five sets of shop drawings for each overhead sign structure for approval. Fabrication of the overhead sign structures shall not commence until the shop drawings have been approved by the Contracting Agency.

Shop drawings for other than overhead signs will not be required, however, all signs shall conform to the plans and the current edition of the Manual on Uniform Traffic Control Devices. For signs which are shown on the Sign Summary Sheets and are not included in the current edition of the Manual on Uniform Traffic Control Devices, special sign design sheets shall be furnished by the Contracting Agency to the bidders of the project. The special design sheets shall include such information as letter heights, spacing between letters and words, borders, sign radii, etc. These signs shall conform to the special design sheets as well as the drawings noted in the plans.

MATERIALS

627.02.01 GENERAL: Materials shall conform to the following applicable requirements:

Sign Materials Section 716

627.02.02 REFLECTORIZATION: All signs, except overhead signs, shall utilize Class 4 reflective sheeting for sign background, letters, numerals, symbols, borders and accessories. All letters, numerals, symbols, borders and accessories shall be directly applied to the sign background.

627.02.03 OVERHEAD SIGNS: All non-internally illuminated overhead signs shall use Class 6 reflective sheeting.

627.02.04 LETTERS, NUMERALS, SYMBOLS, AND ACCESSORIES FOR GUIDE SIGNS: All names of places and highways on guide signs shall be composed of lower case letters with initial capital letters. The initial capital letters shall be one and one-third times the "loop" height of the lower case letters. Other legends on guide signs shall be in capital letters.

It is intended that the initial capital letters (and numerals) used shall be Series E, modified by widening the stroke-width to approximately one-fifth the letter (or numeral) height. Tables of recommended letter spacing can be obtained from the FHWA.

Arrows which are used for large directional guide shall be in direct proportion to the arrows shown in the MUTCD.

CONSTRUCTION

627.03.01 PANEL FASTENINGS: The panel sections shall be provided with suitable fastenings, as shown on the plans, to permit easy attachment to the supporting frames. These fastenings shall be so designed as to carry the full design load with a factor of safety of not less than 1.5. Panel sections shall be provided with closure strips at the joints.

Panel fastenings for use on sign panels covered with Class 4 or 6 reflective sheeting shall utilize nylon washers for contact between the reflective sheeting and the metal washer.

627.03.02 CLOSURE STRIPS: Closure strip shall be anchored by aluminum rivets as shown on the plans. Rivets shall be the same color as the sign face. Closure strips are required only on aluminum sign panels.

627.03.03 INSTALLATION: Sign locations indicated on the plans are approximate only. Final determination of sign locations will be made in the field by the Engineer.

Signs and sign islands shall be constructed to the lines and grades given by the Engineer and in accordance with the design and locations shown on the plans.

All signs shall be erected as specified, before, during or immediately after the completion of bituminous plantmix surface operations.

The date of installation, consisting of month and year shall be permanently stamped on the back of each sign with metal dies and shall be visible only on close inspection. The stamp shall be placed on the lower right hand corner when facing the rear of the sign.

Each sign face shall be thoroughly cleaned according to the reflective material manufacturer's recommendations, and all undesirable material that is visible on the face of the sign shall be removed. The use of abrasives or other cleaning material that will scratch or otherwise deface shall not be permitted.

Sign islands shall be constructed as roadway embankment on conformity with Section 203, "Excavation and Embankment." Structure excavation and backfill shall conform to the requirements of Section 206, "Structure Excavation" and Section 207, "Backfill." Anchor bolts shall be set true to line and grade and posts shall be plumb.

Sign faces of all directional signs facing public traffic and directing such traffic to a portion of the project not yet open to public traffic, shall have the message covered.

Care shall be exercised at all times in the handling, storing, transporting, and erecting of the signs. Signs which

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are damaged shall be repaired or replaced at the Contractor's expense.

Pipe sign posts may be field cut and drilled to adjust for local conditions when approved by the Engineer. Flame cutting will not be permitted. All field cuts and abraded areas on steel posts shall be thoroughly cleaned and given two coats of paint having a high-zinc dust content conforming to the requirements of Federal Specification MIL-P-21035.

Extending the lengths of sign posts to adjust for local conditions by splicing or welding will not be permitted.

627.03.04 TESTS: It shall be the Contractor's responsibility to ascertain that all required tests have been made by qualified testing laboratories as approved by the Contracting Agency. The Contractor shall furnish the Contracting Agency with a written certification that all required tests have been satisfactorily completed and that materials and fabrication thereof comply with all the requirements.

627.03.05 RELOCATION: This work shall consist of temporary or permanent relocation of existing permanent sign panels, posts and footings as shown on the plans and as directed by the Engineer. Existing sign panels and posts that are removed for relocation shall be stockpiled on the jobsite at locations determined by the Engineer and shall remain the property of the administering entity. The Contractor shall remove and dispose of all concrete from sign posts prior to stockpiling as directed by the Engineer.

Temporary relocation of permanent sign panels for public bus or transit stops shall be as indicated on the plans or as directed by the Engineer. Temporary locations for public bus or transit stops shall conform to requirements of Subsection 107.07, "Traffic and Access."

The Contractor shall exercise care when removing and stockpiling signs for relocation. Signs which are damaged shall be repaired or replaced at the Contractor's expense.

METHOD OF MEASUREMENT

627.04.01 MEASUREMENT: Permanent signs, other than signs listed as "Overhead," shall be measured for payment by the number of square feet (square meter) of sign face surface. The square footage shall be determined from the dimensions of sign panels in the completed and accepted work.

The quantity of "Permanent Signs, Relocate" to be measured for payment shall be per each sign relocated, temporary or permanent.

Sign panels on permanent signs listed as "Overhead" signs shall be measured by the square foot (square meter) of sign panel in the completed and accepted work.

Sign supports for permanent signs listed as "Permanent Overhead Sign Support Structures" shall be measured on a Lump Sum basis.

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

BASIS OF PAYMENT

627.05.01 PAYMENT: Sign panels shall be paid for at the contract unit price bid per square foot (square meter) for "Permanent Signs (Ground Mounted)," which shall be full compensation for furnishing all labor, materials, tools, supplies, equipment and incidentals and for doing all the work involved in furnishing and erecting permanent signs (other than signs listed as overhead) complete in place as shown on the plans and as herein specified, including but not limited to structure excavation and backfill, concrete foundations, supports, sign islands, and

PERMANENT SIGNS

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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

PAINTING TRAFFIC STRIPING, PAVEMENT MARKINGS, AND CURB MARKINGS

DESCRIPTION

628.01.01 GENERAL: The Contractor shall apply all traffic striping, marking, and all other directional information on the surfaces of highways, streets, detour roads, parking lots, median strips and curbing only when required by the contract documents.

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 10 feet (3 meters) wide and no lane shall encroach within 5 feet (1.5 meters) of an open excavation or within 2 feet (600 millimeters) of a longitudinal curb.

This work shall also include the furnishing and placing of permanent pavement marking tapes as shown on the plans.

The specifications are for identity only, and approval of any specification by the Contracting Agency does not place any liability on the Contracting Agency or relieve the Contractor from warranty of the finished lines.

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.

Warranty

The Contractor shall warranty the applied markings for three year from the date of installation. 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 his expense.

MATERIAL

628.02.01 PAINT FOR TRAFFIC STRIPING, PAVEMENT MARKING AND CURB MARKING: Paint for traffic striping and marking shall conform to the applicable requirements of Subsection 714.03.05.

628.02.02 All traffic stripes (except black stripes) shall be beaded on the final finish coat in accordance with Subsection 714.03.09.

The Contractor shall furnish all equipment, materials, labor and supervision necessary for painting 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 remove by wet sandblasting (or by other approved methods) all existing or temporary traffic markings and lines that are no longer needed. When temporary detour striping or markings are no longer required, they shall be removed prior to painting the new traffic stripes or markings.

628.02.03 RETROREFLECTIVE PREFORMED PAVEMENT MARKINGS: The retroreflective preformed pavement markings shall conform to the applicable requirements of Subsection 714.03.06. These retroreflective preformed pavement markings shall consist of film with pigments selected to conform to standard highway colors.

