

**UNIFORM STANDARD SPECIFICATIONS
CLARK COUNTY AREA**

SPECIFICATIONS - YEAR 2003 REVISIONS

<u>SPECIFICATION NUMBER AND TITLE</u>	<u>PAGE NUMBER(S)</u>	<u>NATURE OF CHANGE</u>	<u>EFFECTIVE DATE</u>
408 Pavement Surface Treatments	408-(4-12)	Revision to Subsection 408-2 to update requirements for slurry seal and micro-surfacing.	3/1/03
401 Plantmix Bituminous Pavements - General	401-1	Revision to Subsection 401.01.02 (8) to change AASHTO test designation.	4/1/03
613 Concrete Curb, Walk, Gutters, Driveways and Alley Intersections	613-6	Subsection 613.03.18, "Detectable Warnings," added to provide requirements for detectable warning surface on sidewalk ramps in accordance with ADA.	"
623 Traffic Signals and Streetlighting	623-(5-7)	Revision to Subsection 623G.03.01 to provide requirements for communications infrastructure.	"
401 Plantmix Bituminous Pavements - General	401-1	Revision to Subsection 401.01.02 (1) to define the standard normal deviation for the AASHTO pavement design.	9/1/03
401 Plantmix Bituminous Pavements - General	401-2	Revision to Subsection 401.01.02 to allow actual vehicle counts and assigned axle values be used in pavement design.	10/1/03
111 BLANK	111-1	Section contents deleted; Section reserved for later use.	12/1/03
203 Excavation and Embankment	203-(1,13)	Revised to include required test methods and frequencies.	"

<u>SPECIFICATION NUMBER AND TITLE</u>	<u>PAGE NUMBER(S)</u>	<u>NATURE OF CHANGE</u>	<u>EFFECTIVE DATE</u>
206 Structure Excavation	206-(1-2)	Revised to include required test methods and frequencies.	12/1/03
207 Structure Backfill	207-(1-4)	“	“

Revised February 2004

**UNIFORM STANDARD
SPECIFICATIONS**

**FOR
PUBLIC WORKS'
CONSTRUCTION
OFF-SITE IMPROVEMENTS**

**CLARK COUNTY AREA
NEVADA**

FOREWORD

Publication of these Uniform Standard Specifications for Public Works Construction Off-site Improvements, Clark County Area, Nevada, is the third edition of this important document and will supersede the 1986 edition. **All revisions to these specifications approved by the Regional Transportation Commission through December 2003 have been included in this publication.**

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

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

The Uniform Standard Specifications for Public Works Construction may be revised by issuance of revisions or supplements to correct errors and omissions found in these specifications and to reflect advanced thinking and the changing technology of the construction industry. Each revision or supplement will supersede any previous supplement by inclusion of all pertinent portions. Upon approval by the Regional Transportation Commission, revisions will be posted to the RTC website, www.rtcsonthernnevada.com, on the first day of the month following the meeting.

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

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

CLARK COUNTY

Adopted by Resolution July 20, 1993

CITY OF LAS VEGAS

Adopted by Resolution R32-93 June 16, 1993

CITY OF NORTH LAS VEGAS

Adopted by Resolution No. 1685 June 16, 1993

CITY OF HENDERSON

Adopted by Ordinance No. 549 August 20, 1984

Revisions Adopted By Council Action (3rd Edition) June 15, 1993

CITY OF BOULDER CITY

Adopted by Resolution No. 2379 March 22, 1994

CITY OF MESQUITE

Adopted by Resolution No. 26 January 8, 1987

Revisions Adopted By Council Action (3rd Edition) June 10, 1993

REGIONAL TRANSPORTATION COMMISSION

Adopted by Resolution No. 7 June 14, 1984

Revisions Adopted By Commission Action Various Dates

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- (c) The provisions of this Section shall be made known to all private contractors performing such excavation or work for any agency of the State or its political subdivisions.
- (d) The contractor shall also, immediately, report any historic, pre-historic or paleoenvironmental evidence found on the site to the owner or owner's representative.

SECTION 111

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This section reserved for future use.

REMOVAL OF STRUCTURES AND OBSTRUCTIONS

Payment will be made under:

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

SECTION 203

EXCAVATION AND EMBANKMENT

DESCRIPTION

203.01.01 GENERAL: This work shall consist of grading and excavating the roadway, excavating borrow pits, removing slide material, and excavating ditches and stream channels and satisfactorily disposing of all excavated material and all work necessary for the construction and completion of cuts, embankments, slopes, ditches, dikes, stream channels, approaches, parking areas, intersecting driveways and highways, and subsidiary work. Exceptions are slope rounding, structure excavation, or other separately designated pay items of work which are made a part of the contract. All work shall be in conformity with the alignment, grades, and cross sections shown on the plans or established by the Engineer. Testing requirements for this section are contained in Subsection 203.06.01, "Testing."

203.01.02 GRADE TOLERANCE: Immediately prior to placing subsequent layers of material thereon, the grading plane shall conform to one of the following:

- (1) The subgrade shall not vary more than 0.10 foot (30 millimeters) above or below the grade established by the Engineer or Contractor.
- (2) The final subgrade layer prior to application of the structural base shall not vary more than 0.05 foot (15 millimeters) above or below the grade.

MATERIALS

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

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

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

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

in the Special Provisions or designated by the Engineer. The source of material to be excavated shall be approved in advance by the Engineer. Borrow shall be excavated to the lines and grades established by the Engineer.

The Contractor shall notify the Engineer sufficiently in advance of opening any borrow site so that adequate time will be allowed for testing the material and establishing cross section elevations and measurements of the ground surface. The widening of roadway cuts shall be considered as roadway excavation and not as borrow, unless otherwise specified. Borrow excavation will not be classified according to type or character of material encountered in the borrow area unless otherwise required in the Special Provisions.

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

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

CONSTRUCTION

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

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

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

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

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

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

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

203.03.03 BLASTING: Any material outside the authorized cross section on the backslopes which may be shattered or loosened because of blasting shall be removed by the Contractor at his expense. Shattered or

loosened material below the bottom limits of required excavation shall be uniformly distributed and compacted or otherwise disposed of in a manner satisfactory to the Engineer. The Contractor shall discontinue any method of blasting which leads to overshooting or is dangerous to the public or destructive to property or to natural features.

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

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

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

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

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

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

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

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

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

If the quantity of surplus material is specified in the contract documents, such quantity shall be considered approximate only. The Contractor shall satisfy himself that there is sufficient material available

for the completion of the embankments within the areas involved before disposing of any indicated surplus material inside or outside the right-of-way. Any shortage of material caused by premature disposal of the indicated surplus material by the Contractor shall be replaced by him and no compensation will be allowed the Contractor for such replacement.

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

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

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

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

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

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

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

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

V-type ditches shall be formed to the cross section and dimensions on the plans by means of suitable equipment which will deposit all loose material on the downhill side so that the bottom of the finished ditches shall not be less than two (2) feet six (6) inches (2.5 meters) below the crest of the loose material piled on the downhill side.

Rev. November 13, 2003

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

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

203.03.12 CHANNELS: To avoid destruction of natural growth during construction of ditches, channels, or dikes, travel of equipment shall be confined to the construction limits. Where ditches, channels or dikes are nearly parallel to the roadway, turn-arounds shall not be located closer than two hundred (200) feet (60 meters) apart. Attention is directed to Subsection 107.12, "Protection and Restoration of Property and Landscape."

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

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

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

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

In all borrow pits having undesirable material, including overburden, refuse, organic and deleterious substances, the material shall be removed and wasted or redistributed, in a manner satisfactory to the Engineer. All costs incurred therefor shall be considered as incidental and subsidiary to the borrow.

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

The Contractor shall notify the Engineer sufficiently in advance of opening any borrow areas so that cross section elevations and measurements of the ground surface after stripping may be taken, and the borrow materials can be tested before being used. Sufficient time for testing the borrow shall be allowed.

Borrow deposits shall be excavated to regular lines as staked to permit accurate measurement. The dimensions of the borrow deposit will be designated and the Contractor shall not excavate below the depth or outside limits given, except with prior approval. The depth of excavation throughout the area of the borrow pits shall be as uniform as practicable and the side slopes shall conform to the requirements of Section 626, "Final Clean Up." Unless otherwise permitted, borrow pits shall be excavated so that they will drain to the nearest natural outlet.

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

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

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

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

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

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

Where twelve (12) inches (300 millimeters) or less of embankment is placed over existing bituminous surface, such surface shall be removed and incorporated in the embankment or otherwise disposed of as approved by the Engineer. Where more than twelve (12) inches (300 millimeters) of embankment is placed over existing bituminous surface, such surface shall be left undisturbed. Measurement for removal of existing bituminous material will be as prescribed in Subsection 203.04.01, "Measurement," and paid for as roadway excavation unless the contract documents specifically called for payment under Section 202, "Removal of Structures and Obstructions."

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

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

When there is a choice of material, the excavation shall be made so the best material will be placed on top of the embankment for at least one (1) foot (300 millimeters) in depth. This paragraph shall not be interpreted as to require the Contractor to stockpile and subsequently rehandle embankment materials except as provided in Subsection 203.03.09, "Selected Material."

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

Where embankments are to be made of material from rock cuts or other material which is unsuitable for finishing the roadbed, the upper six (6) inches (150 millimeters) of the roadbed shall be formed of approved material.

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

Where structure abutments are placed on embankment, the embankment shall be constructed to subgrade

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

Where a structure is to be covered by a rockfill, it shall be covered with not less than two (2) feet (0.6 meters) of satisfactory soil or granular materials before the rock embankment is placed over the structure.

Embankments shall, except as hereinafter specified, be constructed in layers. The construction of an embankment shall begin at the lowest point of the fill below the grade or the bottom of ravines. Individual layers shall be spread evenly to uniform thickness throughout and parallel with the finished grade for the full width of the embankment, unless otherwise permitted. The thickness of the layer shall be as necessary to secure the required compaction with an twelve (12) inch (300 millimeters) maximum thickness after compaction. Excepted provisions are hereinafter outlined for placing in marsh and placement of rock. Hauling equipment shall be routed to obtain uniform compaction and channelization of haul routes and rutting of the fill shall be avoided.

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

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

Embankment which, in the opinion of the Engineer, contains enough rock larger than four (4) inches (10 centimeters) to make it impractical to place and compact in twelve (12) inch (300 millimeter) lifts shall be considered as "Rock Embankment." The materials shall be spread in a uniform horizontal layer over the full width of the embankment. The layer thickness shall not exceed one and one-third (1-1/3) times the vertical dimension of maximum size material larger than eight (8) inches (200 millimeters). The largest size rock allowed in the embankment will be three (3) feet (1 meter) measured in vertical direction and rocks larger than this shall be broken up before being placed in the embankment. Rock to be wasted may exceed three (3) feet (1 meter) and be disposed of in an inconspicuous manner approved by the Engineer.

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

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

Rock, in general, shall be placed so as to form the base of embankment for the full width of the cross

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

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

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

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

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

203.03.17 COMPACTION, DIRT EMBANKMENT: Optimum moisture content of the various soils will be determined by the Engineer. At the time of compaction, the moisture content of the various soils shall be within the following ranges:

Optimum Moisture Content	Tolerances
0% - 20%	+2% to -4%
20% - 30%	+2% to -5%
31% or more	+3% to -6%

When necessary, each layer before being compacted, shall be processed as required in order to bring its moisture content within the prescribed limits. The material shall be wetted by the application of water or dried as necessary and either process may be carried out either on the embankment or at the source of the material or otherwise as approved by the Engineer. Full compensation of any work involved in wetting or drying embankment material to obtain the required moisture content shall be considered as included in the contract unit price bid for excavating or furnishing the material and no additional compensation will be allowed therefor.

Hauling and leveling equipment shall be routed and distributed full width over each layer of the fill in such a manner as to uniformly distribute the compaction afforded thereby. In addition to hauling and leveling equipment, the Contractor shall provide compaction equipment that is specifically designed and manufactured for the purpose of compacting dirt embankments. Said compaction equipment shall work continuously with the grading equipment.

The top 8 inches (200 millimeters) of the base of cuts and natural ground having less than five (5) feet (1.5 meters) of embankment, measured from the subgrade, and all embankment material, shall be compacted to not less than ninety (90) percent relative compaction. When natural ground material is encountered that cannot be compacted to the required density, compaction requirements shall be determined by the Engineer.

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

It is to be expected that a loss of density in the upper portion of earth subgrade may occur due to the

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elements, or for lapse of time, or for other reasons. Recompaction to the specified density will be required prior to placement of any subsequent course and no additional compensation will be allowed therefor.

203.03.18 COMPACTION, ROCK EMBANKMENT: Field density tests will not be required on rock embankments. In lieu thereof, the required compaction shall be tested by proof rolling. In this case, compaction shall be attained and tested by using construction methods and equipment as follows:

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

Hauling and leveling equipment shall be routed and distributed over each layer of the fill in such a manner as to make use of the compaction afforded thereby. Rollers, vibrators, or compactors shall compact the embankment full width with a minimum of three (3) complete passes for each layer of embankment. The compacting equipment shall not exceed a speed of five (5) miles (8 kilometers) per hour and shall work continuously with the grading equipment.

Rolling shall be done in a longitudinal direction along the embankment and shall generally begin at the outer edges and progress toward the center. The travel paths of traffic and construction equipment shall be kept dispersed over the entire width of the embankment so as to aid in obtaining uniform compaction. Weights of equipment used in making embankments over soil having an excessive moisture content may be limited, if, in the judgment of the Engineer, such limitations are necessary in order to maintain the fill in a satisfactory condition.

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

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

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

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

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

Payment for rolling and proof rolling or for the correction of any subgrade weakness or deficiencies disclosed by the proof rolling operation shall be considered subsidiary to the price bid for the "Excavation" item.

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

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

203.03.20 SUBGRADE TOLERANCE: Subgrade upon which pavement, sidewalk, curb and gutter, driveways, or other structures are to be directly placed shall not vary more than 1/4 inch (6 millimeters) below or above the specified grade and cross section. Subgrade upon which sub-base or base material is to be placed shall meet the tolerances as specified in Subsection 203.01.02, "Grade Tolerance." Variations within the above specified tolerances shall be compensating so that the average grade and cross section specified are met.

METHOD OF MEASUREMENT

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

The quantity of excavation to be measured for payment will be the number of cubic yards (cubic meters) excavated and placed as required. The estimated quantities shown on the plans, plus or minus authorized changes will be the quantity used for payment. The Contracting Agency or the Contractor may, however, request a final measurement in which case final cross sections will be taken. When final cross sections are taken the determination of quantities derived therefrom will be the quantities used for payment. Furthermore, when the Contractor requests final measurement and the quantities thus determined are less than the planned quantities plus authorized changes, the Contractor shall reimburse the Contracting Agency for the Agency's expenses incurred by such final measurement and calculation.

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

- (a) **Unsuitable Material.** When the removal and disposal of unsuitable material is shown in the contract documents, such material will be measured for payment as excavation for the related item.

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

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

- (b) **Overbreak.** All sideslope overbreak as defined in Subsection 203.03.05, "Overbreak," shall not be paid for.

Rock removed to a maximum depth of six (6) inches (150 millimeters) below subgrade will be measured for payment provided the rock has been removed sufficiently to permit accurate cross sectioning. Replacement to this depth shall be with material designated on the plans approved by the Engineer and will be measured and paid for at the contract unit price for the material used.

Rock loosened or removed in excess of six (6) inches (150 millimeters) below subgrade will not be measured nor paid for. When ordered by the Engineer, the loosened material will be removed and the resultant space refilled with approved material at the expense of the Contractor.

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

- (d) **Selected Material.** Selected material stockpiled as provided in Subsection 203.03.09, "Selected Material" will be measured for payment as roadway excavation both in its original position and also from the stockpile. Measurement of the material taken from stockpile will be made of the volume actually removed.

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

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

Where slopes have been previously completed by the Contractor, the cost of resloping required in areas

where unstable material is removed will be paid for as extra work as provided in Subsection 104.03, "Extra Work."

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

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

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

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

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

V-type ditches will be measured parallel to the ground and each one hundred (100) linear feet (30 meters) shall constitute a unit of measure. The volume of excavation for such ditches will not be measured for payment.

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

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

BASIS OF PAYMENT

203.05.01 PAYMENT: The accepted quantities of excavation measured as specified in Subsection 203.04.01, "Measurement," will be paid for at the contract unit price bid for each of the pay items listed in the bid schedule. Such price shall include excavating, loading, hauling, depositing, spreading, compacting, and maintaining the material complete and in place.

The accepted quantities of selected borrow or selected borrow excavation will be paid for at the contract unit price bid per cubic yard or ton (cubic meter or metric ton) for "Selected Borrow" or "Selected Borrow Excavation" which price shall be full compensation for furnishing all materials, loading, hauling, depositing, spreading, watering, compacting and maintaining the material complete and in place.