Type I Film: These retroreflective preformed pavement markings shall be used for stop bars, preformed words and symbols, and crosswalks within the limits of the project. Glass 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."

Type II Film: These retroreflective preformed pavement markings shall be used for lane lines and edge lines within the limits identified in the plans. Ceramic beads shall be incorporated into the film to provide immediate and continuing retroreflection.

CONSTRUCTION

628.03.01 WEATHER CONDITIONS: Paint shall be applied only when the pavement surface is dry and clean, when the air temperature is above 40 degrees Fahrenheit (4 degrees Celsius), and when the weather is not windy, foggy, or humid.

628.03.02 EQUIPMENT: All equipment required to perform the work shall be approved in advance by the Engineer, and shall include 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.

The striping machine shall be an approved spray-type marking machine suitable for applying traffic paint at the temperatures specified in Subsection 714.03.06 or 714.03.07 for the particular paint 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. A standard skip-line pattern is normally a 24-foot (7.3 meters) cycle of which 9 feet (2.7 meters) are painted and 15 feet (4.6 meters) are unpainted. However, the machine shall 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 strip. An acceptable tolerance in the skip pattern is plus

or minus 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.

Provision shall be made for a dispenser capable of applying glass beads at the required rate.

Equipment for applying molten thermoplastic material shall readily extrude the material between 400 - 425 degrees Fahrenheit (204 - 218 degrees Celsius) to produce a continuous line 1/8 inch to 3/16 inch (3 to 5 millimeters) thick, of uniform cross section, and having clear sharp dimensions.

Thermoplastic material may also be applied by an approved machine that flame sprays the material onto clean road surfaces. This machine shall be capable of applying a coating 10 mils (0.3 millimeters) thick which will dry to "no pick up" in accordance with ASTM D 711. The equipment shall produce a smooth continuous line having clear sharp dimensions.

Word markings, letters, numerals, and symbols shall be applied using suitable spray equipment together with stencils and templates.

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 manual and Volume I of the Uniform Standard Drawings for the Clark County Area.

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 paint 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 paint, the existing pavement surface shall be cleaned by washing, sweeping, blowing, or vacuuming as necessary to remove moisture, dirt, grease, oils, acids, laitance or other foreign matter which would reduce the bond between the paint and the pavement. Areas which cannot otherwise be satisfactorily cleaned shall be scrubbed with a water solution of tri-sodium phosphate (10% Na₃ PO₄ by weight) or other approved cleaning solution. After cleaning, the surface shall be rinsed with water and dried before painting.

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 1/2 inch (13 millimeters) in 50 feet (15 meters) from the specified alignment.

The Contractor shall stripe or otherwise delineate the traffic lanes per the MUTCD manual in the new roadway

or 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 paint.

628.03.06 APPLICATION OF PAINT: Traffic striping and marking shall be applied at locations and to the dimensions and spacing indicated on the approved plans in the amounts required in Subsection 714.03.06 or 714.03.07 as applicable 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.

Paint 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. If the paint is applied in two coats, the first coat shall be thoroughly dry before the second coat is applied. Before applying thermoplastic paint on concrete surfaces, there shall be a prime coat consisting of either a two-component epoxy or a 10% solution of buna N rubber in methylethyl ketone applied one-half hour before application of the thermoplastic paint.

If the paint is applied in two coats, 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 14 calendar days after initial application.

Ten days shall elapse between the application of a bituminous seal coat and the permanent traffic marking. The paint shall not bleed, curl or discolor when applied to bituminous surfaces. If bleeding or discoloring occurs, the unsatisfactory areas shall be given an additional coat of paint.

Straight stripes deviating more than 1/2 inch in 50 feet (13 millimeters in 15 meters) shall be obliterated by sandblasting, and the markings corrected. The width of markings shall be as designed, within a tolerance of 4%. When existing striping and markings are to be repainted, they shall be repainted so as to completely cover the old markings within 1/4 inch (6 millimeters). Stripe repainting shall be retraced within a longitudinal tolerance of 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.

Painting 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 shall be minimized by heating the traffic paint to provide for a uniform flow of material.

Reflective material shall be applied to traffic stripes and markings, in accordance with Subsection 714.03.09.

Temporary striping and marking shall be renewed when the stripes and markings have lost 50% of their original visual effectiveness.

Paint materials shall be tested before application to verify that they meet the specification requirements. The Engineer shall be notified upon delivery of the paint to permit inspection and sampling. When required by the Engineer, the Contractor shall furnish a notarized certificate signed by either an authorized employee of the manufacturer or testing laboratory stating that the paint conforms to the specified requirements. This certificate shall not be interpreted as final approval of the paint.

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 while the paint is drying. Adjacent surfaces shall be protected from disfiguration by spatter, splashes, spillage, and dripping of paint or other material.

In areas of high traffic volume, the Contractor shall schedule his work to paint 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: The retroreflective pavement marking films shall not be applied within two weeks after laying and rolling asphalt concrete wearing courses. Both types of pavement marking films shall be capable of being adhered to asphalt concrete by a pre-coated pressure sensitive adhesive. A primer may be used to precondition the pavement surface. 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 Contractor shall identify proper solvents and/or primers (where necessary) to be applied at the time of application, all equipment necessary for proper application, and recommendations for application that will assure effective performance.

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 firm.

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 6 inches (150 millimeters) each side of the failure and the patch shall be a minimum of 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 film for symbols and legends measured for payment shall be per each, complete and in place.

The quantity of the Type I film 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 film 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 painting of all traffic striping or 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

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sandblasting of existing lines and markings, shall be at his sole expense.

The contract unit bid price paid for Type I and Type II film shall be full compensation for furnishing all materials, as well as all labor, tools, equipment and incidentals necessary to complete the work.

Payment shall be made under:

PAY ITEM**PAY UNIT**

Type I Film "ONLY"	Each
Type I Film (arrow)	Each
Type I Film for Crosswalks and Stop Bars	S.F. (SM)
Type II Film White 4" Marking	L.F. (LM)
Type II Film 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 631

STREET NAME SIGNS

DESCRIPTION

631.01.01 GENERAL: The street name signs, mounting post, location, fabrication and installation shall conform to these specifications and any specifications referred to as part of this specification.

631.01.02 STREET NAME SIGN FACES: The legend shall include the name of the street with proper suffix, ordinal and block number as assigned by the responsible agency for that jurisdiction, all in accordance with the Standard Drawings.

MATERIALS

631.02.01 GENERAL: The finished face shall be applied to an aluminum sign blank conforming to the Standard Drawings.

631.02.02: The legend shall be made by one of the following two methods:

- (1) By reverse screening with green (blue for the City of North Las Vegas) transparent ink on a white wide-angle prismatic retroreflective sheeting which conforms to the material specified in Subsection 716.03.01, "Reflective Sheeting," Class 6. When this method is used, the block number on the sign face may be two inch (2") (5 centimeters) numerals, die-cut from white conforming to the material specified in Subsection 716.03.01 "Reflective Sheeting," Class 6, White, using pressure-sensitive adhesive.
- (2) By applying white die-cut letters to green (blue for the City of North Las Vegas) wide-angle prismatic retroreflective sheeting which conforms to the material specified in Subsection 716.03.01 "Reflective Sheeting," Class 6. When this method is used, the letters and numerals shall be die-cut from white sheeting conforming to the material specified in Subsection 716.03.01, "Reflective Sheeting," Class 6, White, and shall be applied using pressure-sensitive adhesive. The sign fabricator shall supply the Contracting Agency with a written guarantee of workmanship, stating that any such lettering which peels or loosens from the sign face within five (5) years will be repaired, or the sign replaced, free of charge.
- (3) By applying green (blue for the City of North Las Vegas) electronic cutable transparent overlay film to white wide-angle prismatic retroreflective sheeting which conforms to the material specified in Subsection 716.03.01, "Reflective Sheeting," Class 6.

CONSTRUCTION

631.03.01 STREET NAME SIGN INSTALLATION: The fabricated signs shall be installed using the hardware and piping as shown on the Standard Drawings and as specified in Subsection 716.03.06, "Sign Hardware, Posts and Related Materials".

The signs shall be installed on the corners of the intersection as indicated on an approved plan. Further, the signs shall be located on the P.C. line as indicated in the Standard Drawings.

631.03.02 EXCEPTIONS: No exceptions to the above specifications shall be allowed without prior written consent from the accepting agency.

METHOD OF MEASUREMENT

631.04.01 METHOD OF MEASUREMENT: The quantity of street signs measured for payment will be the number of complete signs in place.

BASIS OF PAYMENT

631.05.01 BASIS OF PAYMENT: Payment for street name signs shall be for each complete sign in place.

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 6 inches (15 centimeters), except that the radius of the 1/2 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.

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- (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 butadiene 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.

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 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 500 psi (3.45 MPa), when tested with epoxy adhesive. Markers with length and width both equal to 4 inches (10.2 millimeters) shall undergo flexural strength testing and must withstand a minimum 2000 lbs (909 kg) without breakage or significant deformation. Markers with length less than 4 inches (10.2 millimeters) shall undergo compressive strength testing and must support a minimum load of 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_1), expressed as candelas per footcandle and millicandelas per lux (mcd/lx). One candela per lux equals 10.76 candelas per footcandle.

Table 1. Minimum R_1 Values

Entrance angle $b_2 =$ ($b_1 = 0^\circ$)	0°	$\pm 20^\circ$
Observation angle:	$.2^\circ$	$.2^\circ$
Minimum R_1 (cd/ftcd)	3.0	1.2
Minimum R_1 (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 show above. If abrasion-resistant reflective pavement markers are used, markers shall meet the same minimum retroreflectance values for the following tests:

Abrasion Resistance - Entire lens surface of the marker shall be subjected to 100 rubs with a 1 inch (25.4 millimeter) diameter flat pad of No. 3 coarse steel wool conforming to Federal Specification FF-W-1825A. A load of 50 ± 0.5 lb (22 ± 0.2 kg) is applied to steel wool pad during testing.

Temperature Resistance - The marker shall be conditioned for 12 hours at $145^{\circ}\text{F} \pm 5^{\circ}\text{F}$ ($62.7^{\circ}\text{C} \pm 2.5^{\circ}\text{C}$).

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 50 degrees Fahrenheit (10 degrees Centigrade). No markers shall be installed if the relative humidity of the air is greater than 80 percent or if the pavement is not surface dry. 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

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SECTION 634

TEMPORARY PAVEMENT STRIPING TAPE

DESCRIPTION

634.01.01 GENERAL: This work shall consist of furnishing, locating, placing, maintaining, and removing temporary pavement striping tape and temporary pavement striping tape (pilot line).

MATERIALS

634.02.01 TEMPORARY PAVEMENT STRIPING TAPE: Temporary striping tape shall be yellow or white or any combination thereof as directed by the Engineer and shall conform to the following requirements:

The striping material shall be reflectorized adhesive marking tape which will be readily visible when viewed with automobile headlights at night and shall be composed of a conformable backing coated with a pressure sensitive adhesive and shall be designed for marking of pavements. The tape shall be four inches (10 centimeters) wide and not less than 20 mils (.003 centimeter) or more than 30 mils (.007 centimeter) thick with a minimum tensile strength forty pounds per inch (7.1 kilograms per centimeter) of width. The color shall closely match the color normally used by the Agency in pavement striping. The upper of visible surface shall have a minimum apparent reflectance of seventy-five (75) percent as determined in accordance with ASTM Designation E 97. Beads shall be strongly adhered to the four inch (10 centimeter) tape at the rate of at least 1.76 but not more than 1.95 pounds per 100 linear feet (.786 to .870 kilograms per 30 meters). The striping material backing shall permit complete removal without requiring sandblasting, solvent or grinding methods.

Temporary pavement striping tape (pilot line) shall be 4 inch x 4 inch (10 x 10 centimeters) square and shall be placed on traffic lane lines at ____*-foot intervals. Lane lines and ____*-foot intervals shall be located by the Contractor as approved by the Engineer.

CONSTRUCTION

634.03.01 INSTALLATION: The Contractor shall furnish, apply, maintain, and remove all temporary pavement striping tape. Temporary pavement striping tape may be used on construction crossovers, detours and temporary connections. Temporary pavement striping tape (pilot line) may be placed on lane lines of permanent unmarked bituminous surfaces prior to allowing public traffic thereon, or, when approved by the Engineer, at the conclusion of paving operations on the day public traffic is first allowed on the unmarked bituminous surface.

The surface to which the tape is applied shall be dry, free of oil, grease, dust or dirt. The tape shall be tamped down immediately after applications in order to obtain a proper bond, and shall be removed from final pavement surface and where necessary to reroute public traffic as directed by the Engineer.

It should be considered normal and expected that portions of the temporary striping tape shall have to be replaced during the life of the contract. The locations and extent of these replacements shall be determined by the Engineer.

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)

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 Cement (Plus Fly Ash) Ratio
Type II & Fly Ash	6.5 ¹	0.45
Type I-P (MS)	6.5	0.45
Type V	6.5	0.45
Type V & Fly Ash	6.0 ¹	0.45

Note: ¹ - Sacks per cubic yard before replacement with fly ash.

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.

PHYSICAL PROPERTIES AND TESTS

701.03.01 REQUIREMENTS: The cement, except Type I-P and Type II cements shall meet the requirements set out in the current Standard Specifications for Portland cement, AASHTO Designation M 85.

Type I-P cement shall conform to the specifications of ASTM Designation C 595.

Type II cement shall conform to the specifications of ASTM Designation C 150 with the following exceptions:

- (a) The cement shall not contain more than 0.60 percent by weight of alkalies calculated as Na_2O plus 0.658 K_2O when determined by flame photometry, using the direct intensity method in the specifications of ASTM Designation C 114.
- (b) The percentage of tricalcium silicate shall not be limited.

The percentage of soluble sulfates in the soil shall be determined by an analysis in conformance with California Test Method 417-B or equivalent. Upon approval of the Engineer, the concentrations of soluble sulfates in the soil may be determined from the results of two recent soils tests in the same general area as the location of the proposed off-site construction, or by an equivalent method.

SECTION 702
CONCRETE CURING MATERIALS AND ADMIXTURES

SCOPE

702.01.01 MATERIALS COVERED: This specification covers concrete curing materials, air-entraining admixtures, water retardants, fly ash, and hydrated lime. Attention is directed to Section 722, "Water" for mixing and curing.

PHYSICAL PROPERTIES AND TESTS

702.03.01 CURING MATERIALS: Curing materials shall conform to the requirements of the following tests:

Burlap Cloth made from Jute or Kenaf	AASHTO M 182
Waterproof Paper for Curing Concrete	AASHTO M 171
Liquid Membrane-Forming Compounds for Curing Concrete	ASTM C 309, Type 1D*
Plastic Sheeting	ASTM C 171
White Pigmented Curing Compound	ASTM C 309, Type 2, *&**
White Polyethylene Sheeting (film) for Curing Concrete	ASTM C 171

* *Except* the curing compound shall not react harmfully with the components of concrete or contain oils, waxes, or other materials which would prevent bonding of traffic marking paints. The film of curing compound shall be continuous, uniform, and free from pinholes, bubbles, or blisters.

** *Except the loss of water in the water retention test shall not exceed 0.40 kg/m² of surface.*

All curing compounds not previously approved shall be tested by a reputable testing laboratory, recognized by the Contracting Agency, who shall certify that the curing compound meets these specifications and requirements. The Contractor shall furnish the Contracting Agency with this certification prior to using the curing compound.

702.03.02 BLANK

702.03.03 AIR-ENTRAINING ADMIXTURES: Air-entraining admixtures shall conform to the requirements of ASTM C 260.

702.03.04 ADMIXTURE OTHER THAN AIR-ENTRAINING: These admixtures shall meet the requirements of ASTM Designation C 494 and shall be clearly marked as to Type A, B, C, D, E, F, or G.

702.03.05 HYDRATED LIME: Hydrated lime shall conform to the requirements of ASTM C 207, Type N.

- (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.