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

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

Payment will be made under:

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

TESTING

203.06.01 TESTING:

Spec. Section	Description	Test	Reference Specification And/Or Test Procedure	Recommended Frequency
203.02.01	Roadway Excavation (Subgrade)	Field Density	AASHTO T310	1/5000 SF
203.02.02	Drainage Excavation (Subgrade)	Field Density	AASHTO T310	1/5000 SF
203.02.03	Channel Excavation (Subgrade)	Field Density	AASHTO T310	1/5000 SF
203.02.04	Borrow	Sieve Analysis	AASHTO T11 & T27 (RTC 301 & Special Provisions)	1/Type
203.02.05	Selected Borrow	Plasticity Index	AASHTO T89 & T90 (RTC 301 & Special Provisions)	1/Type
		R-Value	AASHTO T190	1/Type
203.03.01	Roadway (Subgrade)	Field Density	AASHTO T310	1/5000 SF
203.03.09	Selected Material	Sieve Analysis	AASHTO T11 & T27 (RTC 301 & Special Provisions)	1/5000 SF
		Plasticity Index	AASHTO T89 & T90 (RTC 301 & Special Provisions)	1/5000 SF
		R-Value	AASHTO T190	1/Type
		Field Density	AASHTO T310	1/5000 SF
203.03.14	Foundation (Subgrade)	Field Density	AASHTO T310	1/5000 SF/Lift
203.03.17	Embankment	Field Density Fill	AASHTO T310	1/5000 SF/Lift
		Field Density Subgrade	AASHTO T310	1/5000 SF/Lift
		Field Density Structures	AASHTO T310	If Riding Equipment Used: 1/5000 SF/Lift Per Structure If Walk Behind Equipment Used: 1/1000 SF/Lift Per Structure/Per Day
203.03.18	Rock Embankment	Visual	Issue Inspection Report	Full Time

NOTE: A maximum testable lift is defined as a twelve (12) inch (30 centimeter) layer of compacted material.

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SECTION 204

ROUNDED AND TRANSITION SLOPES

DESCRIPTION

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

CONSTRUCTION

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

Slopes will be staked for flattening and rounding in places where the material is other than solid rock. Rock formations such as shales, decomposed sandstone and granite that can be readily excavated by means of hand tools, shall have the slopes flattened and rounded the same as earth slopes. A layer of earth overlying a rock cut shall be rounded above the rock the same as earth slopes. Where the depth of cut is insufficient to provide the full rounding required, the distance for rounding shall be proportionately adjusted.

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

Whenever the treatment of the slopes may destroy or injure standing timber, trees or other vegetation which should be preserved, adjustments in slope grading will be made. These adjustments shall be effected by a gradual transition from the theoretical grading section required.

The degree of smoothness required in rounding and warping slopes shall be as specified in Subsection 203.03.06, "Slopes."

METHOD OF MEASUREMENT

204.04.01 MEASUREMENT: The quantity of rounded cut slopes to be paid for shall be measured in linear feet of slopes, treated as specified, measured along the roadway ditch each side of the roadway centerline. The quantity of rounded embankment slopes to be paid for shall be measured in linear feet (meters), treated as specified, measured along the centerline of the embankment to be rounded, and each side shall be considered separately. In all cases, each one hundred (100) feet (30 meters) shall constitute the unit of one station. Earthwork quantities within the limits of "Slope Rounding" will not be measured for payment.

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

BASIS OF PAYMENT

204.05.01 PAYMENT: The accepted quantity of slope rounding measured as specified in Subsection 204.04.01, "Measurement," will be paid for at the contract unit price bid per station of the completed work.

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

Payment will be made under:

PAY ITEM	PAY UNIT
Slope Rounding	Stations (30 Meters)

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SECTION 206

STRUCTURE EXCAVATION

DESCRIPTION

206.01.01 GENERAL: This work shall consist of the removal of all material of whatever nature encountered in the construction of foundations for bridges, retaining walls, headwalls for culverts and other structures; the excavation of trenches for pipe culverts, box culverts, cut-off walls for slope paving and concrete aprons, footings for riprap and other excavation specifically designated on the plans, in these specifications or in the Special Provisions as structure excavation, which shall include the work of disposing of surplus material and cleaning up the sites. Structure excavation shall include dewatering and the furnishing of all equipment and the construction or installation of all cofferdams, cribs, and other facilities which may be necessary to perform the excavations and the subsequent removal of such facilities except where they are required or permitted by the plans or specifications to remain in place. It shall also include all the necessary clearing and grubbing within the proposed structure area and removing old structures or parts thereof as required if the proposal does not include separate bid items for such work. Testing requirements for this section are contained in Subsection 206.06.01, "Testing."

For separate requirements pertaining to the excavation involved in the installation of pipe culverts and underground piping, attention is directed to those sections of these specifications governing such work.

206.01.02 CLASSIFICATION: Classification of structure excavation will not be made on the basis of materials or conditions encountered. Classification of excavation, if made, will be on the basis of the material removed between certain elevations, and such classification as shown on the plans or set forth in the Special Provisions shall not be changed regardless of the material encountered.

CONSTRUCTION

206.03.01 GENERAL: The Contractor shall notify the Engineer a sufficient time in advance of the beginning of excavation for structures so that elevations and measurements may be taken of the existing ground before it is disturbed and of existing substructure units within the limits of excavation for structures before they are removed. Any material excavated or removed before these measurements have been taken will not be paid for.

The excavated area shall conform to the outlines of the footings, as shown on the plans, and shall be of sufficient size to permit placing of the full width and length of the footings shown. The elevation of the bottoms of footings as shown on the plans shall be considered as approximately only, and the Engineer may order, in writing, such changes in dimensions or elevation of footings as may be necessary to secure a satisfactory foundation.

Unless otherwise permitted by the Engineer, foundations shall be compacted to not less than ninety (90) percent relative compaction for culvert pipe and not less than ninety-five (95) percent relative compaction for

STRUCTURE EXCAVATION

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structures. For fine-grained soils, the relative compaction may not be less than ninety (90) percent for structures if approved by the entity engineer. Test method to be determined by the Engineer.

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

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

Should the Contractor remove 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.

TESTING

206.06.01 TESTING:

Spec. Section	Description	Test	Reference Specification And/Or Test Procedure	Recommended Frequency
206.03.01	Structure Excavation	Field Density	AASHTO T310	If Riding Equipment Used: 1/5000 SF/Lift Per Structure
				If Walk Behind Equipment Used: 1/1000 SF/Lift Per Structure/Per Day

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

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. Testing requirements for this section are contained in Subsection 207.05.01, "Testing."

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 five (95) percent of the maximum density. For fine-grained soils, the relative compaction may not be less than ninety (90) percent for structures if approved by the entity engineer.

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 five (95) percent of the maximum density is achieved. Test method shall be as specified in Subsection 207.05.01, "Testing".

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 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.

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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 AASHTO T22 using cylinders cured per Test Method AASHTO T23 and/or T126.

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 twelve (12) inches (300 millimeters) in depth after compaction. 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.

TESTING

207.05.01 TESTING:

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

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

SECTION 208

TRENCH EXCAVATION AND BACKFILL

DESCRIPTION

208.01.01 GENERAL: This work shall consist of the excavation and backfill of trenches for the accommodation of substructures including, but not limited to electrical conduits, telephone conduits, television cable, traffic signal conduits, gas lines, sewer lines, water lines, and storm drains.

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 CONTROLLED LOW STRENGTH MATERIAL (CLSM): CLSM (flowable fill) shall consist of a low-strength, self-leveling concrete material composed of various combinations of cement, fly ash, aggregate, water, and chemical admixtures. It shall have a design compressive strength at an age of 28 days within the ranges

SECTION 401

PLANTMIX BITUMINOUS PAVEMENTS - GENERAL

DESCRIPTION

401.01.01 GENERAL: These specifications include general requirements that are applicable to all types of bituminous pavements of the plantmix type irrespective of gradation of aggregate, kind, and amount of bituminous material, or pavement use. Deviations from these general requirements will be indicated in the specific requirements for each type.

This work shall consist of one or more courses of bituminous mixture constructed on the prepared foundation in accordance with these specifications and the specific requirements of the type under contract, and in conformity with the lines, grades, thicknesses, and typical cross sections shown on the plans or established by the Engineer.

401.01.02 PAVEMENT STRUCTURAL DESIGN: All public pavement sections shall be designed in accordance with the 1993 AASHTO® Guide for Design of Pavement Structures. The following parameters, based upon the AASHTO® Guide and the 1996 Nevada Department of Transportation Pavement Structural Design and Policy Manual, shall be used in the design calculations. Parameters which are specific to a road classification are identified by the right-of-way dimension. The design must be stamped and signed by a Professional Engineer registered in the State of Nevada.

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- (1) The reliability factor will be a minimum of eighty (80) percent with a standard normal deviate (Z_R) of -0.841 for fifty-one (51) foot, sixty (60) foot, and eighty (80) foot right-of-way, and a minimum ninety (90) percent with a standard normal deviate (Z_R) of -1.282 for one hundred (100) foot right-of-way.
- (2) The standard deviation will be 0.45 for all classifications.
- (3) The initial service index will be 4.2 and the final service index 2.5 for all classifications.
- (4) Drainage coefficients shall not exceed 1.0.
- (5) The structural coefficient for asphalt will be 0.35.
- (6) For materials meeting the Uniform Standard Specification 704.03.04, Type II Aggregate Base, the elastic modulus will be 25,000 psi (172 MPa) and the structural coefficient 0.12.
- (7) For materials meeting the Uniform Standard Specification 704.03.02, Type I Aggregate Base, the elastic modulus will be 15,000 psi (103 MPa) and the structural coefficient 0.11.

Rev.
3/13/03

- (8) Prior to design, soil testing will be performed in accordance with ASTM D 2844, or AASHTO T190, to determine a representative Resistance (R) value for the prepared subgrade. The subgrade shall be prepared in accordance with the Geotechnical Soils Investigation Report, and soil sampling performed subsequent to rough grading to confirm the original results. An average of the R-values can be used if the soil classification results are consistent, or if the values do not differ by more than 10. The minimum testing requirements are one (1) right-of-way R-value test and post grading soil classifications every one thousand (1,000) lineal feet (305 meters) of roadway, with a minimum of two (2) classifications per project.
- (9) The subgrade R-value (psi) shall be converted to a Resilient Modulus (MR, psi) using the following correlation: $MR = 145 * (10^{((0.0147 * R) + 1.23)})$

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- (10) The minimum AC sections are two (2.0) inches (51 millimeters) for a residential street, three (3.0) inches (76 millimeters) for a minor collector, four (4.0) inches (102 millimeters) for a major collector, and four (4.0) inches (102 millimeters) for an arterial street.
- (11) All designs require a minimum of four (4) inches (102 millimeters) Type II aggregate base material.
- (12) The subgrade must be scarified and recompact to a minimum of ninety-five (95) percent, to minimum depth of eight (8) inches (204 millimeters).
- (13) Expansive soils may require additional design compensation. If native soils classify as either an AASHTO A-6 or A-7 (more than thirty-six (36) percent passing the #200 sieve and a PI equal to or greater than 11), the design may include stabilization, over-excavation, or utilization of a geomembrane, as recommended by the geotechnical engineer.
- (14) Hydro-collapsible soils, or the presence of soluble materials, may require additional design compensation, as recommended by the geotechnical engineer.

The minimum design equivalent axial loads (EAL) based on a 20 year design are $7.2E+3$ for a residential street, $3.3E+4$ for a minor collector, $3.7E+5$ for a major collector, and $1.0E+6$ for an arterial street. Locations with heavier than normal traffic must be designed accordingly. A traffic study may be required for roads with a projected TI greater than 9.5. If required by the agency, actual vehicle count data and assigned axle factors shall be used in the design of the pavement section. Definition of the roadway classifications, for design purposes, are listed below:

- (1) Residential roadways are those that provide access for residential areas only: Most fifty-one (51) foot right-of-way roads are residential. The normal design TI is 5.0. A Residential road is considered to have heavy traffic, and a TI of 5.5, if minor amounts of thru-traffic use the road or bus traffic is encountered due to an adjacent school. Category II mix designs shall be used on residential streets.
- (2) Minor Collector roadways are those that collect residential traffic or service limited commercial facilities: Most sixty (60) foot, and some fifty-one (51) foot, right-of-way roads fit this classification. The normal design TI is 6.0. A Minor Collector is assumed to have heavy traffic, and a TI of 6.5, if there is substantial commercial truck traffic, or bus traffic due to an adjacent school.
- (3) Major Collector roadways are those that serve as destination roadways or service normal commercial or light industrial facilities: Most eighty (80) foot, and some sixty (60) foot, right-of-way roads fit this classification. The normal design TI is 8.0. A Major Collector is assumed to have heavy traffic, and a TI of 8.5, if there is substantial commercial or industrial truck traffic.
- (4) Arterial roadways are those that provide primary traffic routes or service heavy industrial facilities: All one hundred (100) foot, and some eighty (80) foot and sixty (60) foot, right-of-way roads fit this classification. The normal design TI is 9.5. An arterial may have light traffic, if there is a disruption or decrease in the road capacity, in which case the design TI is 9.0. An Arterial is assumed to have heavy traffic if it is at full capacity with substantial truck traffic, or if there is heavy industrial traffic. A traffic study is recommended in those situations.

MATERIALS

401.02.01 COMPOSITION OF MIXTURES: The bituminous plantmix shall be composed of a mixture of aggregate, mineral filler if required, and bituminous material. The several aggregate fractions shall be sized, uniformly graded, and combined in such proportions that the resulting mixture meets the grading requirements of the job-mix formula.

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.

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 LMCQS-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 emulsion by co-milling with the manufacture of the asphalt emulsion at a minimum rate of 3% polymer solids by weight of the base asphalt in the emulsion prior to loading at the emulsion 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 (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.

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. The test sections will be evaluated for a minimum of three (3) days after placement under traffic and normal usage. 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.

At the direction of the Engineer, if the pavement cracks have not been previously sealed, the 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, or by use of pressurized water at not greater than one thousand (1000) pounds per square inch (6.9 Megapascals) at the nozzle prior to the sweeping or vacuuming operations. If pressurized water is used, the cracks may be damp but shall not have freestanding water in the crack. All surface debris from the crack cleaning process shall be thoroughly cleaned prior to placement of slurry seal. Payment for crack cleaning shall be by force account. 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.

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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, washed off or protected from the slurry by a method approved by the Engineer.

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.

Slurry Seal Spreader box: The Slurry Seal shall be spread with a box specifically designed to place Slurry Seal. The mixture shall be spread uniformly by means of a conventional slurry seal surfacing spreader box attached to the mixer. Front, rear and side seals shall be provided to insure no loss of the mixture at the pavement contact point. The rear seal shall be provided to act as a final strike-off and shall be adjustable. The spreader box and rear strike-off shall be so designed and operated that a uniform consistency is achieved to produce a free flow of material to the rear strike-off. Augers within the box maybe required due the consistency of the material and/or the pavement slope. The spreader box shall have suitable means provided to side shift the box to compensate for variations in the pavement geometry. A burlap-drag or other approved material shall be attached to the rear of the spreader box to provide a uniform, highly textured mat. The spreader box shall be kept clean and build-up of asphalt and aggregate on the box shall not be permitted. If a burlap drag is used, it shall be clean, flexible, and not leave drag or scour marks in the finished slurry seal surface.

Micro-surfacing spreader box: The micro-surfacing shall be placed with a spreader box specifically designed to place micro-surfacing. Conventional slurry seal boxes will not be allowed to spread micro-surfacing. Attached to the mixer machine shall be a mechanical spreader box capable of placing the micro-surfacing at a minimum width of twelve (12) feet (3.7 meters) and shall prevent the loss of micro-surfacing materials from the box. The spreader box shall have baffles, reversible hydraulic motor driven augers or paddles to insure uniform application on super elevated sections and shoulder slopes. The mixture shall be agitated and spread uniformly within the spreader box by means of twin shafted paddles or spiral augers fixed within the spreader box. Spreader box skids shall be a minimum of six (6) feet (1.8 meters) in length and maintained in such a manner as to prevent chatter (wash boarding of the surface) in the finished mat. The spreader box shall have suitable means provided to side shift the box to compensate for variations in the pavement geometry. The spreader box shall have a series of strike-off devices at the rear of the box. The leading strike-off device shall be fabricated of steel, stiff rubber or other suitable material. The first strike-off shall be designed to maintain close contact with the pavement during spreading operations, shall obtain the uniform thickness required, and shall be capable of being adjusted to the various pavement cross sections for the application of a uniform micro-surfacing finished surface. The final strike-off device shall be fabricated of flexible material suitable for the intended use and shall be designed and operated to ensure that a uniform texture is achieved in the finished surface of the micro-surfacing. The final strike-off shall have the same type adjustments as the spreader box. The final strike-off shall be cleaned daily and changed if problems with longitudinal drag marks or scouring occur. The spreader box shall be kept clean and build-up of asphalt and aggregate on the box shall not be permitted.