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 degrees Celsius).

These specifications cover the following viscosity grades: AC-2.5, AC-5, AC-10, AC-20, AC-30, AC-40 and AC-20P.

The various AC-viscosity grades set forth above shall conform to the requirements and the methods of testing shown in Table 1 and Table 1A.

703.03.03 LIQUID ASPHALTS: Liquid asphalts shall consist of materials conforming to the following classifications. Rapid curing products designated by the letters RC, shall consist of paving asphalt with a penetration of approximately 85 to 100 fluxed or blended with a naphtha solvent. Medium curing products, designated by the letters MC, shall consist of paving asphalt fluxed or blended with a kerosene solvent. Slow curing products, designated by the 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 ISSA procedures.

TABLE 1
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	99.0	99.0	99.0	99.0	99.0	99.0
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. Viscosity at 140°F. (60° C.), poise max.	T 240 T 202	1000	1.0 2000	0.5 4000	0.5 8000	0.5 12000	0.5 16000

TABLE 5
UNIFORM PACIFIC COAST SPECIFICATIONS FOR ANIONIC EMULSIFIED ASPHALTS

Type	Rapid Setting								Slow Setting				
Grade	AASHTO Test Method		ASTM Test Method		RS-1		RS-2		SS-1		SS-1h		
					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		---	---	---	---		---	---	---	---
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		60	---	60	---		---	---	---	---
Calcium Chloride***	T 59		D 244										
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 distillation, %	T 59		D 244		55	---	63	---		57	---	57	---
Tests on Residue from Distillation Test:													
Penetration @ 77°F. (25°C.)	T 49		D 5		(4)	(4)	(4)	(4)		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 5 days time, or the purchaser may require that the settlement test be run from the time the sample is received until it is used, if the elapsed time is less than 5 days.

** The 24 hours (1 day) storage stability test may be used instead of the 5 day settlement test.

*** The demulsibility test shall be made within 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 6

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 Min. Max.	CRS-2 Min. Max.	CMS-2S Min. Max.	CMS-2 Min. Max.	CMS-2h Min. Max.	CSS-1 Min. Max.	CSS-1h Min. Max.	CQS-1h Min. Max.	
Tests on Emulsions: Viscosity SSF 77°F. (25°C.) sec. Viscosity SSF 122°F. (50°C.) sec. Settlement 5 days, %* Storage Stability Test 1 day** Demulsibility, 35 ml 0.8% sodium dioctyl sulfosuccinate, %*** Coating Ability/Water Resistance Coating, dry aggregate Coating, after spraying Coating, wet aggregate Coating, after spraying Particle Charge Test Sieve Test, % Cement Mixing Text, %	T72	D 88	-- --- 20 100	-- --- 100 400	-- --- 50 450	-- --- 50 450	-- --- 50 450	20 100 -- ---	20 100 -- ---	20 100 -- ---	
	T72	D 88	-- --- 5 5	-- --- 5 5	-- --- 5 5	-- --- 5 5	-- --- 5 5	-- --- 5 5	-- --- 5 5	-- --- 5 5	
	T59	D 244	-- --- 1 1	-- --- 1 1	-- --- 1 1	-- --- 1 1	-- --- 1 1	-- --- 1 1	-- --- 1 1	-- --- 1 1	
	T59	D 244	40 ---	40 ---	-- ---	-- ---	-- ---	-- ---	-- ---	-- ---	
	T59	D 244	-- ---	-- ---	Good ---	Good ---	Good ---	-- ---	-- ---	-- ---	
	T59	D 244	-- ---	-- ---	Fair ---	Fair ---	Fair ---	-- ---	-- ---	-- ---	
	T59	D 244	-- ---	-- ---	Fair ---	Fair ---	Fair ---	-- ---	-- ---	-- ---	
	T59	D 244	POSITIVE -- 0.10 -- ---	POSITIVE -- 0.10 -- ---	POSITIVE -- 0.10 -- ---	POSITIVE -- 0.10 -- ---	POSITIVE -- 0.10 -- ---	POSITIVE ⁵ -- 0.10 -- 2.0	POSITIVE ⁵ -- 0.10 -- 2.0	POSITIVE -- 0.10 -- 2.0	
	Distillation: Oil Distillate by volume of emulsion, % Residue, %	T59	D 244	-- 3 60 ---	-- 3 65 ---	-- 20 60 ---	-- 12 65 ---	-- 12 65 ---	-- --- 57 ---	-- --- 57 ---	-- --- 60 ---
		T59	D 244								
Tests on Residue from Distillate Test: Penetration 77°F. (25°C.) Ductility 77°F. (25°C.) Solubility in Trichloroethylene, %	T 49	D 5	(4)	(4)	100 250	100 250	40 90	40 90	45 60		
	T 51	D 113	40 --- 97.5 ---	40 --- 97.5 ---	40 --- 97.5 ---	40 --- 97.5 ---	40 --- 97.5 ---	40 --- 97.5 ---	40 --- 97.5 ---	40 --- 97.5 ---	
	T 44	D 2042									

* The test requirement for settlement may be waived when the emulsified asphalt is used in less than 5 days time; or the purchaser may require that the settlement test be run from the time the sample is received until it is used, if the elapsed time is less than 5 days.

** The 24 hour (1 day) storage stability test may be used instead of the 5 day settlement test.

*** The demulsibility test shall be made within 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.

SPECIFICATION FOR SLURRY SEAL MIX
TABLE 7

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/ft ² max.
Wet Stripping, % coating	ASTM T114	90 min.
Wet track Abrasion (6 day soak)	ASTM D3910/ISSA T100	75 g/ft ² max.
Wet track Abrasion (1 hour soak)	ASTM D3910/ISSA T100	75 g/ft ² max.
System Compatibility	ISSA T115	pass
Mix time @ 77°F	ASTM D-3910/ISSA T113	controllable to 180 sec minimum

SPECIFICATION FOR MICRO-SURFACING MIX
TABLE 8

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/ft ² max.
Wet Stripping, % coating	ISSA T114	90 min.
Wet track Abrasion (6 day soak)	ASTM D3910/ISSA T100	75 g/ft ² max.
Wet track Abrasion (1 hour soak)	ASTM D3910/ISSA T100	50 g/ft ² 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

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BASE AGGREGATES

704

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Project Control Test	Test Method	Requirements
Sieve Analysis.	AASHTO T 27	Above
Sampling Aggregate	ASTM D 75	-----
Plasticity Index.	ASTM D 4318 ¹	Table 1
Liquid Limit	ASTM D 4318	35 Maximum
Resistance (R Value)	ASTM D 2844	60 Minimum
Percentage of Wear (500 Rev.)	ASTM C 131	45% Maximum

¹ Test specimens shall be prepared following the dry preparation procedure described in Sections 10.2 through 10.2.5 of ASTM D4318.

704.03.03 BLANK

704.03.04 TYPE II AGGREGATE BASE: This aggregate shall conform to the following requirements:

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

Project Control Test	Test Method	Requirements
Sieve Analysis.	AASHTO	Above
Sampling Aggregate	ASTM D 75	-----
Fractured Faces.	Nev. T 230	70% Minimum
Plasticity Index	ASTM D 4318 ¹	Table 1
Liquid Limit.	ASTM D 4318	35 Maximum
Resistance (R Value).	ASTM D 2844	78 Minimum
Percentage of Wear (500 Rev.)	ASTM C 131	45% Maximum

¹ Test specimens shall be prepared following the dry preparation procedure described in Sections 10.2 through 10.2.5 of ASTM D4318.

Type 2 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 BLANK

704.03.06 BLANK

704.03.07 BLANK

704.03.08 AGGREGATE FOR PORTLAND CEMENT TREATED BASE: This aggregate shall conform to the following requirements:

Sieve Sizes	Percentage by Dry Weight Passing Sieve	
3 Inch.	100	
2 Inch.	90-100	
No. 4	35-75	
No. 200	20	

Test	Test Method	Requirements
Sieve Analysis	AASHTO T 27	Above
Sampling Aggregate.	ASTM D 75	-----
Percentage of Wear (500 Rev.). . .	ASTM C 131	45% Maximum

SECTION 705

AGGREGATES FOR BITUMINOUS COURSES

SCOPE

705.01.01 MATERIALS COVERED: This specification covers the quality and size of local mineral materials and commercial mineral fillers used in bituminous base and surface courses.

REQUIREMENTS

705.02.01 GENERAL: The mineral aggregate shall be the crushed and screened product of approved deposits. The Engineer reserves the right to prohibit the use of aggregates from any source when:

- (a) The character of the material is such, in the opinion of the Engineer, as to make improbable the furnishing of aggregates conforming to the requirements of these specifications.
- (b) The character of the material is such, in the opinion of the Engineer, that undue additional costs may be accrued by the Contracting Agency.
- (c) The maximum allowable water absorption of either coarse or fine aggregate shall not exceed 2.5 percent when tested in accordance with ASTM C127 (coarse aggregate) and ASTM C128 (fine aggregate).

The mineral aggregate shall be clean, hard, durable, free from frozen lumps, deleterious matter, and harmful adherent coatings.

When producing plantmix aggregate, all natural fines passing the No. 4 sieve shall be screened from the coarse aggregate and may be reintroduced into the mix at a rate not to exceed twenty (20) percent by dry weight of the combined aggregates.

The natural fines may be used only when all applicable mix design criteria have been met.

705.02.02 DEFICIENCIES: If the product of any deposit is deficient in the fraction passing the No. 50 sieve, additional filler from other approved deposits meeting the physical requirements may be added. The added material shall be fed to the drier in a uniform manner from a separate stockpile. If the added material is a commercial mineral filler, it shall be uniformly fed directly to the plant. This is not to be construed as a waiver of any of the requirements contained herein.

PHYSICAL PROPERTIES AND TESTS

705.03.01 PLANTMIX AND ROADMIX BITUMINOUS BASE AND SURFACE AGGREGATE, TYPES TWO FINE AND COARSE AND THREE: The aggregate shall conform to the following requirements:

Sieve Sizes	Percent By Weight Passing Sieve		
	Type 2 Coarse <u>Arterials</u>	Type 2 Fine Residential/ <u>Collector</u>	Type 3
1 Inch	100	100	-----
3/4 Inch	84-97	90-100	-----
1/2 Inch	66-82	78-94	100
3/8 Inch	56-72	68-84	90-100
No. 4	35-50	50-65	55-85
No. 8	23-38	30-49	32-67
No. 50	5-19	7-25	7-27
No. 200	2-7	2-9	2-10

Project Tests	Test Methods	Requirements
Sieve Analysis	AASHTO T 27	Above
Sampling Aggregate.	ASTM D 75	-----
Fractured Faces	NEV. T 230	60% Minimum (2 Fractures minimum) for Traffic Category I 35% Minimum (2 Fractures minimum) for Traffic Category II
Plasticity Index.	ASTM D 4318 ¹	6 Maximum
Liquid Limit.	ASTM D 4318	35 Maximum

Source Tests	Test Methods	Requirements
Percentage of Wear (500 REV.).	ASTM C 131	45% Maximum

¹ Test Specimens shall be prepared following dry preparation procedure described in Sections 10.2 through 10.2.5 of ASTM D4318.

705.03.03 PLANTMIX BITUMINOUS OPEN-GRADED SURFACE AGGREGATE: The aggregate shall conform to the following requirements:

Sieve Sizes		Percentage By Weight Passing Sieve
½ Inch.		100
3/8 Inch.		90-100
No. 4		35-55
No. 8		5-15
No. 200.		0-3

Project Tests	Test Methods	Requirements
Sieve Analysis	AASHTO T 27	Above
Sampling Aggregate.	ASTM D 75	----
Fractured Faces.	NEV. T 230	90% Minimum (2 fractures minimum)

Source Tests	Test Methods	Requirements
Percentage of Wear (500 REV.).	ASTM C 131	37% Maximum

705.03.04 COMMERCIAL MINERAL FILLER: Commercial mineral filler shall conform to the requirements of ASTM C977 for quicklime, ASTM C1097 for hydrated lime, and /or ASTM D-3910 and ASTM D-242 for slurry seal and microsurfacing.

Sampling of the mineral aggregate and mineral filler shall conform to AASHTO T2/ASTM D-75 methods. All aggregate shall be from the same source. No field blending will be allowed.

When tested according to the following tests, the mineral aggregate shall meet the following requirements:

MINERAL AGGREGATE GRADATION		
Property	Test Method	Specification
Sand Equivalent	AASHTO T176/ASTM D2419	50 Minimum for Slurry & 65 minimum for Micro-surfacing
Plasticity Index	ASTM D4318	NP
Soundness, %	AASHTO T104/ASTM C88	15 max. (using Na_2SO_4)
Abrasion Resistance, %	AASHTO T96/ASTM C131	30 maximum*
*The abrasion test is to be run on the aggregate before it is crushed.		

When tested in accordance with AASHTO T27 & T11/ASTM C136 & C117, the mineral aggregate with mineral filler shall conform to the requirements of gradations as indicated below (The percentage passing shall not vary from the high limit to the low limit on any two consecutive sieves).

705.03.05 SCREENINGS: The screenings shall conform to the following requirements:

Sieve Sizes	Percentage By Weight Passing Sieve	
	½ Inch	3/8 Inch
½ Inch.	100	-----
3/8 Inch.	90-100	100
No. 4	15-35	20-45
No. 16.	0-4	0-6
No. 200	0-2	0-2

Project Tests	Test Methods	Requirements
Sieve Analysis	AASHTO T 27	Above
Sampling Aggregate	ASTM D 75	-----
Fractured Faces	NEV. T 230	90% Minimum (2 fractures minimum)

Source Tests	Test Methods	Requirements
Percentage of Wear (500 REV.).	ASTM C 131	37% Maximum

705.03.06 SAND BLOTTER: The sand shall conform to the following requirements:

Sieve Sizes	Percentage By Weight Passing Sieve	
	½ Inch	3/8 Inch
½ Inch.	100	-----
No. 4	90-100	100
No. 16.	30-75	20-45
No. 200	0-12	0-6

Project Tests	Test Methods	Requirements
Sieve Analysis.	AASHTO T 27	Above
Sampling Aggregate.	ASTM D 75	-----
Organic Impurities.	ASTM C 40	-----

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	5 - 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.

709.03.08 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.

709.03.09 THERMOPLASTIC, PLASTIC PIPE CULVERTS AND DRAINS:

MATERIALS

- (a) **Corrugated Polyethylene Pipe, Type C** - Type C corrugated polyethylene pipe shall be manufactured from high density polyethylene (HDPE) virgin compounds and shall conform to AASHTO Designation M 294, unless otherwise specified herein or in the special provisions. Both the inside and outside surface of the pipe shall be corrugated.
- (b) **Corrugated Polyethylene Pipe, Type S** - Type S corrugated polyethylene pipe shall be manufactured from high density polyethylene (HDPE) virgin compounds and shall conform to AASHTO Designation M 294, unless otherwise specified herein or in the special provisions. The pipe wall shall be corrugated exterior construction with a smooth inner liner.
- (c) **Corrugated Polyethylene Pipe, Type D** - Type D corrugated polyethylene pipe shall be manufactured from high-density polyethylene (HDPE) virgin compounds. Nominal sizes of 42 inches (1050 mm) and 48 inches (1200 mm) shall conform to AASHTO Designation M-294, and nominal sizes of 54 inches (1350 mm) and 60 inches (1500 mm) shall conform to AASHTO Designation MP7-97, 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.

- (d) **Ribbed Profile Wall or Spiral Wound Polyethylene Pipe** - Ribbed wall polyethylene pipe shall be manufactured from high density polyethylene (HDPE) virgin compounds and shall conform to ASTM Designation F 894. The pipe wall shall be of either solid or hollow rib exterior construction with a smooth inner surface.
- (e) **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 Designation 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.

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- (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.
- (g) **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.