Rut Filling Box: When required in the specifications, before the final surface course is placed with the spreader box, preliminary micro-surfacing may be required to fill ruts, utility cuts, depressions in the existing surface, etc. Ruts of one-half (1/2) inch (13 millimeters) or greater in depth shall be filled independently with a rut filling spreader box, either five (5) foot or six (6) foot (1.5 or 1.8 meters) in width. For irregular or shallow rutting of less than one-half (1/2) inch (13 millimeters) in depth, a full-width scratch-coat pass may be used as directed by the Engineer. Ruts that are in excess of one and one-half (1 1/2) inches (20 millimeters) in depth may require multiple placements with the rut-filling spreader box to restore the cross-section. All rut-filling level-up material should cure under traffic for at least a twenty-four (24) hour period before additional material is placed on top of the level-up course. The spreader box shall be kept clean and build-up of asphalt and aggregate on the box shall not be permitted.

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 of aggregate per square yard (3.6 to 5.5 kilograms per square meter) of Type I aggregate, twelve to twenty (12-20) pounds of aggregate per square yard (5.5 to 9 kilograms per square meter) for Type II aggregate, and eighteen to thirty (18-30) pounds of aggregate per square yard (8.2 to 14 kilograms per square meter) for Type III aggregate. The application rate shall be adjusted for the surface texture of the pavement to ensure effective embedment of the aggregate and the durability of the surface treatment.

The Contractor shall submit a signed written report to the Engineer each working day indicating the amount of aggregate and emulsion delivered, aggregate and emulsion used on the project, and the amount of area in square yards completed. In order to comply with and verify the mixture of materials to the mix design and the specified aggregate application rate the contractor shall submit a signed written report to the Engineer each working day indicating the percentage of emulsion used to aggregate used, and the application rate in pounds of aggregate applied per square yard (kilograms per square meter) of area covered.

The contractor shall submit to the Engineer from the aggregate and emulsion suppliers an original copy of the Bill of Lading daily for each delivery of material to be used on the project. The contractor shall submit with each emulsion bill of lading a certificate of compliance from the emulsion supplier verifying that each delivery of emulsion is in compliance with the contract requirements.

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. At the direction of the Engineer, parking lot applications, heavy application rates 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.

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 smooth pneumatic tire roller, with a minimum weight of four (4) tons (3.6 metric tons). The roller shall be equipped with a water tank and a sprinkler apparatus which shall be used to keep the wheels damp and to prevent the adherence of slurry seal on the wheels during the rolling process. Steel wheel rollers may be used in a supplementary capacity when approved by the Engineer. Rolling shall start when the slurry seal/micro-surfacing has set sufficiently to prevent any pick-up of material and rolled a minimum of three coverages by the roller or 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.

The contractor shall cooperate with and give written notice to all emergency agencies, public entities, each home, homeowners association, business and school that will be affected by any part of the construction process, particularly concerning temporary interruptions to vehicular access. To accomplish the notification process the contractor shall provide a minimum of two notifications. The first written notice of the approximate schedule and explanation of the work process shall be distributed at least seven (7) days prior to the commencement of work in the area. A second written notice shall be distributed at least twenty-four (24) hours prior to construction to remind all affected parties of the construction to take place. The contractor shall employ a qualified traffic control supervisor to be on site locally at all times traffic control devices are being used or when notifications have been sent out.

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. Temporary traffic markings shall comply with Section 6, "Temporary Traffic Control", of the MUTCD.

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/micro-surfacing surfaces shall be swept by the Contractor with 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. Sweeping required beyond the initial five (5) days cure, due to "normal raveling" shall be paid for under the appropriate bid item for sweeping.

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.

PAVEMENT SUFACE TREATMENTS

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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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SECTION 613

CONCRETE CURB, WALK, GUTTERS, DRIVEWAYS AND ALLEY INTERSECTIONS

DESCRIPTION

613.01.01 GENERAL: Concrete curb, walk, gutters, cross gutters, driveways, and alley intersections shall be constructed of Portland cement concrete prepared as prescribed in Section 501, "Portland Cement Concrete".

MATERIALS

613.02.01 GENERAL: Materials shall conform to the applicable requirements of Section 501, "Portland Cement Concrete," Section 502, "Concrete Structures" and Section 505, "Reinforcing Steel."

CONSTRUCTION

613.03.01 The thickness of Type I or II Base under Concrete Curbs, Gutters, Walks, Driveways and Alley Intersections shall be shown on the Plans or Standard Drawings or as specified in the Special Provisions.

The subgrade shall be constructed true to grade and cross sections as shown on the Plans or as established by the Engineer. It shall be watered and compacted until the subgrade reaches the compaction required for the adjacent roadway or base course.

613.03.02 The dimensions of the concrete curbs, gutters, walks, driveways and alley intersections shall be as shown on the Plans or Standards Drawings or as specified in the Special Provisions.

613.03.03 DRAINAGE OUTLETS THROUGH CURB: The Contractor will be required to provide suitable outlets through new curb for all existing building drains along the line of the work. He shall place outlets opposite any low area on adjacent property, the drainage of which will be effected by the new work.

Where sidewalk or curb will be higher than adjacent property, the Contractor shall provide at least one four (4) inch (10 centimeters) diameter opening through the curb for each parcel when directed by the Engineer.

613.03.04 DRIVEWAY ENTRANCES AND ALLEY INTERSECTIONS: Driveway entrances and alley intersections shall be provided in new curb at all existing driveways and alley intersections along the line of the work at locations shown on the Plans or Standard Drawings or as specified in the Special Provisions.

613.03.05 STANDARD FORMS: Form material shall be free from warp, with smooth and straight upper edges, and if used for the face of curb, shall be surfaced on the side against which the concrete is to be placed. Wooden forms for straight work shall have a net thickness of at least one and one-half (1-1/2) inches (3.8 centimeters); metal forms for such work shall be of a gage that will provide equivalent rigidity and strength.

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Curb face forms used on monolithic curb and gutter construction shall be of a single plank width when the curb face is ten (10) inches (25 centimeters) or less, except for those used on curb returns. Wooden forms used on curb returns shall be not less than three-fourths (3/4) inch (1.9 centimeters) in thickness, cut in the length and radius as shown on the plans, and held rigidly in place by the use of metal stakes and clamps. The curb face shall be cut to conform exactly with the curb face batter as well as being cut in the required length and radius. Forms shall be of sufficient rigidity and strength, and shall be so supported, as to adequately resist springing or deflection from placing and tamping the concrete. Metal forms shall not be used for curb returns or on curves of less than 250 foot radius.

Form material shall be clean at the time it is used, and shall be given a coating of light oil, or other equally suitable material, immediately prior to the placing of the concrete.

All forms except back planks of curb shall be set with the upper edges flush with the specified grade of the finished surface of the improvement to be constructed, and all forms shall be not less than a depth equivalent to the full specified thickness of the concrete to be placed.

Back forms shall be held securely in place by means of stakes driven in pairs at an interval not to exceed four (4) feet (1.2 meters), one at the front form and one at the back. Clamps, spreaders, and braces shall be used to such extent as may be necessary to insure proper form rigidity. Forms for walk, gutter, and similar work shall be firmly secured by means of stakes driven flush with the upper edge of the form at intervals not to exceed five (5) feet (1.5 meters). Form stakes shall be of sufficient size and be driven so as to adequately resist lateral displacement.

Commercial form clamps for the curb and gutter may be used provided they fulfill the requirements specified herein.

613.03.06 SLIP FORMS: At the option of the Contractor and with the approval of the Engineer, slip form equipment may be used for the construction of concrete curb and gutter and concrete curb, gutter, and sidewalk except for commercial driveways and curb returns with valley gutters.

If machines designed specifically for such work and approved by the Engineer are used, the results must be equal to or better than that produced by the use of forms. If the results are not satisfactory to the Engineer, the use of the machines will be discontinued. All applicable requirements of construction by use of forms shall apply to the use of machines.

Slip form equipment shall be provided with traveling side and top forms of suitable dimensions, shapes, and strength to support the concrete for a sufficient length of time during placement to produce curb and gutter of the required cross section. The equipment shall spread, consolidate and screed the freshly placed concrete in such a manner as to provide a dense and homogeneous product.

Any curb, except on structures, may be placed by using an extrusion machine provided the finished curb is true to line and grade and the concrete is dense and of the required surface texture and strength. The combined aggregate for the concrete placed by the extrusion method shall be of such size that the percentage composition by weight will conform to the Grading Limits of Combined Aggregates as specified in Subsection 706.02.01 for the three-fourths (3/4) inch (1.9 centimeters) maximum grading.

The grading limits shall be further restricted, if necessary, to produce concrete that after extrusion has well defined web marks of water on the surface and is free from surface pits larger than three-sixteenths (3/16) inch (0.5 centimeters) in diameter.

The concrete shall be of such consistency that after extrusion, it will maintain the shape of the curb section without support. It shall contain the maximum amount of water that will permit this result.

In lieu of placing dowels and bar reinforcing steel and in advance of placing curbs on existing pavement or

base, the surface shall be thoroughly cleaned and the adhesive specified below shall be applied. Cleaning of the pavement or base shall be accomplished by wire brushing or by blast cleaning if the latter method is ordered by the Engineer. The cleaned surface shall be free from dust, loose material or oil.

The adhesive shall consist of two (2) components which shall be mixed together at the site of the work and shall conform to the requirements of California State Specification 741-80-43 for "Epoxy Resin Adhesive for Bonding New Concrete to Old Concrete.

The grade for the top of the curb shall be indicated by an offset guide line set by the Contractor from survey marks established by the Engineer. The forming tube portion of the extrusion machine shall be readily adjustable vertically during the forward motion of the machine to provide when necessary, a variable height of curb conforming to the predetermined curb grade. A grade line gage or pointer shall be attached to the machine in such manner that a continual comparison can be made between the curb being placed and established curb grade as indicated by the offset guide line.

In lieu of the above method for maintaining the curb grade, the extrusion machine may be operated on rails or forms set at uniform depth below the predetermined finished top of the grade.

The top and face of the finished curb shall be true and straight, and the top surface of curbs shall be of uniform width, free from humps, sags, or other irregularities. When a straightedge ten (10) feet (3 meters) long is laid on the top or face of the curb or on the surface of gutters, the surface shall not vary more than 0.01 foot (0.30 centimeters) from the edge of the straightedge, except at grade changes or curves.

Crawler track driven extrusion machines shall not be used on finished course plantmix surface. Concrete shall be fed to the machine at a uniform rate. The machine shall be operated under sufficient uniform restraint to forward motion to produce a well compacted mass of concrete free from surface pits larger than three-sixteenths (3/16) inch (0.48 centimeters) in diameter and requiring no further finishing, other than light brushing with a brush filled with water only. Finishing with a brush application of grout will not be permitted.

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

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

Expansion joints shall be constructed as specified in Subsection 613.03.09.

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

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

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

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

Concrete shall be placed in cross gutters in horizontal layers of not more than four (4) inches (10 centimeters) in thickness, each layer being spaded along the form faces and thoroughly tamped into a dense and

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compact mass. If internal vibrators are used, the full specified thickness may be placed in one operation.

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

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

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

One-half inch (1.3 centimeters) joints shall be constructed in curb and gutter at the end of all returns except where cross gutter transitions extend beyond the curb return, in which case they shall be placed at the ends of the cross gutter transition. No joints shall be constructed in returns. Where monolithic curb and gutter is constructed adjacent to concrete pavement, no expansion joints will be required except at E.C. and B.C. of curb returns.

Expansion joint filler one-half (1/2) inch (1.3 centimeters) thick shall be placed in walk at the E.C. and B.C. of all walk returns, around all utility poles which may project into the concrete along the line of the work, and in walk returns between the walk and the back of curb returns when required by the Engineer. At the E.C. and B.C. and around utility poles, the joint filler-strips shall extend the full depth of the concrete placed. Joint filler strips between walk and curb shall be the depth of the walk plus one (1) inch (2.5 centimeters) with the top set flush with the specified grade at the top of curb.

All expansion joint filler strips shall be installed vertically, and shall extend to the full depth and width of the work in which they are installed, and be constructed perpendicular to straight curb or radially to the line of the curb constructed on a curve. Expansion joint filler materials shall completely fill these joints to within one-fourth (1/4) inch (0.6 centimeters) of any surface of the concrete. Excess filler material shall be trimmed off to the specified dimension in a neat and workmanship manner. During the placing and tamping of the concrete, the filler strip shall be held rigidly and securely in proper position.

613.03.10 WEAKENED PLANE JOINTS: Weakened plane joints shall be straight and constructed in accordance with paragraphs (a) or (b) below, unless otherwise shown on the plans.

In walk, joints shall be transverse to the line of work and at regular intervals not exceeding ten (10) feet (3 meters). At curves and walk returns, the joints shall be radial.

In gutter, including gutter integral with curb, joints shall be at regular intervals not exceeding ten (10) feet (3 meters). Where integral curb and gutter is adjacent to concrete pavement, the joints shall be aligned with the pavement joints where practical.

- (a) **Control Joint.** After preliminary trowelling, the concrete shall be parted to a depth of two (2) inches (5 centimeters) with a straightedge to create a division in the coarse aggregate. The concrete shall be refloated to fill the parted joint with mortar. Headers shall be marked to locate the weakened plane for final joint finishing, which shall be accomplished with a jointer tool having a depth of one-half (1/2) inch (1.3 centimeters) and a radius of one-eighth (1/8) inch (0.3 centimeters). The finished joint opening shall not be wider than one-eighth (1/8) inch (0.3 centimeters).

- (b) **Plastic Control Joint.** The joint material shall be a T-shaped plastic strip at least one (1) inch (2.5 centimeters) deep, having suitable anchorage to prevent vertical movement, and having a removable stiffener with a width of at least three-fourths (3/4) inch (1.9 centimeters). After preliminary trowelling, the concrete shall be parted to a depth of two (2) inches (5 centimeters) with a straightedge. The plastic strip shall be inserted in the impression so that the upper surface of the removable stiffener is flush with the concrete. After floating the concrete to fill all adjacent voids, the removable stiffener shall be stripped. During final trowelling, the edges shall be finished to a radius of one-eighth (1/8) inch (0.3 centimeters) using a slit jointer tool.

613.03.11 FINISHING: Finishing shall be completed as specified herein for the type of work being performed.

613.03.12 CURB: The front forms may be stripped as soon as the concrete has set sufficiently.

The face and top of the curb shall be carefully trowelled to a smooth and even finish; the top being finished to a transverse slope of one-fourth (1/4) inch (0.6 centimeters) toward the gutter, with both edges rounded to a radius of three-fourths (3/4) inch (1.9 centimeters). The trowelled surface shall be finished with a fine hair broom applied parallel with the line of the work. The edge of the concrete at all expansion joints shall be rounded to a one-fourth (1/4) inch (0.6 centimeters) radius. The surface of the work shall be finished as prescribed; after which the name of the Contractor, together with the year in which the improvement is constructed, shall be stamped therein to a depth of one-fourth (1/4) inch (0.6 centimeters), in letters not less than three-fourths (3/4) inch (1.9 centimeters) high, at B.C. and E.C. curb returns.

613.03.13 WALK: The forms shall be set to place the finished surface in a plane sloping up from the top of curb at a rate of one-fourth (1/4) inch to one (1) foot (0.6 to 30 centimeters) when measured at right angles to the curb.

Following placing, the concrete shall be screeded to the required grade, tamped to consolidate the concrete and to bring a thin layer of mortar to the surface, and floated to a smooth, flat, uniform surface. The concrete shall then be edged at all headers, given a preliminary trowelling and provided with weakened plane joints.

Walk shall be steel trowelled to a smooth and even finish. All formed edges shall be rounded to a radius of one-half (1/2) inch (1.3 centimeters). Edges at expansion joints shall be rounded to a radius of one-eighth (1/8) inch (0.3 centimeters). Preliminary trowelling may be done with a long-handled trowel or "Fresno", but the finish trowelling shall be done with a hand trowel. After final trowelling, walk on grades of less than 6% shall be given a fine hair broom finish applied transverse to the centerline. On grades exceeding 6%, walk shall be finished by hand with a wood float. Walk shall be remarked as necessary after final finish, to assure neat uniform edges, joints, and weakened plane lines.

Weakened plane lines, where required, shall have a minimum depth of one and one-half (1-1/2) inch (3.8 centimeters) and a radius of one-eighth (1/8) inch (0.3 centimeters). When longitudinal weakened plane lines are required, they shall be parallel to, or concentric with, the lines of the work. Walks twenty (20) feet (6.1 meters) or more in width shall have a longitudinal center weakened plane line. In walk returns, one weakened plane line shall be made radially midway between the B.C.R. and E.C.R. When directed by the Engineer, longitudinal and transverse weakened plane lines shall match the adjacent walk. The Contractor shall have sufficient metal bars, straightedges, and joint tools on the project.

Headers shall remain in place for at least sixteen (16) hours after completion of the walk but must be removed before the work is accepted.

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The name of the Contractor, together with the year in which the improvement is constructed, shall be stamped therein to a depth of 1/4 of an inch, in letters not less than 3/4 of an inch, at intervals of not less than 200 feet. A metal identification plate with the exposed face set flush with the finished surface of the concrete, anchored to a depth of not less than 1-1/2 inches, may be substituted for the stamping in the concrete. At least one such stamping or identification plate shall be made on each cement concrete job at the project.

613.03.14 GUTTER: After the concrete has been thoroughly tamped in such manner as to force the larger aggregate into the concrete and bring to the top sufficient free mortar for finishing, the surface shall be worked to a true and even grade by means of a float, trowelled with a long-handled trowel (or "Fresno") and wood float finished. The flow line of the gutter shall be trowelled smooth for a width of approximately four (4) inches (10 centimeters) for integral curb and gutter and four (4) inches (10 centimeters) on either side of the flow line on cross and longitudinal gutters. The outer edges of the gutter shall be rounded to a radius of one-half (1/2) inch (1.3 centimeters).

Side forms shall remain in place for at least twenty-four (24) hours after completion of the gutter, but must be removed before the work will be accepted.

Median island paving shall be as shown on the Standard Drawings.

613.03.15 CURING: Immediately after finishing operations are completed, the exposed surfaces shall be cured in accordance with Section 502, "Concrete Structures."

613.03.16 REPAIRS AND REPLACEMENTS: Any new work found to be defective or damaged prior to its acceptance shall be repaired or replaced by the Contractor at no expense to the Contracting Agency and in accordance with Subsection 105.12, "Removal of Unacceptable Work."

613.03.17 BACKFILLING AND CLEANUP: Backfilling to the finished surface of the newly constructed improvement must be complete before acceptance of the work.

Upon completion of the work the surface of the concrete shall be thoroughly cleaned and the site left in a neat and orderly condition.

613.03.18 DETECTABLE WARNINGS: In accordance with the Americans with Disabilities Act (ADA), detectable warnings shall be constructed on all sidewalk ramps. Detectable warnings shall provide a tactile surface which visually contrasts with ramp and street surfaces to assist visually impaired persons in the identification of street and driveway crossings. Detectable warnings shall be constructed at the bottom of sidewalk ramps to a minimum depth of 24 inches (610 millimeters) and extending the full width of the ramp in accordance with Uniform Standard Drawings. The materials and method of constructing the warning strips shall be as directed by the Engineer of the entity having jurisdiction over the ramp. Additional information on detectable warning materials and applications is available from the U.S. Access Board.

MEASUREMENT

613.04.01 MEASUREMENT: The quantity of curb, gutter, and combination curb and gutter measured for payment will be the number of linear feet (meters) along the base of the curb face or along the flow line of the gutter.

The quantity of sidewalk, driveway, and alley intersections shall be measured for payment by area in square feet (square meters).

In the case of integral curb and walk, the width of the walk shall extend to the back face of the curb.

All quantities measured for payment herein will be complete and in place.

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

BASIS OF PAYMENT

613.05.01 PAYMENT: The accepted quantities of concrete measured as provided in Subsection 613.04.01, "Measurement," will be paid for at the contract unit price bid per linear feet (meter) for curb, gutter, curb and gutter and per square foot (square meter) for sidewalks, driveway or alley intersection as the case may be.

All excavation and base course work required for and performed during construction of the items of this section will be paid for as provided in the respective sections of the specifications; however, when the contract does not provide bid items for excavation or base course, such work required and performed will be considered subsidiary to the pay item contained herein and no further payment will be made therefor.

Any excavation or backfill required other than roadway quantities will be considered subsidiary to the major items of work and no further payment will be made therefor.

Reinforcing steel placed in curbs and gutters as shown on the plans or ordered by the Engineer will not be paid for directly but the cost thereof shall be considered as included in the contract bid prices for other items of work.

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

Payment will be made under:

PAY ITEM	PAY UNIT
Type A Curb	Linear Foot (Meter)
Type L Island Curb and Gutter	Linear Foot (Meter)
Type L Curb and Gutter	Linear Foot (Meter)
Concrete Sidewalk	Square Foot (Square Meter)
Concrete Driveway	Square Foot (Square Meter)
Concrete Sidewalk and Driveway	Square Foot (Square Meter)
Concrete Alley Intersection	Square Foot (Square Meter)
Concrete Valley Gutter	Square Foot (Square Meter)
Concrete Commercial Driveway	Square Foot (Square Meter)

SECTION 614

PAINTING

DESCRIPTION

614.01.01 GENERAL: This work shall consist of the preparation of surfaces to be painted and the application, protection, and drying of the required number of coats of paint of the kinds and at the points specified or ordered by the Engineer.

MATERIALS

614.02.01 GENERAL: Materials shall meet or exceed the minimum standards hereinafter set forth:

- (a) **Materials.** The raw materials for use in the various paint formulas shall conform to the specifications designated by Federal or Military serial number or paint material code number under the various paint classifications hereinafter specified. Subsequent amendments to the specifications quoted shall apply to all raw materials and finished products. No "or equal" substitutions for any specified material shall be made without written consent of the Engineer.
- (b) **Manufacturing and Packaging.** All manufactured paint shall be prepared at the factory ready for application. The addition of thinner or other material to the paint after the paint has been shipped will not be permitted, unless so specified.

The finished paint shall be furnished in new, round steel containers of not more than 6 gallon capacity and of metal not thinner than 0.024 inch nominal thickness. The containers shall have lug type crimp lids with ring seals and be equipped with ears and bails. The containers shall meet U.S. Department of Transportation Hazardous Material Shipping Regulations. The container shall be lined if necessary to prevent attack by the paint. The lining shall not come off the can as skins.

No finished paint shall be used until at least 7 days have elapsed from the date of its manufacture.

All containers of paint shall be labeled showing the exact title of the paint specification, California State specifications number, manufacturer's name, date of manufacture, and manufacturer's batch number.

Precautions concerning the handling and the application of paint shall be shown on the label of paint and solvent containers.

614.02.02 NUMBER OF COATS: Unless otherwise required in the contract documents, the number and kinds of coats of paint shall be as set forth in Section 714, "Paint."

SECTION 622 - BLANK

SECTION 623

TRAFFIC SIGNALS AND STREET LIGHTING

DESCRIPTION

623 G.01.01 GENERAL: Electrical work shall consist of furnishing and installing, modifying or removing traffic signals, school flashers, flashing beacon systems, street and highway lighting systems, sign illumination systems, traffic count stations, electrical equipment in structures, falsework lighting, partial installations for future systems, or combinations thereof, all as shown on the plans, and as specified in these specifications and the Special Provisions. Standard Drawings for Street Lighting and Traffic Signals shall be the "Uniform Standard Drawings, Volumes I and II."

Unless otherwise indicated on the plans or specified in the Special Provisions, all materials shall be new.

The locations of signals, beacons, standards, lighting fixtures, signs, controls, services, and appurtenances shown on the plans are approximate and the exact locations will be established by the Engineer in the field.

All materials furnished and used shall conform to the provisions in Section 106. The materials shall be manufactured, handled, and used in a manner to insure completed work in accordance with the plans, specifications, and Special Provisions.

All systems shall be complete and in satisfactory operating condition at the time of acceptance of the contract. Where an existing system is to be modified, the existing material shall be reused in the revised system, removed, salvaged, and stockpiled or abandoned as shown on the plans, as specified in the Special Provisions or as directed by the Engineer.

623 G.01.02 REGULATIONS AND CODE: All electrical equipment shall conform to the standards of the National Electrical Manufacturers Association (NEMA), and listed by Underwriters' Laboratories, Inc. (UL), or the Electronic Industries Association (EIA), wherever applicable. In addition to the requirements of the plans, these specifications, and the Special Provisions, all materials and workmanship shall conform to the requirements of the National Electrical Code (NEC); National Electrical Safety Code (NESC); Standards of the American Society for Testing and Materials (ASTM); American National Standards Institute (ANSI) manuals; International Municipal Signal Association (IMSA) cable specifications; Institute of Electronic and Electrical Engineers (IEEE); Illumination Engineering Society (IES); Rural Electrification Association (REA); Nevada Occupational Safety and Hazard Act (NOSHA); National Board of Fire Underwriters (NBFU); Manual on Uniform Traffic Control Devices (MUTCD); Uniform Standard Drawings, Clark County Area; and any local ordinance which may apply.

Wire sizes shall be indicated in American Wire Gage (AWG).

All work performed on any traffic signal component must be under the direct on-site supervision of an IMSA Certified Technician. Effective March 30, 2000 the level of certification required is Level I, and the level of certification required shall be increased to Level II effective March 30, 2001.

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623 G.01.03 EQUIPMENT LIST AND DRAWINGS: Unless otherwise permitted in writing by the Engineer, the Contractor shall within fifteen (15) days following approval of the contract, submit to the Engineer for approval, a list of equipment and materials which he proposes to install. The list shall be complete as to name of manufacturer, size, and identifying number of each item. The list shall be supplemented by such other data as may be required, including scale drawings of cabinets showing location and spacing of shelves, terminal blocks and equipment, including dimensioning.

All of the above data shall be submitted, in triplicate, for review. Where electrical equipment is constructed as detailed on the plans, the submission of detailed drawings and diagrams will not be required.

Where a basic controller cabinet wiring diagram is provided, circuit diagrams for detector plug connections, peripheral equipment, and external solid-state logic shall be provided.

The Contractor shall furnish five (5) blue-line and one (1) mylar reproducible set of cabinet schematic wiring diagrams 24 inches x 36 inches in size, multiple sheets may be used. The diagrams shall show the location of the installation and shall list all equipment installed in each cabinet. In addition, for each signal installation, the Contractor shall furnish an intersection sketch showing poles, detectors, field wire connection terminals and phasing as shown on the plans. The Contractor shall also furnish a minimum of five (5) operating manuals and five (5) maintenance manuals with each controller and cabinet type. The manuals shall include any and all peripheral equipment specified herein or in the Special Provisions to be installed with the controller, such as preempt system, if specified.

All schematic wiring diagrams of the controllers and auxiliary equipment, all cabinet diagrams, and all operation manuals shall be submitted at the time the controllers are delivered for testing, or, if ordered by the Engineer, previous to purchase. This diagram shall show in detail all circuits and parts. Such parts shown thereon shall be identified by name or number and in such manner as to be readily interpreted.

623 G.01.04 WARRANTIES, GUARANTEES, AND INSTRUCTION SHEETS: Manufacturers warranties, guarantees, and certifications for materials used in the work and instruction sheets and parts list shall be supplied with materials and shall be delivered to the Engineer prior to acceptance of the project.

MATERIALS

623 G.02.01 CONDUIT: Underground conductors shall be installed in conduit unless otherwise specified in the Special Provisions or the drawings. Conduit shall be listed by the Underwriters' Laboratories Inc., and shall bear the U.L. label on each length.

Signal conductors and low voltage conductors shall not be installed in high voltage light standards.

The conduit sizes to be used will be indicated on the plans, or specified in the Special Provisions. Conduit shall be 1-1/4 inches (32 millimeters) minimum diameter, unless otherwise indicated on the plans or Special Provisions.

The Contractor may, at his own expense with Engineer approval, use larger size conduit, and where used, it shall be for the entire length of the run from outlet to outlet with no reducing couplings permitted.

P.V.C. coated rigid steel conduit shall consist of galvanized rigid steel conduit conforming to applicable federal specifications and Underwriter's Laboratories. The exterior surface of the conduit shall be acid-treated to provide an acceptable surface for plastic coating with a heat polymerizing lacquer with a thickness not to exceed 0.0005 inch (0.01 millimeter) thick. A polyvinyl chloride compound shall then be bonded to the prepared conduit with a thickness not less than 0.035 inch (0.9 millimeter) for the full length of the conduit

except the threads. The bond between the metal and the plastic shall be equal or greater than the tensile strength of the plastic coating. In addition, the P.V.C. compound shall have the following physical characteristics:

- (a) Hardness: 85+ Shore A Durometer
- (b) Dielectric Strength: 400 (Volts/mil @ 60 cycles)
- (c) Tensile Strength: 3500 psi

623 G.02.02 PULL BOXES: Pull boxes shall be precast reinforced concrete or composite boxes of the sizes and details shown on the plans and standard drawings. Reinforcement shall be 3/4 inch (19 millimeters) mesh, No. 20 U.S. gage, hardware cloth or bar reinforcement. Either steel, cast iron or non-conductive lids shall be used. For traffic signal systems, pull box covers shall be inscribed "TRAFFIC SIGNALS," and for lighting systems the covers shall be inscribed "STREET LIGHTING." Any voltage over 600 shall be inscribed "HIGH VOLTAGE."

Pull boxes for structure installation shall conform to the dimensions and locations shown on the plans. Boxes or vaults formed in concrete shall have metal frames and covers with wording inscribed on the covers as shown on the plans.

All metal parts shall be hot-dip galvanized and shall conform to the applicable portions of ASTM Designation A 153, after fabrication. Gasket surfaces shall form a true plane. Gaskets shall be one piece neoprene 1/8 inch (3 millimeters) thick, and shall cover the contact surface between the frame and cover.

All metal parts shall have provisions for attaching an equipment grounding conductor.

623 G.02.03 EXPANSION FITTINGS: Expansion fittings, as detailed on the plans, shall be installed where the conduit crosses an expansion joint in the structure. Each expansion fitting shall be provided with a bonding jumper of No. 6 AWG copper wire, or equal. Expansion fittings shall be used where they exit a structure or bridge abutment.

623 G.02.04 CONDUCTORS AND CABLE: Conductors and cable shall conform to the following specifications:

- (a) Insulation for multiple circuit lighting conductors shall be rated at 600 volts, 75 degrees C. minimum. Conductors, unless otherwise specified, shall be single conductor, solid or stranded copper of the gage shown, or indicated herein, insulated with THW grade plasticized polyvinyl chloride.

Copper wire shall conform to the applicable portions of ASTM Designation D 2220, B3 and B8.

- (b) Conductors for series lighting shall be No. 8 AWG, solid copper wire insulated with 10/64 inch (4 millimeters) approved polyethylene compound and rated at 5000 volts.

Conductors for traffic signals shall be IMSA approved signal cable of proper size for the required installation unless otherwise shown on the drawings or specified in the Special Provisions.

623 G.02.05 SPLICING: Overhead wire shall be No. 6 M.H.D. solid bare copper continuous from standard to standard with no splices.

Double wire circuits shall have pressed steel conductor arms at 45 degrees from the pole and 180 degrees

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from the direction of service.

Where overhead lines change direction, up to 45 degrees, they shall be bisected by rotating feeder arms; for angles of change greater than 45 degrees an additional set of feeder arms shall be provided to maintain proper wire separation.

623 G.02.06 COLOR CODING: For traffic signals and signs, insulation shall be of solid color, or of basic colors with a permanent colored stripe, to identify conductors as detailed below, unless otherwise specified.

CONDUCTORS COLORS AND SEQUENCE -- I.M.S.A. SPECIFICATIONS -- #19-2 OR #19-1

Conductor	Base Color	First Tracer
1	Black	
2	White	
3	Red	
4	Green	
5	Orange	
6	Blue	
7	White	Black
8	Red	Black
9	Green	Black
10	Orange	Black
11	Blue	Black
12	Black	White
13	Red	White
14	Green	White
15	Blue	White
16	Black	Red
17	White	Red
18	Orange	Red
19	Blue	Red
20	Red	Green

CONSTRUCTION

623 G.03.01 MAINTENANCE OF EXISTING AND TEMPORARY ELECTRICAL SYSTEMS: Existing electrical systems (traffic signal, ramp metering, highway and street lighting, flashing beacon and sign illumination), or approved temporary replacements thereof, shall be kept in effective operation for the benefit of the traveling public during the progress of the work, except when shutdown is permitted to allow for alterations or final removal of the systems. Traffic signal shutdown shall be as specified in the Special Provisions or as requested by the Engineer. Lighting system shutdowns shall not interfere with the regular lighting schedule, unless otherwise permitted by the Engineer. The Contractor shall notify the Operating Engineer's Agency in writing three (3) normal working days prior to performing any work on existing systems.

The Contracting Agency and/or Agency's Operating Engineer shall be notified in writing three (3) normal working days in advance by the Contractor prior to any operational shutdown of a traffic signal system.

The Contracting Agency will continue operation and maintenance of existing electrical facilities.

Where damage is caused by the Contractor's operations, the Contractor shall at his expense, repair or

replace, at the direction of the Engineer, damaged facilities promptly in accordance with these specifications. Should the Contractor fail to perform the required repairs or replacements, the cost of performing such repairs or replacements will be deducted from any monies due or to become due the Contractor.

The exact location of existing conduits and pull boxes shall be ascertained by the Contractor before using equipment that may damage such facilities or interfere with any system.