High density polyethylene (HDPE) and polyvinyl chloride (PVC) compounds used in the manufacture of thermoplastic pipe culverts shall conform to the following provisions:

The Contractor shall provide the Engineer with a Certificate of Compliance from the manufacturer, for each type of thermoplastic pipe furnished, in accordance with the provisions of Subsection 106.05, "Certificates of Compliance," of these Specifications. Said certificate shall certify that the thermoplastic pipe complies with the requirements of the specifications, and shall include the resin material cell classification, unit weight of pipe, average pipe stiffness and the date of manufacture.

The cell classification for each individual property of HDPE compounds shall conform to ASTM Designation D 3350 and the following:

Property	Cell Classification
Density	3
Melt Index	2(*), 3 or 4
Modulus of Elasticity	4, 5 or 6
Tensile Strength	4, 5 or 6
Environmental Stress Crack Resistance	2 or 3
Hydrostatic Design Basis	0, 1, 2, 3, or 4
Ultraviolet-Stabilizer	C(**)

- (*) The Melt Index for cell classification 2 material used to manufacture pipe shall not be greater than 0.6. Rotationally molded couplings and end fittings may be produced from material compounds having a melt index cell classification of 1.

- (**) HDPE resin shall contain not less than $2 \pm 1/2$ percent carbon black ultraviolet-stabilizer.

SECTION 715

GALVANIZING

SCOPE

715.01.01 MATERIALS COVERED: This specification covers the quality and thickness of galvanizing used on various material when called for on the plans or designed in the specifications.

PHYSICAL PROPERTIES AND TESTS

715.03.01 PRODUCTS ONE-EIGHTH (1/8) INCH (0.3 CENTIMETERS) THICK AND THICKER: Galvanizing of products fabricated from rolled, pressed, and forged steel shapes, plates, bars, and strip shall conform to the requirements of ASTM Designation A 123.

715.03.02 GUARDRAIL ELEMENTS: All rail elements shall be galvanized in accordance with AASHTO Designation M 180, Type 2.

715.03.03 HARDWARE: Bolts, nut, washers, and fastenings shall be galvanized in accordance with the requirements of ASTM Designation A 153.

SECTION 716

SIGN MATERIALS

SCOPE

716.01.01 MATERIALS COVERED: This specification covers the kind and quality of materials used in the construction and fabrication of "Work Zone Signs," "Temporary Signs," "Street Name Signs" and "Permanent Signs."

REQUIREMENTS

716.02.01 GENERAL: The following materials shall conform to the requirements as noted:

Portland Cement Concrete		Section 501
Reinforcing Steel		Section 505

716.02.02 CERTIFICATES: It shall be the Contractor's responsibility to ascertain that all required tests have been made by qualified testing laboratories as approved by the Contracting Agency. The Contractor shall furnish the Engineer with a written certification that all required tests have been satisfactorily completed and that materials and fabrication thereof comply with all the requirements.

PHYSICAL PROPERTIES AND TESTS

716.03.01 REFLECTIVE SHEETING: Sheeting shall be of the following class sets, as specified in the plans or the proposal, and unless otherwise specified or approved by the Engineer, shall be Class 4, except for street name signs which shall be Class 6. The sheeting shall be a material approved by the Engineer, applied to approved sign substrate per manufacturer's instructions, and conform to the applicable requirements below.

Class 1 - Non-retroreflective plastic film (ScotchCal. or equal). Pressure sensitive adhesive coated plastic film for sign copy and borders shall be a material recommended by the retroreflective sheeting manufacturer as compatible with the background retroreflective sheeting, and shall meet the requirements for Type I, Class 1 of MIL-M-43719B, "Marking Materials and Markers, Adhesive, Elastomeric, Pigmented."
Life: 7 years

Class 2 - Enclosed Lens Retroreflective Sheeting (Engineer grade, or equal). Class 2 sheeting shall meet the requirements of USDOT FHWA Specification FP-96, Section 718, for Type I Sheeting.
Life: 7 years

Class 3 - Enclosed Lens Retroreflective Sheeting (Super Engineering grade, or equal). Class 3 sheeting shall meet the requirements of FP-96, Section 718, for Type II Sheeting.
Life: 10 years

Class 4 - Encapsulated Lens Retroreflective Sheeting (High Intensity grade, or equal). Class 4 sheeting shall meet the requirements of FP-96, Section 718, for Type III Sheeting and the following additional values for the minimum coefficients of retroreflection in units of candelas per footcandle per square foot (candelas per lux per square meter) for sheeting used in construction work zones, except as provided in this subsection for Class 5 sheeting:

Observation Angle (°)	Entrance Angle (°)	White	Yellow	Orange
0.2	+50	75	40	25
0.5	+50	35	20	10

Life: 10 years

Class 5 - Wide Angle Prismatic Retroreflective Sheeting (Diamond grade, or equal). Class 5 sheeting is a wide angle retroreflective sheeting with optimized performance at narrow observation angles and with extended entrance angle performance and shall have minimum coefficients of retroreflection, R' (determined in accordance with ASTM E 810, in units of candelas per footcandle per square foot (candelas per lux per square meter)), not less than the values shown below:

Observation Angle (°)	Entrance Angle (°) (0 degree orientation)	White	Red	Yellow	Blue	Green
0.2	-4	800	215	660	43	80
0.2	+30	400	100	340	20	35
0.2	+45	145	25	85	7.6	12
0.2	+60*	35	6.6	23	1.0	2.0
0.5	-4	200	45	160	9.8	20
0.5	+30	100	26	85	5.0	10
0.5	+45	75	18	60	2.8	6.0
0.5	+60*	30	6.4	20	2.0	2.0

* 60 degree angle shall be measured at a 90 degree orientation.

Observation Angle(°)	Entrance Angle(°) (90 degree orientation)	Fluorescent Orange
0.2	-4	200
0.2	+30	120
0.2	+50	50
0.5	-4	80
0.5	+30	50
0.5	+50	20

Life: 7 years

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Legends for signs using Class 5 fluorescent orange retroreflective sheeting shall be in accordance to manufacturer's recommendations.

NOTICE: Class 5 fluorescent orange sheeting shall be used on construction signs. Fluorescent orange sheeting shall meet the requirements established in the table above. Construction signs using Class 4 orange sheeting shall be replaced with Class 5 fluorescent orange signs in accordance with the following phase-in schedule:

- (a) All projects beginning work after June 1, 1998, shall require the use of fluorescent orange sheeting on advance warning signs ("ROAD WORK AHEAD" and "FLAGGER AHEAD", including flagger symbol sign).
- (b) Road construction and maintenance projects under contract beginning work after January 1, 1999 shall require the use of fluorescent orange sheeting on all construction signs.
- (c) All construction and maintenance projects shall be required to use fluorescent orange sheeting on all construction signs after June 1, 1999.

Class 6 - Wide Angle Prismatic Retroreflective Sheeting (Diamond grade VIP, or equal). Class 6 sheeting is a wide angle retroreflective sheeting with optimized performance over a broad range of observation angles and shall have minimum coefficients of retroreflection, R' (determined in accordance with ASTM E 810, in units of candelas per footcandle per square foot (candelas per lux per square meter)), not less than the values shown below:

Observation Angle (°)	Entrance Angle (°) (0 degree orientation)	White	Yellow	Red	Blue	Green
0.20	-4	430	350	110	20	45
0.20	+30	235	190	60	11	24
0.20	+40*	150	125	40	6	15
0.33	-4	300	250	75	15	33
0.33	+30	150	130	30	7	18
0.33	+40*	85	75	25	4	8
0.50	-4	250	200	60	10	25
0.50	+30	170	140	40	7	19
0.50	+40*	35	30	10	1.5	3.5
1.00	-4	80	65	20	4	10
1.00	+30	50	40	13	2.5	5
1.00	+40*	20	17	6	0.7	2.0

* 40 degree angle shall be measured at a 90 degree orientation.

Observation Angle(°)	Entrance Angle(°) (0 degree orientation)	Fluorescent Yellow-Green
0.2	-4	375
0.2	+30	225
0.2	+45	25
0.5	-4	225
0.5	+30	145
0.5	+45	7
1.0	-4	75
1.0	+30	45
1.0	+45	4

Life: 7 years

Flourescent yellow-green reflective sheeting may be used on the following signs only: School advance (S1-1), School Crossing (S2-1), School Bus Stop Ahead (S3-1), School Speed Limit (S5-1), Pedestrian Crossing (W11A-2), Advance Pedestrian Crossing (W11-2) and Bicycle Crossing (W11-1).