Where roadways are to remain open to traffic and existing lighting systems are to be modified, the lighting systems shall remain in operation and the final connection to the modified circuit shall be made so that the modified circuit will be in operation by nightfall of the same day.

Temporary electrical installations shall be kept in effective operation until the temporary installations are no longer required for the traveling public.

These provisions will not relieve the Contractor in any manner of his responsibilities as provided in Subsection 107.11, "Responsibility for Damage," and Subsection 107.16, "Contractor's Responsibility for the Work and Materials."

A temporary overhead cable system may be used for the existing signal system circuitry in lieu of maintaining the underground installations during construction if approved by the Operating Engineer's Agency.

Where an existing system is being modified, work not shown on the plans or specified in the Special Provisions and which is considered by the Engineer as necessary to keep all or any part of the existing system in effective operation shall be considered as included in the prices paid for the systems, or units, therefore no additional compensation will be allowed.

COMMUNICATIONS INFRASTRUCTURE FOR THE LAS VEGAS AREA COMPUTER TRAFFIC SYSTEM (LVACTS): Communications infrastructure installed for the use of the LVACTS shall meet the following guidelines:

- (1) For rights-of-way one hundred (100) feet (30.5 meters) or greater where public roadway is to be originally constructed, a four (4) inch (100 millimeter) PVC conduit shall be installed on each side of the roadway with "P30" pullboxes, as shown in the Standard Drawings, with "FIBER OPTIC" inscribed on the lid, placed at a nominal spacing of five hundred (500) feet (150 meters). For developments where street frontage is less than five hundred (500) feet (150 meters), "FIBER OPTIC" pull boxes shall be placed adjacent to the roadway at each property line. If adjacent property has "FIBER OPTIC" pull box already installed directly adjacent to proposed pull box location, the entity Engineer may waive placement of the new box for this particular location.
- (2) For rights-of-way from eighty (80) feet (24.4 meters) to ninety-nine (99) feet (30.2 meters) where public roadway is to be originally constructed, a three (3) inch (76 millimeter) PVC conduit shall be installed on each side of the roadway with "P30" pullboxes, as shown in the Standard Drawings, with "FIBER OPTIC" inscribed on the lid, placed at a nominal spacing of five hundred (500) feet (150 meters). For developments where street frontage is less than five hundred (500) feet (150 meters), "FIBER OPTIC" pull boxes shall be placed adjacent to the roadway at each property line. If adjacent property has "FIBER OPTIC" pull box already installed directly adjacent to proposed pull box location, the entity Engineer may waive placement of the new box for this particular location.
- (3) For rights-of-way from sixty (60) feet (18.3 meters) to seventy-nine (79) feet (24.1 meters) where public roadway is to be originally constructed, a two (2) inch (51 millimeter) PVC conduit shall be

installed on each side of the roadway with "P30" pullboxes, as shown in the Standard Drawings, with "FIBER OPTIC" inscribed on the lid, placed at a nominal spacing of five hundred (500) feet (150 meters). These locations shall be reviewed on a case-by-case basis by the Intelligent Transportation System maintenance organization. For developments where street frontage is less than five hundred (500) feet (150 meters), "FIBER OPTIC" pull boxes shall be placed adjacent to the roadway at each property line. If adjacent property has "FIBER OPTIC" pull box already installed directly adjacent to proposed pull box location, the entity Engineer may waive placement of the new box for this particular location.

- (4) For each of the right-of-way widths in 1-3, the communications conduit shall run "straight through" the pullbox, entering the side of the box near the bottom, to allow for a continuous fiber optic pull of no more than six thousand (6000) feet (1800 meters). A #8 bare or green conductor shall be installed in all empty conduits.
- (5) For rights-of-way less than sixty (60) feet (18.3 meters) in a residential area, conduit and pullboxes will not be required unless specified by the Agency and approved by the LVACTS System manager and the installation is in concert with the area's communications facilities used for the Intelligent Transportation System.
- (6) Installation of conduit in areas of existing offsites should be normally limited to one side of the roadway.
- (7) The cover depth from the finish grade of all conduits shall be a minimum of 30 inches (760 millimeters) with allowances for conduit to rise near pullboxes for entry points. If conduit exists adjacent to the proposed conduit installation, the depth and location of the end of the new conduit shall be required to match the existing conduit. If "match" will requires new conduit to be installed in violation of existing standards, the governing entity Engineer shall remedy the situation and ensure conduit meets minimum requirements.
- (8) The installation of a "Type 200" Splice Vault as shown in the Standard Drawings with the letters "FIBER OPTIC" inscribed on the lid shall be mandated at intersections where trunks lines shall meet and where splicing is to be performed, or at any other locations deemed necessary for use with the regional Intelligent Transportation System. At these splice point locations, a "sweep" with radius of 36 inches (900 millimeters) minimum shall be installed with the angle of entry/exit conducive to pulling fiber optic cable directly out the lid of the vault without the use of pulleys inside the vault.
- (9) Innerduct shall not be used unless specifically required on design plans. If innerduct is proposed, the specific use of each innerduct cavity shall be identified on project plans.
- (10) All buried conduits shall have underground marking tape placed twelve (12) inches (300 millimeters) above the installed conduit and marked with the letters "FIBER OPTIC".
- (11) All communication facilities shall be identified by the Contractor with "survey grade" GPS locating equipment. GPS coordinates shall be collected for conduit location every 100 feet (30 meters)

maximum, for each pull box location and as required by the governing entity Engineer for existing locations of conduit or pull boxes which have been modified. These coordinates must be supplied electronically and in hard copy to the ITS maintenance organization for inclusion into the system's database.

- (12) For roadway projects where the sidewalk, curb and gutter are already installed and communications facilities are required, the appropriate size conduit shall be installed at the lip of gutter with a large sweeping elbow laying sideways under the curb. The angle of the elbow's entry into the "P30" pullbox or "Type 200" communications vault shall be determined in order to provide a straight pull over the lip of the pullbox lid. The spacing of these pullboxes or the inclusion of this conduit shall be determined by the LVACTS system manager or th appropriate ITS staff during the review/design process and shall be dependent upon the existing infrastructure. All decisions shall be in conjunction with the continually updated master planed approach for the Valley's communication facilities.
- (13) When fiber optic cable is installed, a minimum of thirty (30) feet (9.1 meters) of slack shall be safely coiled into each "P30" pullbox and a minimum sixty (60) feet (18.3 meters) in each "Type 200" vault, hung on the sidewall attachment.

MAINTAINING LAS VEGAS AREA COMPUTER TRAFFIC SYSTEM (LVACTS) INTERCONNECT CABLE: The exact location of existing conduits and pull boxes shall be ascertained by the Contractor before using any equipment that may damage such facilities or interfere with the LVACTS. Any damage to the traffic system interconnect cable is considered by the Contracting Agency to constitute an emergency.

Where damage is caused by the Contractor's operations, the Contractor shall, at his expense, begin temporary repairs immediately after the damage occurs and shall proceed with repairs expeditiously until complete. Occupancy permits may be held at the request of the Signal Systems Manager if the repairs are not completed expeditiously and satisfactorily.

Should the Contractor fail to perform the required repairs or replacements, the cost of performing such repairs or replacements will be deducted from any monies due or to become due the Contractor.

Each conductor in all cable runs in which damage occurs shall be tested for continuity and resistivity to ensure no latent damage exists elsewhere in the cable.

Cable meeting the LVACTS Specification, 22 AWG, has a D.C. resistivity of 17.4 ohms/1000 feet at 20 degrees C. Any cable exhibiting a D.C. resistivity in excess of 18.3 ohms/1000 feet at 20 degrees C. in more than one (1) pair of conductors shall be deemed to be damaged when tested hereunder and shall be replaced/repared in accordance with this provision.

Pull box splicing shall not be permitted for permanent restoration unless specifically approved in writing, after a system review, by the LVACTS Signal Systems Manager.

ACCEPTABLE METHODS OF REPAIR AND RESTORATION: Temporary repairs of damage at a single discrete point in the interconnect cable may consist of a splice made with a re-enterable splice kit in a standard pull box placed temporarily. Direct burial of a splice is not permitted. The Contractor shall be responsible for maintaining the temporary repair until such time as the permanent repairs are completed.

Temporary repairs of damage to an extended length of cable or of damage at more than a single discrete point may consist of placing cable overhead until permanent replacement is completed.

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Permanent restoration of a damaged interconnect cable shall be made in one (1) of the following methods as approved by LVACTS personnel:

Method 1. Pulling out all damaged cable and replacing with a new cable conforming to R.E.A. Specification 39, 22 AWG, between existing terminal boards housed in controller, junction cabinets, or engineering office at each end of the damaged cable run. The new cable shall be tested after installing for continuity and with a "megger" to ensure no damage resulted from the installation process.

Method 2. Install a new standard junction cabinet if the damage occurs within a street intersection no closer than 300 feet to an existing junction, controller cabinet, JMC or TMC.

Method 3. All repairs of fiber optic cable shall be made per manufacturer's recommendations.

All damaged cable removed from the system under any of the restoration methods shall be removed from the conduit in continuous lengths, wound on a reel and returned to the local agency.

All cable repairs or restoration shall be made only under inspection by LVACTS personnel or Traffic Operations personnel from the local agency in whose jurisdiction the repair is being made.

All materials, equipment and workmanship incorporated into any cable repair or restoration shall be guaranteed for a period of one (1) year after the final acceptance of the work or equipment. If during the guarantee period any defects or faulty materials are found the Contractor shall immediately, upon notification by the local agency or LVACTS, proceed at his own expense to replace and repair same, together with any damage to all finishes, fixtures, equipment and furnishings that may be damaged as a result of this defective equipment or workmanship.

623 G.03.02 SCHEDULING OF WORK: Traffic signals shall not be placed in operation for use by public traffic without the energizing of street lighting at the intersection to be controlled if street lighting exists or is being installed in conjunction with the traffic signals.

Traffic signals shall not be placed in operation until all discrepancies are corrected and the roadways to be controlled are open to public traffic, unless otherwise directed by the Engineer.

Roadway lighting and traffic signals shall not be placed in operation, including flashing operation, prior to commencement of the functional test period specified in Subsection 623 T.02.03(e),(f), and (g), "Field Tests," unless ordered otherwise by the Engineer.

Conductors shall not be pulled into conduit until pull boxes are set to grade, crushed rock sumps installed, and metallic conduit bonded.

In vehicular undercrossings, soffit lights shall be placed in operation as soon as practicable after falsework has been removed from the structure. Lighting for pedestrian structures shall be placed in operation prior to opening the structure to pedestrian traffic.

If the Engineer orders soffit lights or lighting for pedestrian structures placed in operation before permanent power service is available, the cost of installing and removing temporary power service will be paid for as extra work as provided in Subsection 104.03, "Extra Work."

Traffic signals or street lighting shall not be inspected for acceptance or turn on until a completed set of red lined plans is received by the local agency. This does not preclude the preparation and submittal of as-built plans.

623 G.03.03 SAFETY PRECAUTIONS: Before starting work on existing series street lighting circuits, the Contractor shall obtain daily a safety circuit clearance from the responsible local agency. By-pass shall be switched to the "off" position, fuses shall be removed, and signs posted at the switch box before any work is done.

623 G.03.04 EXCAVATING AND BACKFILLING: Excavations required for the installation of conduit, foundations and other facilities, shall be performed in such a manner as to cause the least possible damage to the streets, sidewalks, and other improvements. Excavations shall not be larger than necessary for the proper installation of conduit, electrical facilities and foundations. Excavating shall not be performed until immediately before installation of conduit, facilities, and foundations.

The material from the excavation shall be placed in a position where the least disruption and obstruction to vehicular and pedestrian traffic will be realized and the least interference with surface drainage will occur.

Surplus excavated material shall be removed and disposed of by the Contractor outside of the right-of-way.

At the end of each day's work, and at other times when construction operations are suspended, equipment and other obstructions shall be removed from the right-of-way.

Structural excavation and backfill shall conform to the requirements of Section 206, "Structure Excavation" and 207, "Structure Backfill."

Trench excavations shall be backfilled in conformance with the requirements of Section 208, "Trench Excavation and Backfill."

Backfilled excavations shall be kept well filled and maintained in a smooth and well-drained condition, until permanent resurfacing is completed as specified in Subsection 208.03.05, "Cutting and Restoring Street Surfacing."

Unless otherwise specified in the Special Provisions, excavation in the street and highway shall be performed in such a manner that not more than one lane of traffic is restricted in either direction at any time, unless otherwise approved by the Engineer.

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

Barricading shall conform to the latest editions of the Traffic Control Plans for Highway Work Zones for the Clark County Area and the Manual On Uniform Traffic Control Devices.

623 G.03.05 REMOVING AND REPLACING IMPROVEMENTS: Improvements, such as sidewalks, curbs, gutters, Portland cement concrete and asphalt concrete pavement, bituminous surfacing, base material and other improvements removed, broken or damaged by the Contractor, shall be replaced or reconstructed in compliance with the applicable sections of these specifications.

Whenever a part of a square or slab of existing concrete sidewalk or driveway is broken or damaged, it shall be repaired in accordance with Subsection 202.03.02, "Removal of Structures and Obstructions."

The outline of all areas to be removed in Portland cement concrete sidewalks and in pavements shall be cut to a minimum depth of 1-1/2 inches (38 millimeters) with an abrasive type saw prior to removing the sidewalk and pavement material. Cut for the remainder of the required depth may be made by any method satisfactory to the Engineer. Cuts shall be neat and true with no shatter outside the removal area.

623 G.03.06 FOUNDATIONS: Foundations for posts, standards, and pedestals shall be concrete conforming to the applicable requirements of Section 501, "Portland Cement Concrete."

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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. In addition, for traffic signal installations, the bottom two-thirds (2/3) minimum of the concrete foundation shall be poured against undisturbed soil. If signal foundation is to be placed in area which has been filled, fill shall meet compaction requirements as specified in the Standard Specifications or special provisions and bottom two thirds (2/3) minimum of the foundation shall be poured in drilled compacted fill and/or undisturbed soil.

Forms shall be true to line and grade. Tops of footings for posts and standards, except special foundations, shall be finished one (1) inch (25 millimeters) above grade of curb or sidewalk or as ordered by the Engineer.

Forms shall be rigid and securely braced in place. Conduit ends and anchor bolts shall be held in place by means of a template until the concrete sets. Both forms and ground which will be in contact with the concrete shall be thoroughly moistened before placing concrete. Forms shall not be removed until the concrete has thoroughly set.

Ordinary surface finish shall be applied to exposed surfaces of concrete. Where the edge of a concrete foundation extends within eighteen (18) inches (450 millimeters) of any existing concrete improvement, a slab with a minimum thickness of four (4) inches (100 millimeters) shall be extended to meet said existing improvement.

Concrete for Type XX poles and/or XX-A poles shall set for a minimum of ten (10) days unless otherwise approved by the Engineer. Concrete for smaller bases shall set for a minimum time of seventy-two (72) hours.

623 G.03.07 WIRING: Wiring shall conform to appropriate articles of the National Electrical Code. Wiring within cabinets, junction boxes, etc., shall be neatly arranged and laced. Powdered soapstone, talc, or other approved lubricant shall be used when installing conductors in conduit.

Each conductor shall have eighteen (18) inches (450 millimeters) of slack coiled within each standard and at least two feet (600 millimeters) of slack coiled in each pull box.

Series lighting cable shall be installed without splices from luminaire to luminaire and from service to luminaire unless otherwise specified. Multiple lighting conductors may be spliced in the base of standards or in pull boxes adjacent thereto. Signal cable shall run from terminal to terminal without splices unless otherwise indicated on the plans.

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 new conduit is installed for future use, it shall have a #8 green (stranded) pull which is secured at both ends.

The ends of all conduits shall be well reamed to remove burrs and rough edges. Field conduit cuts shall be made square and true so that the ends will butt or come together for the full circumference in the couplings or adapters. Slip joints or running threads shall not be permitted for coupling metal conduit.

When a standard coupling can not be used, an approved union coupling shall be used.

Couplings for steel conduit shall be tightened until the ends of the conduits are brought together, so that a good electrical connection will be made throughout the entire length of the conduit run.

Conduit ends shall be threaded and capped with standard pipe caps until wiring is started. When caps are removed, the threaded ends shall be provided with approved conduit bushings.

Manual or power-operated equipment normally used for cutting rigid steel conduit is acceptable for use in cutting P.V.C. coated rigid steel conduit. P.V.C. shall not be peeled back before cutting and all cuts shall be reamed. Threading shall be the same as for non-coated rigid conduit. All scarred and grip marked areas shall be touched up with approved heavy consistency coating compound.

For P.V.C. coated rigid steel, all couplings and threaded fittings shall be hand tightened before using a wrench. Use strap wrench for the final two turns only. All wrench marks and scores shall be recoated and joints must be sealed with heavy consistency P.V.C. compound. Ensure that the final installation does not have any exposed metal areas.

Conduits shall be bent, without crimping or flattening, and no single run shall include more than two 45 degree bends and two 90 degree bends without prior approval of the Engineer.

P.V.C. coated rigid steel conduit, 2 inches (51 millimeters) in diameter or larger, shall be used for all bends, except for 90 degree bends at street light pole foundations. Standard field bending techniques shall be used which typically uses a shoe one size larger to accommodate the larger pipe diameter. The minimum radius of the bend shall be 36 inches (914 millimeters) for P.V.C. coated rigid steel conduit.

Conduit shall be placed to a depth of not less than 24 inches (600 millimeters) below the finished grade in all areas with the following exceptions. Conduit may be laid on top of and secured to the existing pavement where such pavement is covered by a raised dividing strip having concrete curb. Conduit under railroad tracks shall be installed to railroad specifications. Conduit shall be placed under existing pavement by approved jacking or drilling method. Pavement shall not be disturbed without the approval of the Engineer, and then only in the event obstructions are encountered; however, upon approval of, or as required by the Engineer, small test holes may be cut into the pavement. Jacking or drilling pits shall be kept two (2) feet (600 millimeters) from the edge of any type of pavement whenever possible. Use of water which might undermine pavement, or soften subgrade, will not be permitted.

Conduit terminating in pedestals shall be a minimum of two (2) inches (50 millimeters) and a maximum of four (4) inches (100 millimeters) above the foundation and should be sloped toward the handhole opening.

Conduit shall enter concrete pull boxes from the bottom and shall terminate two (2) inches (50 millimeters) inside the box wall and not less than two (2) inches (50 millimeters) nor more than four (4) inches (100 millimeters) above the bottom, and shall be sloped to facilitate pulling of conductors. Conduit entering the bottom of a pull box shall be located near the end walls to leave the major portion of the box clear. At all outlets, conduit shall enter from the direction of the run.

Existing underground conduit to be incorporated into a new system shall be cleaned by blowing out with compressed air, or by other methods required by the Engineer.

Conduit runs shown on the plans are for bidding purposes only and may be changed with the approval of the Engineer to avoid underground obstructions.

623 G.03.08 SERVICE: Service points when required by the Contracting Agency for street lighting, traffic signals, etc. shall be as indicated on the drawings.

Since service points indicated by those other than the Contracting Agency may be subject to change (subdivision street lighting) the Contractor shall obtain the points of attachment from the serving utility company and shall be as close to the center of the circuit as possible.

Padmount service, when called for, shall conform to Uniform Standard Drawings, Clark County Area as applicable.

The Contractor shall furnish and install conduit and conductors to the service point as shown on the plans or as required to complete the installation.

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

TRAFFIC SECTION

MATERIAL

623 T.02.01 CABINETS ENCLOSURE: The type of cabinet to be furnished shall be a "TYPE VIII" cabinet, and shall conform to Drawing No. 404.307, sheet 1 of 1, in Volume II of the Uniform Standard Drawings, Clark County Area, Nevada. This is commonly referred to as an "R" cabinet. All external seams exposed to the outside shall be 100% welded (no gaps). The cabinet shall be painted with two coats white enamel both inside and outside, or polished aluminum, depending upon contract provisions. There shall be a minimum of 4 shelves provided with each cabinet.

All cabinets shall be provided as a complete unit to include all shelves, foundations, anchor bolts with template, a standard #2 lock, two (2) door stops, etc., and to be completely painted white inside and outside if required by the contract plans. The police panel shall be keyed with a standard police key lock.

All cabinets shall be weatherproof, properly ventilated, and have at least two (2), 110 CFM ventilation fans, with each fan having an independent thermostat. All cabinets shall have the door mounted with hinges welded to door and jamb. There shall be a standard multi-point door stop, along with a supplemental, single-arm door stop. The location of these will be at the top and bottom of the cabinet door, and they shall be fully retractable as not to interfere with the door's closing and opening operation.

Each cabinet must fit the anchor bolt locations and foundations as specified in Standard Drawing 404.213. This shall be accomplished without modification to the cabinet or foundation.

Cabinets shall have two (2) fluorescent fixtures and lights mounted in the cabinet interior. One mounted over the door, at a location least likely to be damaged. The length shall be determined by the cabinet width. The second, an 8 to 15 watt lamp, shall be attached to the bottom of the lowest shelf above the field terminals, yet it still must illuminate the back panel connection terminals. Both fixtures shall have an on-off switch which automatically illuminates the lights when the door is opened, and de-energizes them when the door is closed. The "Back Panel" in each cabinet shall be wired to the NEMA TS2 TYPE 2 standard inputs and outputs. There shall be standard NEMA "A," "B," & "C" connectors with all pins provided a termination point onto the back panel, including spares or unassigned pins. The terminals shall be clearly marked as to their associated function, with silk-screen or other approved method of marking.

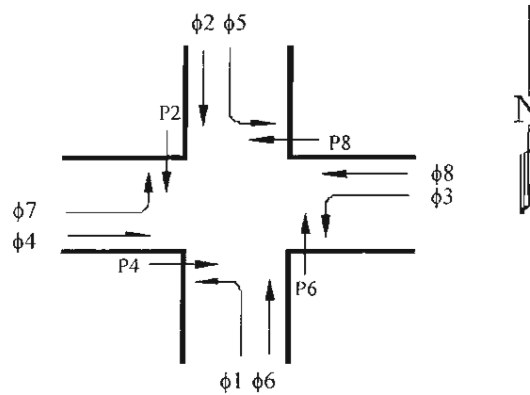
Only cabinets that are designed to use rails with infinite adjustability ('uni-strut' design) on the side of the cabinet that the shelves and panels are connected to will be accepted. These utilize "spring nuts" in the rail channel to tighten the bolts that are used. Cabinets that use carriage bolt assemblies are not acceptable.

When specified a rear access door shall be provided. Permanently affixed lifting eyes shall be provided.

- (a) All cabinet harnesses and wiring shall be neatly and firmly laced or bound together (with ty-rap or approved equivalent).
- (b) Every terminal shall be numbered and identified in accordance with the cabinet wiring diagrams and prints.

- (c) The cabinet shall contain a plastic envelope that can be sealed, which is attached to the cabinet door. This will be used to house wiring diagrams. The cabinet wiring diagrams shall show and identify the connectors for all equipment, switches, terminal blocks, relays, flashers and signal control bases. There shall be included three (3) complete sets of wiring diagrams on "D" size paper, along with a complete copy of the cabinet wiring diagram on a 3 1/2 " floppy disk drawn in Autocad LT95, Autocad Rev. 12, program or approved equivalent.

The cabinet wiring diagram shall have an intersection sketch with signal heads and push-buttons identified as related to phasing. A generic phasing layout similar to the following would be acceptable. The cabinet "controller" phasing shall be referenced as follows:



- (d) All mechanical relays shall have clear dust covers.
- (e) The following equipment shall be furnished and wired in all cabinets:
 - (1) Three (3), single-pole, surface-mount circuit breakers: One (1), 20-amp circuit breaker to operate all the electronic equipment, (e.g. controller, conflict monitor, detection equipment, and preemption equipment) and the upper utility plug.
 - One (1) 15-amp circuit breaker for the fan, light, and lower utility plug.
 - One (1) 60-amp circuit breaker to operate the other cabinet equipment, and to illuminate all the indications at the intersection external from the cabinet.

The circuit breakers must accommodate a #2 AWG stranded conductor which comes from the utility company's service meter. If not, the cabinet must have a supplemental terminal block that can accept this wiring requirement. This terminal block must be a Buss 16204-3, or approved equivalent.

- (2) There shall be a specific terminal, unfused, able to accept # 2 wire for the neutral wire of the power supply line. This terminal point shall be in the Buss 16204-3 terminal block, or approved equivalent.

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- (3) There shall be a specific terminal, unfused, able to accept # 2 wire for the chassis ground wire of the power supply line. This terminal point shall be in the Buss 16204-3 terminal block, or approved equivalent.
- (4) The terminal blocks for connecting the pedestrian and vehicle field wires which illuminate the independent signal heads shall be Thomas and Betts #35301, or approved equivalent. The mounting height to the bottom of these terminal blocks must be 14" from the bottom of the cabinet base.
- (5) Terminal blocks Cinch 12-142 with Thomas and Betts chair lugs, or approved equivalent will be used for connection of pedestrian push button "field" conductors.
- (6) Terminal blocks for all pins on the wiring harnesses on all connectors of the controller, conflict monitor, detection systems, and preemption systems must be provided separately. All connector pins shall be wired and terminated.
- (7) A minimum of two (2), sixteen terminal, "Compression type" Copper Ground Strips, with one mounted and grounded to each side of the cabinet wall, for connection of all common conductors must be provided in the cabinet. These terminal strips will be connected to the terminal block that accepts the # 2 stranded wire for the neutral ground wire. These shall be mounted from 2" to 4" up from the bottom of the cabinet.
- (8) Two compression-type mechanical ground strips shall be mounted on and grounded to the cabinet wall for connection of all mechanical grounds. One shall be mounted on the left and one on the right side of the cabinet 2" to 4" above the cabinet base, and they must be tied to the ground wire from the service point through the terminal block that is used to accept the #2 stranded wire.
- (9) Two, dual-circuit, solid state NEMA jack-mounted flashers having a flash rate of 50 to 60 flashes per minute (see Section 8, SOLID STATE FLASHERS, of the 1983 TS1 NEMA specifications) will be installed.

Channel "A" on the first flasher is to be wired to flash phases 1 and 4, while channel "B" is wired to flash phases 5 and 8. Channel "A" on the second flasher shall be wired to flash phases 6 and 7, while channel "B" shall be wired to flash phases 2 and 3.

Overlaps driven flash is:

- 1A does phase 1, 4, & OLA
- 1B does phase 5, 8, & OLB
- 2B does phase 2, 3 & OLC
- 2A does phase 7, 6 & OLD

The red transfer relays will be wired in such a manner that the field wire outputs shall be flashing when the relays are de-energized. These transfer relays must be energized to operate the traffic signal with colors.

- (10) A single, duplex, "U" ground type of convenience outlet shall be furnished for tools and lighting. It shall have an integral ground fault protection device. This will be located on the door, or within the lower half of the cabinet. The power source for this outlet shall be the 15-amp circuit breaker.

A second, single, duplex, "U" ground type of convenience outlet shall be furnished for video equipment and other electronic test equipment. It shall not have an integral ground fault protection device. This will be located no more than a foot from the roof of the cabinet, on the right or left hand side. The power source for this outlet shall be the 20-amp circuit breaker.

- (11) Police Panel Switch: There shall be a double-pole, double-throw switch behind the police auxiliary door. This shall be identified "Auto/Flash." With the switch placed in the "Flash" position the switch shall be wired to:
- (a) de-energize signal light power and place the intersection to red flashing operation through the conflict monitor (see "d" below). The controller power, however, must remain energized.
 - (b) activate the "stop time" function within the controller. This will be accomplished through the Conflict Monitor (see "d" below).
 - (c) provide logic ground to inform the 2070N controller that the Police Flash Switch has been turned on to put on the traffic signal on flash, on pin "AA", Controller Plug "A".
 - (d) de-energize +24v II to the Conflict Monitor to cause it to fail, which, in turn, causes the Conflict Monitor to provide a logic ground to Controller Plug "A," Pin "n," and Stop Time to controller. This circuit must be diode-isolated.

When the police switch is placed back into the "Auto" position the intersection shall be transferred from red flashing operation to normal operation.

- (12) The following switches shall be installed on the interior of the cabinet. They must act in the specified manner:
- (a) "Controller Power" switch (identified "On-Off") wired to de-energize only the controller power when switched to the "off" position.
 - (b) "Tech Flash" switch (identified "Auto-Flash") shall be wired to de-energize signal light power feeding the load switches and transfer relays when the switch is placed in the "Flash" position. This switch shall cause the intersection signals to flash red, but must keep controller (and all other equipment) energized. Additionally, the controller shall NOT be activated to stop-time, while providing logic ground to inform the 2070N controller that the Tech Flash Switch has been put on flash (Controller Plug "A," Pin "AA"). When the Tech Flash switch is placed back into the "Auto" position the intersection shall be removed from Flash and return to normal operation.
 - (c) "Stop Timing" switch (identified "On-Off") shall be wired to "stop time" ring 1 and ring 2 on the controller when switched to the "On" position.

- (d) "Interval Advance" switch, which must be a 'Momentary ON' switch, (identified "Interval Advance") shall be enabled by the "MCE" switch and wired to manually step the controller through intervals. The Interval Advance switch shall have a guard to keep from accidentally advancing the controller.
- (e) "Manual Control Enable" switch" (identified "MCE") shall be wired to enable "MCE" in the controller, while allowing the Interval Advance switch to operate.
- (f) "Pedestrian And Vehicle Test" switches (identified "On/Off/Test") shall be provided in each cabinet. These should be installed on a vehicle and pedestrian detector test panel located on the inside of the cabinet door. They shall be equipped according to contract provisions as follows:
 - (1) With toggle switches (on-off-momentary on) wired for permitting the introduction of manual calls into the controller for every possible vehicle and pedestrian detector input. Each toggle switch, in the up position, shall permit calls into the controller from the vehicle and pedestrian detection source. Each toggle switch, in the center position, shall disconnect the vehicle and pedestrian detection source and permit calls into the controller only via manual push down actuation. All possible vehicle and pedestrian detector circuits shall have a separate toggle switch. Toggle switches shall be provided for 8 vehicle and 8 pedestrian phases and wired independently to the terminal blocks.
 - (2) With toggle switches (on-off) wired for permitting the introduction of manual calls via a separate normally open push button switch into the controller for every possible vehicle and pedestrian detector input. Each toggle switch, in the up position, shall permit calls into the controller from the vehicle and pedestrian detection source, and permit calls into the controller via manually depressing the associated push button for the related phase. Each toggle switch, in the lower position, shall disconnect the vehicle and pedestrian detection source and the related push button. All possible vehicle and pedestrian detector circuits shall have a separate toggle and push button switch. These switches shall be for all 8 vehicle and all 8 pedestrian phases and wired independently to the terminal blocks.
 - (3) All switches and the "lower" convenience outlet may be combined on a single panel and mounted on the inside cabinet door behind the police auxiliary panel, if desired by the supplier.
- (g) Surge suppressors for electrical power shall be Model #HS-P-SP-120A-60A-RJ, and for telecommunications line protection shall be Model #MDF 6 95V, or MF 25 95V.

623 T.02.02 CABINET EQUIPMENT:

- (a) **Solid State Load Switches, Red Transfer Relays, and Sockets:** All necessary cabinet wiring, connecting cables, terminal blocks and sockets shall be provided for complete and proper functionality of a 8 vehicle, 4 pedestrian, and 4 overlap phase operation.
A total of 16 NEMA load switches shall be provided with each cabinet. There will be two (2) discrete NEMA flashers accompanying each cabinet. Refer to the 1983 Sections 5 and 8 of the NEMA standard publication for operational and dimensional requirements. It is mandatory that a wide angle, high

intensity LED, clearly visible in sunlight shall be provided for each load switch and flasher indication. A minimum of 6 transfer relays shall be delivered with each cabinet. These shall conform to the 1983 NEMA TS1 specifications. Load bay panels shall not exceed 0.125 inches (3 mm) of flex under 5 pounds pressure .

- (b) **Pedestrian Push Button Circuit Isolation:** To separate the pedestrian detector input circuits to the controller from the pedestrian push button circuits in the field, six solid state isolation circuits shall be provided in the cabinet. For four pedestrian movements; channels one, two , three, and four shall correlate to phase 2, 4, 6, and 8. Therefore, the wiring shall be appropriately terminated within the cabinet. Channels five and six shall be spares and be terminated to allow access from the front side of the detector panel. The “field” push button circuits shall be energized by a 12 VAC source. The isolation circuits shall be mounted on an edge connector-type P.C. board with all required components; i.e., transformer, chips, etc. and shall display an LED indication showing status of field buttons.
- (c) **Video Detection:** All cabinets must be wired for Video Detection in the following manner. This is a requirement whether or not standard loop detection cables are installed into the cabinet. Every cabinet shall have installed and wired into it a discrete “Video Detection Interface Panel” (VDIP). Phase 1 through 8, and overlap A, B, C, & D 24 VDC green and red outputs from the controller be must be wired to the VDIP, from the back panel. Also, vehicle and pedestrian phase “calls” 1 through 8 must have a termination point on the VDIP. This VDIP shall be installed under the assumption that the wiring harnesses that accompany all Video Detection Systems will be connected to these independent termination points at some time. This VDIP shall be installed at a location within the cabinet where the terminal blocks are easily accessible.
- (d) **Loop Detection:** When specified, the cabinet shall be wired for 24, single-channel loop amplifier wiring harnesses, 6, 4-channel loop amplifier wiring harnesses, or a multi-position “rack-mount” style detection system with the breakdown as follows:

(1) **For Single-Channel Detectors:**

There shall be two (2), single-channel loop amplifier wiring harnesses for each of the phases 1, 3, 5, and 7, for left turn operation. These harnesses and plugs conform to the TS-1 1983 specifications. These will be wired as presence loops, with each conductor independently terminated onto an individual terminal. The “Relay Common” (“B” pin) must terminate, then it must be wired to logic ground.