Transparent colored ink reverse screening of white sheeting and overlaying of white sheeting with electronic cutable colored transparent film must result in coefficients of retroreflection not less than 70% of the previously specified values for the corresponding colors for Class 2-4 sheeting. For Class 5 and 6 sheeting, the contrast ratio of the coefficient of retroreflection (R') for the white to the coefficient of retroreflection (R') for the color, when measured at 0.2° observation, -4° entrance, and 0° rotation shall be 5:1 to 15:1 for red, not less than 5:1 for blue and not less than 5:1 for green when processed in accordance with the recommendations of the sheeting manufacturer.

Field Performance Life Requirements. The supplier shall warranty that signs supplied shall have an effective reflective life of not less than that specified in the previous subsections. The retroreflective sign shall be considered unsatisfactory (and failing this life requirement) if it has deteriorated due to natural causes to the extent that:

- (1) the sign is ineffective for its intended purpose when viewed from a moving vehicle under normal day and night conditions;
- (2) the values for the coefficients of retroreflection for Classes 2 - 4 are less than 50% of the required values for the same sign when new or for Classes 5 and 6, the contrast ratio is below the recommended values for the same sign when new or the values for the coefficients of retroreflection for Class 5 Fluorescent Orange and Class 6 Fluorescent Yellow-Green are less than 50% of the required values for the same sign when new, or
- (3) the sign material's integrity or adhesion to the sign substrate has substantially failed. Sheeting which fails this requirement within the specified required lifetime shall be replaced at no charge. Additionally, sheeting which fails this requirement within 3 years shall be replaced on the site at no cost to the using

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Agency for materials or labor. All finished signs shall be dated with the month and year of delivery in order to ascertain compliance with these lifetime requirements.

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716.03.03 ALUMINUM SIGN PANELS (FOR REFLECTIVE SHEETING): Sheet aluminum for sign panels shall be of 0.100 inch (2.5 millimeter) aluminum alloy Alclad 5052-H38 or 6061-T6 and shall conform to specifications for ASTM Designation B 209. Sign panels for street name signs shall be as required in the Standard Drawings.

Sign panel sections shall be fabricated of standard width aluminum sheets not less than four (4) feet (1.2 meters) wide, except that not more than two (2) sheets for any one sign may be cut not less than eighteen (18) inches (460 millimeters) in width, so as to provide sign widths to nearest six (6) inch (150 millimeters) increments. Panel sections shall run from the top edge to the bottom edge of the sign without horizontal joints.

The aluminum shall be free of all corrosion, white rust, and dirt. All sign dimensions, metal gage, and bolt holes shall conform to the requirements set forth on the plans and in these specifications. Blanks shall be cleaned, degreased and chromated or otherwise properly prepared according to methods recommended by the sheeting manufacturer.

Metal shall not be handled, except by device or clean canvas gloves between all cleaning operations and the applications of the sign background material. There shall be no opportunity for the aluminum to come in contact with greases, oils, or other contaminants prior to the applications of the background material.

All fabrication, including cutting, shall be completed prior to the cleaning process. Metal panels shall be cut to size and shape and shall be free of defects resulting from fabrication. The surface of all sign panels shall be a plane surface.

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716.03.05 OVERHEAD SIGN STRUCTURES AND SIGN FRAMES: The materials used in the fabrication of overhead sign structures and footings shall conform to the following requirements:

- (1) **Sign frames.** Bars, plates, and shapes shall be structural steel conforming to the specifications of ASTM Designation A 36.
- (2) **Sign pipe posts.** Pipe posts shall be welded or seamless steel pipe conforming to the specifications of ASTM Designation A 53, Grade B. At the option of the Contractor, posts may be fabricated from structural steel conforming to the specifications of ASTM Designation A 36 or of ASTM Designation A 283, Grade D, except that plates more than one inch (25 millimeters) in thickness shall be structural steel conforming to the specifications of ASTM Designation A 373.
- (3) **Sign steel walkway gratings.** Steel walkway gratings shall be furnished and installed in accordance with details shown on the plans and the following provisions:
 - (a) Gratings shall be the standard product of an established grating manufacturer.

- (b) Material for gratings shall be structural steel conforming to the specifications of ASTM Designation A 36.
 - (c) For welded type gratings, each joint shall be full resistance welded under pressure to provide a sound, completely beaded joint.
 - (d) For mechanically locked gratings, the method of fabrication and interlocking of the members shall be approved by the Engineer, and the fabricated grating shall be equal in strength to the welded type.
 - (e) After fabrication, gratings shall be hot-dip galvanized.
 - (f) Gratings shall be free from warps, twists, or other defects affecting their appearance or serviceability. The tops of the bearing bars and cross members shall be in the same plane. Gratings distorted by the galvanizing process shall be straightened.
- (4) **Bolts and Nuts.** Bolts and nuts shall conform to the specifications of ASTM Designation A 307. Bolted connections shall conform to the provisions in Subsection 506.03.10, "Bolts and Bolted Connections."
 - (5) Bearing plates and gusset or stiffener plates shall be of the sizes and dimensions shown on the plans and shall be galvanized after fabrication. Steel shall conform to ASTM Designation A 36. Galvanizing shall conform to ASTM Designation A 123. All welding shall conform to the requirements set forth in Subsection 506.03.20, "Welding."
 - (6) Anchor bolts, nuts and washers shall be of structural carbon-steel conforming to Section 710, "Structural and Eyebar Steel," and shall be galvanized in accordance with ASTM Designation A 153, or Cadmium plated in accordance with ASTM Designation A 165 Type TS. The top portion of anchor bolts shall be galvanized or cadmium plated to such extent that the galvanized or cadmium plated portion will extend at least two (2) inches (50 millimeters) into concrete. Anchor bolts shall be of the size, shape and length as shown on the plans.
 - (7) All bolts, nuts, clamps and metal washers not otherwise noted shall be galvanized or cadmium plated. Cadmium plating shall conform to the specifications of ASTM Designation A 165, minimum thickness as prescribed for grade Type TS and galvanizing shall conform to the requirements of ASTM Designation A 153.
 - (8) Supporting frame shall be manufactured in accordance with the plans and requirements herein specified. All metal parts shall be galvanized after fabrication, in accordance with the provisions of Section 715. When permission is granted by the Engineer to zinc coat a surface by means other than hot-dip galvanizing, the metalizing process shall be used to place the zinc. Metalizing shall be performed in accordance with the AWS Specifications and the thickness of the sprayed zinc coat shall be at least 5 mils (0.13 millimeters).

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- (9) Truss frames shall be fabricated to the largest practical sections prior to galvanizing. Splice locations shall be submitted to the Engineer for approval and the Contractor shall not commence fabrication until such splice locations are approved.
- (10) All welding on the fabrication of the structure shall be done by welders qualified in accordance with AWS requirements using the inert-gas shielded-arc method. Welds shall be free from cracks, blow holes and other irregularities and shall be wire brushed or otherwise cleaned. No field welding on any part of the structural assembly will be permitted.

NOTE: Before fabrication is started, five (5) sets of shop drawings for each overhead sign structure shall be submitted to the Engineer for approval.

716.03.06 SIGN HARDWARE, POST, AND RELATED MATERIALS: Bearing plates and gusset or stiffener plates shall be of the sizes and dimensions shown on the plans and shall be galvanized after fabrication. Steel shall conform to ASTM Designation A 36. Galvanizing shall conform to ASTM Designation A 123. All welding shall conform to the requirements set forth in Subsection 506.03.20, "Welding."

Structural I-beam steel shall be galvanized in accordance with ASTM Designation A 153, or cadmium plated in accordance with ASTM Designation A 165 Type TS.