There shall be three (3), single-channel loop amplifier wiring harnesses for each of the phases 2, 4, 6, and 8, for thru traffic extension loop operation. These harnesses and plugs conform to the TS-1 1983 specifications. These will be wired as presence loops, with each conductor independently terminated onto an individual terminal. The “Relay Common” (“B” pin) must terminate, then it must be wired to logic ground.

There shall be one (1), single-channel loop amplifier wiring harnesses for each of the phases 2, 4, 6, and 8, for thru-traffic “call loop” operation. These harnesses and plugs conform to the TS-1 1983 specifications. These will be wired not to output a call during the detected phase green

service, with each conductor independently terminated onto an individual terminal. The "Relay Common" ("B" pin) must terminate independently, then it must then be wired to the red and yellow output from the controller (this must be diode isolated).

(2) For Four-Channel Detectors:

There shall be 6 complete wiring harnesses to match with the standard four channel detection unit for a total of 24 channels of detection specified in NEMA TS-1 standards, Section 11.2.28.2. These shall be wired to so the channel inputs of all channels are terminated directly to logic ground. The number of detection outputs per phase shall be as below:

4 outputs per each even phase (2, 4, 6, 8)
2 outputs per each odd phase (1, 3, 5, 7)

(3) For "Rack-Mounted" Detection:

There shall be a Card rack installed with enough capacity to accommodate 24 separate detection channels. Contract provisions shall specify whether two-channel or four-channel rack-mounted detectors are to be utilized. The number of detection outputs per phase shall be as below:

4 outputs per each even phase (2, 4, 6, 8)
2 outputs per each odd phase (1, 3, 5, 7)

All wiring harnesses, and rack positions must be clearly marked as to the appropriate phase to which it belongs.

The wiring harnesses shall be of sufficient length for them to reach the top-most shelf inside the cabinet.

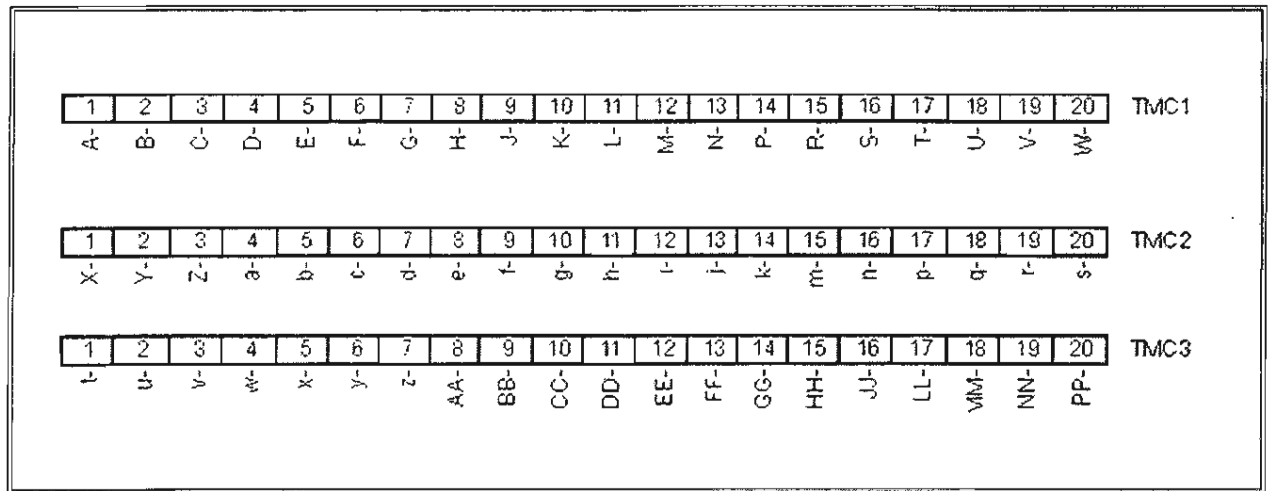
- (e) Optical Preemption Terminal Strip Panel:** Every cabinet supplied shall be wired with an "Optical Emergency Preemption Panel," and shall be marked accordingly. The panel shall have termination points for four preemption outputs directly wired to the discriminator. The M138 Emergency Preemption cable coming from the Optical Detectors shall be terminated to a terminal strip located on this panel.

The wiring from this panel to the back panel shall be as follows:

Channel "A" to Controller Plug "A," Pin "q"
Channel "B" to Controller Plug "A," Pin "y"
Channel "C" to Controller Plug "B," Pin "W"
Channel "D" to Controller Plug "B," Pin "X"

- (f) Supplemental 2070N "D" Plug Interface Panel** (for additional information, see 623 T.02.03)

Every cabinet shall have a "D" panel wired to which the wiring harness for the "D" plug for the controller will terminate. The plug used for the "D" plug on the 2070N controller shall be an MS3116-24-61S. The wiring from this plug's harness shall have independent termination points as shown on the panel below. All wiring on this panel, except for the "D" plug connector wiring harness itself shall be performed by the Agency's staff after delivery and acceptance of the controller cabinet.



- (g) **Conflict Monitor Units:** The wiring harness that the conflict monitor plugs use shall have independent termination points. Each and every conductor shall be terminated independently onto a single terminal. There will be no conductors bound, hanging loose, or not terminated. All conflict monitors shall be NEMA standard, meeting all requirements of section 6 of the 1983 TSI specifications. In addition, all monitors shall be equipped with the features defined below:
 - All cabinets shall be equipped with a conflict monitor harness completely wired in the cabinet to a separate panel as shown above for twelve (12) channels of operation. Conflict monitors shall be provided in all cabinets supplied.
 - Minimum vehicle clearance time monitoring with a time value of 3.0 to 4.0 seconds (able to be selected on a per channel basis).
 - Separate indicators for activity on each of the red, amber, green and walk inputs of each monitor channel.
 - Front panel indicators showing active channel(s), date, time and description of the current status, while showing a log of six or more of the most recent failures. All such data shall be stored in a non-volatile memory.
 - Liquid crystal front panel displays shall be provided.
 - Failure status indicators for CVM, 24-1, 24-2, conflict, red failure, clearance failure, minimum green failure, dual indication, and program card insertion.
 - The monitor shall provide a front panel display of the approximate time and date of the occurrence of any power failure in excess of 500 milliseconds duration and the date and time of power restoration. The monitor program shall have computed and logged this data in non-volatile memory by the end of the power restart flash interval.
 - Front panel connectors "A" and "B" mounted directly to printed circuits will not be accepted.
 - For every integrated circuit custom-programmed device, or any sole source component, within the unit which is of such special design that replacement units would not be available from any local wholesale

electronics distributors, one fully programmed duplicate of each IC/device contained therein shall be furnished directly for each conflict monitor delivered.

All conflict monitors shall have RS-232 capability. The vendor shall supply a software program which when run on an IBM compatible computer will communicate with the monitor unit for the downloading of failure event information and any other programmable event including timing, etc.

623 T.02.03 TRAFFIC SIGNAL CONTROLLERS:

(a) General

- (1) **Controller Assemblies.** A controller assembly shall consist of a complete mechanism for controlling the operation of a traffic control signal, including the controller unit and all necessary auxiliary equipment, mounted in a cabinet. All equipment required to provide the operation shown on the plans and specifications, shall be provided.
- (2) **Flashing Operations.** All controllers shall be equipped for flashing operation of signal lights. Flashing operations, when required by railroad preemption, flashing emergency traffic control, or other causes, shall be set for flashing red on all approaches unless otherwise specified.
- (3) **Wiring Diagrams.** A schematic diagram of the controllers and auxiliary equipment furnished under the contract shall be submitted at the time the controllers are delivered or, on demand of by the Engineer, prior to purchase. This diagram shall give in detail all circuits and parts, and such parts shown thereon shall be identified by name or number and in such manner as to be readily interpreted.
- (4) **Operating Voltage.** All equipment including interconnection facilities and excepting pedestrian push buttons and pressure detectors, shall be designed to operate on 120 volts, 60 Hz. AC. Operation shall be satisfactory at voltages from 105 to 130. The voltage for pedestrian push buttons shall not exceed 24 volts.
- (5) **Tests.** Prior to completion of the work, the Contractor shall cause the following tests to be made on all electrical circuits, in the presence of the Engineer:
 - (1) Test for continuity of each circuit
 - (2) Test for grounds in each circuit
 - (3) A megohmmeter test on each circuit between the circuit conductor and ground. The insulation resistance shall not be less than 150 megohms at 500 volts.
 - (4) A functional test in which it is demonstrated that each and every part of the system functions as specified or intended herein.

Any fault in any material or in any part of the installation revealed by these tests shall be replaced or repaired by the Contractor in a manner approved by the Engineer, and the same test shall be repeated until no fault appears. After testing of each traffic signal system, the system shall be activated and required to function without failure for a period of 14 calendar days. Any fault or failure to the system during this period shall be corrected by the Contractor at his own expense and the system will then be required to function for a period of 14 calendar days without failure. This procedure will continue until the system successfully operates continuously without failure for 14 calendar days.

- (6) **System Turn-On:** The Contractor must have approval of the date for turn-on, at least five (5) working days prior, from the Traffic Engineer. Systems shall be permitted to be made operational

at Agency's direction. Controller manuals shall be available to the Signal Maintenance Division at time of turn-on. The controller manufacturer shall provide a technical representative at the intersection during the turn-on and testing period to provide technical assistance.

The supplier shall provide a manufacturer's representative, with a minimum of an IMSA Level II, Traffic Signal Technician Certification at time of installation for on-street service of all equipment provided.

(b) NEMA Controller Construction Specification.

When a NEMA controller is supplied, it shall meet all requirements of the NEMA standards publication, TS2, Type 2 or later version as well as the following requirements:

- (1) Phase reversal shall be activated by applying a logic ground to controller connector "B."
 - Pin B shall reverse phase 1 & 2
 - Pin W shall reverse phase 3 & 4
 - Pin X shall reverse phase 5 & 6
 - Pin y shall reverse phase 7 & 8
- (2) Each controller unit shall be provided complete with all of the following components and timing features:
 - Four keyboard programmable overlaps
 - Three NEMA connectors "A", "B", "C"
 - Two DB25-RS232C ports on the front of each controller. One port shall be for communications and the second port shall be used for occasional connection to a portable computer having priority over port one.

Each controller will be menu driven, with keyboard programming for listing program, status, utilities, and special options. Being able to move between programs, menus, and/or sub-menus and having the ability to copy timing data from one phase to another. The controller shall be able to dim phase outputs by phase or individual phase color. Readout on the display to be visible in bright sunlight or in the dark with back lighting.

The equipment housing shall be a completely enclosed painted metal fabrication that is easily removed and replaced. The design shall include vent holes. The unit shall consist of a frame and mother board, with separate printed circuit modules (CPU, Memory, I/O, etc.) which will facilitate simple and rapid maintenance. The connectors for interfacing with the controller shall be part of the input/output module and are to be located on the front of the unit for ease of access.

The circuit components shall be standard production types that are readily available from any industrial electronics supply house. All components mounted to the circuit boards shall have their circuit reference symbol clearly marked on the board and be identifiable by referencing to the pictorial assembly drawings.

The power supply shall be self contained in a separate and removable module.

The circuit component design life under continuous duty operation shall not be less than 10 years.

All programmed timing and operational parameters shall be retained within electrically erasable and programmable read only memories (EEPROM'S) or equivalent. No batteries for any such backup systems will be acceptable, except as necessary to maintain TOD clock time-keeping during power failure.

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- (3) A complete operations and repair manual shall be supplied with each controller unit. Each manual shall completely describe all features, keystroke sequences, etc. as necessary to activate all functions provided in the controller. Complete schematic diagrams by circuit function, and separate diagrams by module. Complete block diagrams of equipment circuits, and complete parts listing. Detailed circuit-by-circuit description of the operation that follows component-by-component with the schematic diagram or block by block with the logic diagram. This requirement may be waived at the discretion of the purchasing Agency.
- (4) It shall be possible to perform a series of diagnostic tests of the system, which shall include the following:
- Wrap around Input/output check of connectors A, B and C.
 - Wrap around Input/output check of communications and printer ports.
 - RAM memory check.
 - EEPROM check.

Where special test connectors are required, 2 complete sets of connectors shall be provided per bid order.

- (5) The vendor shall supply a software program to the Agency which when run on an IBM compatible PC connected to the controller will demonstrate to the Agency the controller's communications with respect to baud rates, uploads, downloads, monitoring and activity logging.
- (6) All requisite hardware and software shall be provided fully installed and complete in order to provide the uploading, downloading, monitoring and logging functions required.
- (7) **Double Clearance Overlaps:** The four NEMA required overlap outputs ("A", "B", "C" and "D") shall provide timed double clearance operation. The settings for this type of operation shall include the ability to select which phases and other overlaps may start timing, or commence the display of their green indications, respectively, during the double clearance timer intervals after the terminating parent phase has completed its all red. It shall also be possible to program which phases "on's" and which phases "next's" concurrent output shall cause the double clearance green (lag green interval) to be skipped. It shall be possible to specifically program for each overlap:

Compatible phases

Conflicting phase

This will allow the overlap to go red during the timing of a phase conflicting with the overlap in one ring even though the overlap movement is compatible with a phase timing concurrently in the other ring.

Independent amber and all red clearance timers shall be provided for each overlap of which shall always operate during an overlap clearance. Output suppression of all drivers during the green (only), or green and amber displays of designated phases for use with "Illinois type" right turn overlap or "Florida style" left turn signal indications, respectively. When such operation is selected, the otherwise unused red of the odd phase load switch drivers shall output a "not red" indication for use in red monitor failure prevention.

Each controller shall also internally provide the option to program each of all load switch driver outputs other than overlaps A through D as an overlap of any or all of the timing phases. This shall be true of the red, yellow, and green outputs of phases 1 - 8, outputs and any or all of the eight unused walk, steady ped clear, and flashing ped clear outputs.

- (8) **Power Up Phase and Interval Sequence:** The controller start up point shall be programmable to be either the start of green or the start of amber of any legal phase combination.

- (9) **Scheduled Flash:** The scheduled flash shall be generated internal to the controller, and blink the load switch driver inputs independently of the cabinet (conflict monitor) flash circuitry. It shall be possible to program the following parameters:
Last phases before scheduled flash begins, along with the first phases after scheduled flash ends.
The monitor's red enable function shall be active whenever the signal bus is energized, including periods of controller load switch flash. During a scheduled flash all pedestrian outputs shall remain dark as stated in MUTCD. Scheduled flash may be provided as a form of internal controller preemption, callable for the internal time base coordination schedule, as well as by activation of NEMA test input "A". It shall be possible to specify in every other internal preempt program provided whether or not a call for that preempt overrides scheduled flash operation.
- (10) **Primary Phase Assignments:** It shall be possible to program each detector input for phase assignment and as to whether the input places:
- (a) no call
 - (b) call only
 - (c) extension only
 - (d) both call and extension for each phase
 - (e) Upon bulk initialization detector inputs 1 - 8 shall default to the conventional NEMA one to one detector input number to phase number correspondence, placing both call and extensions on those phases. The inputs shall be routed according to these phase assignments provided that the conditions for detector switching are not true.
- (11) **Alternate Phase Assignments:** It shall be possible to program each detector input for phase assignment and as to whether the input places:
- (a) no call
 - (b) call only
 - (c) extension only
 - (d) both call and extension for each phase
 - (e) Upon bulk initialization, detector inputs 1 - 8 shall default to the conventional NEMA one to one detector input number to phase number correspondence, placing both call and extensions on those phases. The inputs shall be routed according to these phase assignments provided that the conditions for detector switching are not true.
- (12) **Detector Switching:** It shall be possible to program the conditions under which each detector input shall switch to the alternate phases assignments. The conditions for each input shall be defined by the condition of phases 1-8 as to whether each phases, (0) not applicable, (1) has a call, (2) is "on".
- (13) **Recall Mode:** Each phase shall be programmable as to (code definitions shall be displayed with each entry screen) the type of recall mode required as listed below:
- (a) Memory off
 - (b) Memory on
 - (c) Minimum recall
 - (d) Maximum recall
 - (e) Minimum and pedestrian recall
 - (f) Maximum and pedestrian recall
 - (g) Non-Actuated
 - (h) Omit

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- (i) Soft recall or No rest w/detector memory off
- (j) Soft recall or No rest w/detector memory on
- (14) **Max Mode:** Each phase shall be programmable as to (code definitions shall be displayed with each entry screen) the maximum green value required as listed below:
 - (a) Max inhibit (code only assignable for background cycle operation)
 - (b) Max I
 - (c) Max II
- (15) **"No Skip" Phases:** Note that it shall be possible to condition this function to be specific to only those other phases specifically selected (i.e., "Phases always preceded by this one", and "phases always followed by this one").
- (16) Red rest.
- (17) Conditional re-service/service phases, and phases to be either omitted or serviced twice-per-cycle during timing plans called up at certain times of day.
- (18) **Actuated Rest In Walk Operation Phases:** When active, such phase shall rest at the end of its "WALK" interval in the absence of any serviceable opposing call, and shall proceed to time the pedestrian clearance interval as soon as any such opposing call is received and becomes serviceable. The phase shall revert to the beginning of, and proceed to retime the "WALK" interval immediately whenever all opposing calls are lost, so long as the phase remains green and is not under pedestrian omit, whether or not the pedestrian clearance has completed timing.
- (19) **Last Car Passage Phases:** The last car passage and subsequent rest intervals shall not be reset or extended by additional vehicle actuations except in dual ring applications where simultaneous gap is also active and the other ring has not yet reached last car passage or rest.
- (20) Inhibit gap reset after timeout phases (non-simultaneous gap termination).
- (21) **Preemption:** The software shall provide a minimum of handling six unique preempt sequences, and shall operate similarly and provide for transitional timing and signal display to a programmed preempt condition and exit transition timing and display to a programmed return to normal condition. Preempt input priority and the lower four inputs served on a first come first-served basis.
- (22) **Coordination:** The software shall provide a minimum of : Four cycle lengths, Three offsets per cycle, Four splits per cycle, Manual control, Free control and standard interconnect operation.
- (23) **Features Associated With The Internal Time Clock Setting Time/Date:** The internal clock shall be accurately programmable to the second. At the time the clock is updated by the user, all internal commands, coordination patterns and offsets shall also be automatically updated.