Anchor bolts, nuts and washers shall be of structural carbon-steel conforming to Section 710. The top portion of anchor bolts shall be galvanized or cadmium plated to such extent that the galvanized or cadmium plated portion will extend at least two (2) inches (50 millimeters) into the concrete. Anchor bolts shall be of the size, shape and length as shown on the plans.

Steel pipe for posts shall conform to the specifications of ASTM Designation A 120 and shall be galvanized. Galvanized steel pipe posts shall be of the diameter and length shown on the plans. The top of the posts shall be fitted with a cover. Posts showing damage shall be repaired or rejected.

Wood posts shall be constructed of Douglas Fir, West Coast Hemlock, or any other equivalent stress rated wood material, at the option of the Contractor. Said wood material shall be construction grade, free of heart center, minimum stress rating of 1200f, and shall be graded in accordance with the provisions contained in Section 718. Sweep shall not exceed 0.08 feet (24.4 millimeters) in 10 feet (3 meters).

Aluminum stiffeners, braces, and stringers used as horizontal supporting structural members shall be of aluminum alloy 6061-T6. These extrusions shall have a continuous inverted "T" slot. This inverted "T" shall accommodate positionable stainless steel clamping devices. These clamping devices shall provide complete freedom of alignment within this slot forming an interlocking clamp system for fastening the sign to the post. The sign support system described herein shall conform to AASHTO Standard Specifications for Highway Signs, Luminaires and Traffic Signals, latest revision, and be rated for minimum wind velocities of 80 mph. All bolts, nuts, clamps and metal washers in contact with this aluminum channel shall be Stainless Steel Type 304. The system shall be compatible with all I-beam, steel post and wood post systems.

All other bolts, nuts, clamps and metal washers in contact with other aluminum components shall be galvanized or cadmium plated. Cadmium plating shall conform to the specifications of ASTM Designation A 165, minimum thickness as prescribed for grade Type TS and galvanizing shall conform to the requirements of ASTM Designation A 153.

Cantilever arm brackets shall be used when it is desired to offset the entire length of a sign to one side of a post or pole. Cantilever arm brackets shall consist of a stainless steel or aluminum head mounted to an extruded

aluminum "TEE" section. This "TEE" section will have a continuous slot that will accept signs up to 1/8" (3.2 millimeters) thick. If sign thickness (including aluminum sign panel and reflective sheeting) exceeds the width of the "TEE" section slot, sign panel thickness may be reduced to not less than 0.080", or reflective sheeting may be eliminated in the bracket area, as directed by the Engineer. The heads shall be designed to accept 3/4" (19.1 mm) stainless steel banding. The "TEE"-shaped extrusions shall be made from 6061-T6 aluminum alloy. The cantilever arm brackets shall be used to support the entire length of the sign on both the top and the bottom. The sign shall be attached to the brackets using 1/8" (3.2 mm) rivets spaced according to the hole pattern pre-drilled on the extruded "TEE" section. These cantilever arm brackets shall be compatible with any size and shape of post or pole. This system shall be designed for use on signs up to 72 inches (1.83 meters) in length with a maximum surface area of 9.5 square feet (0.88 square meters). Signs with surface area greater than 2 square feet (0.19 square meters) shall be fastened to round posts or poles using 3/4" X .030 (19.1 mm X 0.76 mm) stainless steel banding. When mounting to square posts or flat surfaces, compatible stainless steel threaded studs or bolts can be used as well as 3/4" X .030 (19.1 mm X 0.76 mm) stainless steel banding. For signs less than 2 square feet (0.19 square meters) in surface area, 5/8" (15.9 mm) banding is acceptable.

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728.03.05 BLANK**728.03.06 BINDER (ADHESIVE), EPOXY RESIN BASE, ALKYL BENZENE EXTENDED:**

Classification. This specification covers a medium viscosity liquid alkylbenzene extended epoxy formulated primarily for use with aggregate as a gray seal and skid resistant surfacing for Portland cement concrete and for preparing low strength epoxy mortar and epoxy concrete. This epoxy is suitable for use in freeze-thaw environments. This Binder (Adhesive), Epoxy Resin Base, Alkylbenzene Extended shall conform to the requirements of California State Specification 741-80-46.

Directions for use. The mixing ratio is one part by volume of Component A to one part by volume of Component B. No more material shall be mixed than can be used within 10 minutes from the time mixing operations are started.

728.03.07 BINDER (ADHESIVE), EPOXY RESIN BASE, FAST SETTING:

Classification. This specification covers a medium viscosity liquid rapid set epoxy formulated primarily for use in making high-strength epoxy concrete and epoxy mortar where low curing temperatures are expected or when a fast cure is required. This epoxy is not formulated for use in bonding of new Portland cement concrete to old Portland cement concrete. This epoxy is suitable for use in freeze-thaw environments. This Binder (Adhesive), Epoxy Resin Base, Fast Setting shall conform to the requirements of California State Specification 741-80-47.

Directions for use. The mixing ratio is 2 parts by volume of Component A to one part by volume of Component B. Aggregate shall be added immediately after Components A and B are thoroughly mixed. The epoxy mortar or concrete shall be placed as soon as possible. The useful work life of the mortar will depend on temperature but will be about 10-15 minutes at 75 degrees F. (23.9 degrees Celsius). All surfaces shall be primed with mixed epoxy.

728.03.08 BINDER (ADHESIVE), EPOXY RESIN BASE, FAST SETTING, ALKYL BENZENE EXTENDED:

Classification. This specification covers a medium viscosity liquid rapid set alkylbenzene extended epoxy formulated primarily for use with aggregate as a gray seal and as a skid resistant surfacing for Portland cement concrete and for use in making low strength epoxy concrete and epoxy mortar where low curing temperatures are expected or when a fast cure is required. This epoxy is suitable for use in freeze-thaw environments. This Binder (Adhesive), Epoxy Resin Base, Fast Setting, Alkylbenzene Extended shall conform to the requirements of California State Specification 741-80-48.

Directions for use. The mixing ratio is one part by volume of Component A to one part by volume of Component B. Do not mix more material than can be used within 10 minutes from the time mixing operations are started.

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When applying resinous seal, the aggregate shall be sprinkled in the epoxy film not later than 5 minutes after epoxy is applied to the road surface.

728.03.09 EPOXY SEALANT FOR INDUCTIVE LOOPS:

Classification. This specification covers a high viscosity liquid epoxy formulated primarily for use in sealing inductive wire loops and leads imbedded in asphalt concrete and Portland cement concrete for traffic signal controls and vehicle counters. This epoxy is to be used for repair work on existing spalls, cracks and other deformations in and around saw cuts, housing inductor loops and leads. The rapid cure allows minimum traffic delay. This sealant is suitable for use in freeze-thaw areas and can be used on grades up to 15 percent without excessive flow of material. This Epoxy Sealant for Inductive Loops shall conform to the requirements of California State Specification 741-80-36.

Directions for use. Saw cuts shall be blown clean and dry with compressed air to remove all excessive moisture and debris. For repairing damaged saw cuts, all loose spalled material shall be cleaned away from saw cut, chipping back to sound asphalt concrete or Portland cement concrete and all loose material cleaned from loop wires.

The mixing ratio is one part by volume of Component A to one part by volume of Component B. No more material shall be mixed than can be used within 10 minutes from the time mixing operations are started.

When automatic mixing equipment is used for mixing the sealant, the provisions in the sixth paragraph of Subsection 633.03.01, "Installation," shall apply.

728.03.10 EPOXY ADHESIVES FOR PAVEMENT MARKERS:

- a) **Rapid-Set Epoxy Adhesive** - This specification covers a high viscosity rapid set epoxy formulated primarily for use in bonding pavement markers to Portland Cement Concrete and asphalt cement. The epoxy used under this specification shall conform to the requirements of AASHTO M237, Type I. Tests for requirements for AASHTO M237 shall be performed in accordance with AASHTO T237.
- b) **Standard-Set Epoxy Adhesive** - This specification covers a high viscosity standard set epoxy formulated primarily for use in bonding pavement markers to Portland Cement Concrete and asphalt cement. The epoxy used under this specification shall conform to the requirements of AASHTO M237, Type II. Tests for requirements for AASHTO M237 shall be performed in accordance with AASHTO T237.

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