MANUAL COMMAND - It shall be possible to manually activate the pattern, offset, the system command type.

DAYLIGHT SAVINGS CORRECTION - Provisions shall be made for automatic clock correction for the start and end of daylight savings time (DST), including the ability to revise the month and week of month (1-last) of which DST starts and ends from the keyboard Sync Pulse Reference Time (Hour/Minute) - This sync pulse shall be calculated from this point in time. The internal time base clock shall contain at least 50 event command entries which shall be displayed in chronological order but need not be entered in that order.

DAY SCHEDULE - The programming of the internal time base coordination event clock shall

be of the type in which any event instruction may be directly associated with one or more days of the week or holiday, and not of the type in which day program schedules must be first programmed, and then associated with the calendar days to which they apply. It shall be possible to program any or all of days 0 through 9 for each TOD command with the following association of each number as defined below:

- (1) 0 = Special day program
- (2) 1 = Sunday
- (3) 2 = Monday
- (4) 3 = Tuesday
- (5) 4 = Wednesday
- (6) 5 = Thursday
- (7) 6 = Friday
- (8) 7 = Saturday
- (9) 8 = Special day program
- (10) 9 = Special day program

(c) 2070N Controller Construction Specification.

When a 2070N controller is supplied, the following requirements are mandated:

- (1) The 2070N controllers supplied shall conform to the latest published revision of the California Department of Transportation (CALTRANS), Transportation Electrical Equipment Specifications (TEES) requirements, published at time of bid. The following configuration will apply to any controller supplied:
- (2) A 2070-7 "ASYNC SERIAL COMM MODULE" shall be supplied and installed in each controller. The communications interface connection cable incorporated with the 2070-8 shall be supplied with connector DB-9S to mate with the 2070-7 module.
- (3) A communications modem shall be supplied per LVACTS system requirements. The modem shall be delivered complete with the power cord and a five (5) foot DB25 to DB25 RS232 cable for connection of the EX2 connector on the 2070-8 to the DTE connector on the modem.
- (4) The controller that is provided shall be configured with a short power outage tolerance of at least 400 milliseconds without causing a CPU reset, and a minimum of 4 MB of DRAM memory, 4 MB of FLASH memory, and 512 KB of SRAM.
- (5) Except when waived by the purchasing agency, the proposed supplier or apparent low bidder shall furnish a complete and fully operational 2070-N, along with the associated communications equipment, within 2 weeks of bid opening, but prior to contract award. This unit will be returned to the supplier/bidder following the demonstration test and functional assessment. Contract awards shall be contingent upon obtaining agency approval on all proposed equipment submitted for evaluation, including any proposed "approved equivalents" of supplied equipment.
- (6) The "A," "B," "C," and "D" plugs shall be installed on the front of the controller with the identification letters for the Cannon plugs right-side up. The master key shall be located at the top of the plug, not the bottom.
- (7) The evaluation by the potential purchasing agency will include, but not be limited to:
 - (a) proper implementation of all TEES, and the above, specifications.

- (b) monitoring the operation in a test cabinet environment.
 - (c) confirming that the LCD display and the display cover shall be environmentally sealed to keep dust and other particles from entering between them.
 - (d) verifying operation with short power outages, and momentary surges.
 - (e) verifying operation with the following provisions of software operation and compatibility.
- (8) All 2070N controller units must be compatible and function properly with the latest revision of the Next Phase Intersection Management Software developed by Gardner Transportation Systems.
- (9) All 2070N controller units must be compatible and function properly with the ICONS communication package developed by Gardner Transportation System for the LVACTS Traffic Signal System, and shall be complete with all requisite hardware, cables, connectors, and related firmware for connection to, and communication with the ICONS central software.

CONTROLLER CONNECTOR A			
<u>Pin</u>	<u>Function</u>	<u>Pin</u>	<u>Function</u>
A	Reserved	AA	Test Input B
B	+24 V DC External	BB	Walk Rest Modifier
C	Voltage Monitor	CC	Coded Status Bit A (Ring 1)
D	PH 1 Red	DD	PH 1 Phase ON
E	PH 1 Don't Walk	EE	PH 1 Ped Omit
F	PH 2 Red	FF	Ped Recycle (Ring 1)
G	PH 2 Don't Walk	GG	Max II Selection (Ring 1)
H	PH 2 Ped Clear		
J	PH 2 Walk		
K	PH 2 Veh Call Det		
L	PH 2 Ped Call Det		
M	PH 2 Hold		
N	Stop Timing (Ring 1)		
P	Inhibit Max Term (Ring 1)		
R	External Start		
S	Internal Advance		
T	Indicator Lamp Control		
U	AC- Common		
V	Chassis Ground		
W	Logic Ground		
X	Flashing Logic Out		
Y	Coded Status Bit C (Ring 1)		
Z	PH 1 Yellow		
a	PH 1 Ped Clear		
b	PH 2 Yellow		
c	PH 2 Green		
d	PH 2 Check		
e	PH 2 Phase ON		
f	PH 1 Veh Call Det		
g	PH 1 Ped Call Det		
h	PH 1 Hold		
i	Force-off (Ring 1)		
j	Ext Min Recall All PH's		
k	Manual Control Enable		
m	Call to Non Actuated I		
n	Test Input A		
p	AC + (control)		
q	5 PPS		
r	Coded Status Bit B (Ring 1)		
s	PH 1 Green		
t	PH 1 Walk		
u	PH 1 Check		
v	PH 2 Ped Omit		
w	Omit All Red Clear (Ring 1)		
x	Red Rest Mode (Ring 1)		
y	Spare 1		
z	Call to Non Actuated II		

TRAFFIC SIGNALS AND STREET LIGHTING

CONTROLLER CONNECTOR B			
<u>Pin</u>	<u>Function</u>	<u>Pin</u>	<u>Function</u>
A	PH 1 Phase Next	AA	Overlap A Green
B	*	BB	Overlap B Yellow
C	PH 2 Next	CC	Overlap B Red
D	PH 3 Green	DD	Overlap C Red
E	PH 3 Yellow	EE	Overlap D Yellow
F	PH 3 Red	FF	Overlap C Green
G	PH 4 Red	GG	Overlap B Green
H	PH 4 Ped Clear	HH	Overlap C Yellow
J	PH 4 Don't Walk		
K	PH 4 Check		
L	PH 4 Veh Call Det		
M	PH 4 Ped Call Det		
N	PH 3 Veh Call Det		
P	PH 3 Ped Call Det		
R	PH 3 Phase Omit		
S	PH 2 Phase Omit		
T	PH 5 Ped Omit		
U	PH 1 Phase Omit		
V	Ped Recycle (Ring 2)		
W	*		
X	*		
Y	PH 3 Walk		
Z	PH 3 Ped Clear		
a	PH 3 Don't Walk		
b	PH 4 Green		
c	PH 4 Yellow		
d	PH 4 Walk		
e	PH 4 Phase ON		
f	PH 4 Phase Next		
g	PH 4 Phase Omit		
h	PH 4 Hold		
I	PH 3 Hold		
j	PH 3 Ped Omit		
k	PH 6 Ped Omit		
m	PH 7 Ped Omit		
n	PH 8 Ped Omit		
p	Overlap A Yellow		
q	Overlap A Red		
r	PH 3 Check		
s	PH 3 Phase ON		
t	PH 3 Phase Next		
u	Overlap D Red		
v	*		
w	Overlap D Green		
x	PH 4 Ped Omit		
y	Spare 5		
z	Max II (Ring 2)		

*User Assigned

CONTROLLER CONNECTOR C			
<u>Pin</u>	<u>Function</u>	<u>Pin</u>	<u>Function</u>
A	Coded Status Bit A (Ring 2)	AA	PH 6 Ped Clear
B	Coded Status Bit B (Ring 2)	BB	PH 6 Check
C	PH 8 Don't Walk	CC	PH 6 Phase ON
D	PH 8 Red	DD	PH 6 Phase Next
E	PH 7 Yellow	EE	PH 7 Hold
F	PH 7 Red	FF	PH 8 Check
G	PH 6 Red	GG	PH 8 Phase ON
H	PH 5 Red	HH	PH 8 Phase Next
J	PH 5 Yellow	JJ	PH 7 Walk
K	PH 5 Ped Clear	KK	PH 7 Ped Clear
L	PH 5 Don't Walk	LL	PH 6 Walk
M	PH 5 Phase Next	MM	PH 7 Check
N	PH 5 Phase ON	NN	PH 7 Phase ON
P	PH 5 Veh Call Det	PP	PH 7 Phase Next
R	PH 5 Ped Call Det		
S	PH 6 Veh Call Det		
T	PH 6 Ped Call Det		
U	PH 7 Ped Call Det		
V	PH 7 Veh Call Det		
W	PH 8 Ped Call Det		
X	PH 8 Hold		
Y	Force-off (Ring 2)		
Z	Stop Timing (Ring 2)		
a	Inhibit Max Term (Ring 2)		
b	Spare 1		
c	Coded Status Bit C (Ring 2)		
d	PH 8 Walk		
e	PH 8 Yellow		
f	PH 7 Green		
g	PH 6 Green		
h	PH 6 Yellow		
I	PH 5 Green		
j	PH Walk		
k	PH 5 Check		
m	PH 5 Hold		
n	PH 5 Phase Omit		
p	PH 6 Hold		
q	PH 6 Phase Omit		
r	PH 7 Phase Omit		
s	PH 8 Phase Omit		
t	PH 8 Veh Call Det		
u	Red Rest Mode (Ring 2)		
v	Omit All Red (Ring 2)		
w	PH 8 Ped Clear		
x	PH 8 Green		
y	PH 7 Don't Walk		
z	PH 6 Don't Walk		

CONTROLLER CONNECTOR D			
<u>Pin</u>	<u>Function</u>	<u>Pin</u>	<u>Function</u>
A		AA	
B		BB	
C		CC	
D		DD	
E		EE	
F		FF	
G		GG	
H		HH	
I		JJ	
J		KK	
K		LL	
L		MM	
M		NN	
N		PP	
P			
Q			
R			
S			
T			
U			
V			
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Pins are user defined, and are to be wired.

623 T.02.04 LOOP DETECTORS:

- (a) **General.** The term "loop detector" applies to a complete and operating installation consisting of a loop or loops installed in the roadway in accordance with the plans and specifications, a sensor unit with solid state switching output, and a power source. Loop detectors shall meet the requirements and operate in accordance with the latest edition of the NEMA Standards Publication No. TS1. In addition, the following requirements must be met:
- (1) All detectors shall give a constant output with an "open" or failed loop.
 - (2) All detectors shall be of "shelf mounted" or the "rack mounted" variety, depending upon contract provisions.
 - (3) All detectors must come fitted with a fully functional LCD display that is used for both monitoring and programming purposes.
 - (4) All programming must be accomplished with the cover left intact, preferably through the display.
 - (5) The LCD shall display the complete status of the connected loop, which includes but is not limited to the loop inductance, the loop frequency, and the accumulated number of loop failure incidents.
 - (6) There must be fully functional delay/extend functions incorporated into the programming. There must also be a phase green override input on the detector.
 - (7) Presence or pulse modes of operation are required in each detector.
 - (8) There shall be two or four channels per each loop detector, per contract special provisions.

Loop wires shall be installed after the final layer of asphalt concrete and before any seal coat. The loop or loops shall be installed in slots cut in the pavement and shall be oriented and color-coded or taped in accordance with the Standard Drawings and plans. Sawed slots shall be blown clean of all loose material and dried. Loop wire shall be carefully placed into slot, avoiding damage to the wire insulation. When more than one loop terminates in a pull box, each loop shall have a separate sawed slot for its leads and leads shall be properly marked as shown on the Standard Drawings. A minimum of 5 feet (1.5 meters) shall be provided at both ends of the loop wire to be coiled and stored in the pull box. Sawed slots shall be spaced a minimum of six (6) inches (150 millimeters) apart. The loop system shall be wired with a cable-in-duct assembly, No. 12 AWG minimum, meeting IMSA Specification No. 51-5 as indicated in the Standard Drawings. The loop lead-in cable shall be one (1) pair No. 12 AWG per IMSA Spec. No. 19-2 or 20-2. Each loop system shall have a separate lead-in to the controller cabinet. All loops shall be megohmmeter tested.

(b) Slot Sealant Tests and Acceptance

1. **Insulation Test.** Insulation tests for each loop to ground shall be in accordance with the latest edition of the NEMA Standards Publication No. TS-1. Insulation test between loops shall not be less than 5 meg ohms.
2. **Sensitivity Test.** The completed loop detector shall be capable of detecting any vehicle that may be licensed by the State of Nevada.

(c) **Installation of Inductive Detector Loop Sealant.** Detector loop sealant shall be either a two component epoxy, or a polyurethane material that cures in the presence of moisture or a hot-melt, rubberized asphalt material and which conforms to the following specifications. Sealant shall be suitable for use in both asphalt concrete and Portland cement concrete pavements.

(1) **Two Component Epoxy Composition:**

Component A	Parts by Weight
Epoxy Resin, Araldite 6010	100.00
Nonyl Phenol	20.00
Alkylbenzene, Alkylate 31	20.00
Titanium Dioxide, Titanox 2015	1.62
Colloidal Silica, Cabosil	3.00
Glycerine	0.5
Silicone Anti-foam, G.E. Viscasil	0.01
Component B	Parts by Weight
Poly Mercaptan, Dion 3800 L C	40.00
N-Aminoethylpiperazine	17.00
2,4,6 - Tri (dimethylaminomethyl) Phenol	2.00
Furnance Black	0.03
Nonyl Phenol	34.60
Alkylbenzene, Alkylate 31	34.60
Colloidal Silica, Cabosil	4.00
Glycerine	0.50
Silicone anti-foam, G.E. Viscasil	0.01

Characteristics of Adhesives:

Component A

Viscosity, Poise, Brookfield	150-300
Shear Index	2.5 minimum

Component B

Viscosity, Poise, Brookfield	100-250
Shear Index	2.0 minimum

Characteristics of Compounded Adhesive:

Gel Time, Minutes	13 to 16
On 1/8 inch cast sheet, cured 18 hours at 77 degrees F. plus 5 hours at 158 degrees F.:	
Tensile Strength Minimum	700 psi
Elongation, Percent, Minimum	70
Shore D Hardness, Minimum	50
Color shall match Federal Standard No. 595. The color range shall be 26081 to 26173.	

(2) **Polyurethane Sealant**

Property and Results

Hardness (indentation)--65-85

Tensile Strength--500 psi
(minimum)

Elongation--400%, minimum
Flex at -40 degrees F--no cracks

Weathering Resistance--
Slight Chalking

Salt Spray Resistance--500 psi,
minimum tensile; 400% minimum
elongation

Dielectric Constant--Less than
25% change over a temperature
of -30 degrees C to 50 degrees C

Chemical Resistance

Chemical and Results
De-Icing Chemical--No Effect
Gasoline--Slight Swell
Hydraulic Brake Fluid--No Effect
Motor Oil--No Effect
Calcium Chloride (5%)--No Effect

Measuring Standard and Conditions

ASTM D 2240 Rex Type A, Model 1700
77 degrees F (25 degrees C) 50% relative humidity

ASTM D 412 Die C, pulled at 20 IPM

ASTM D 412 Die C, pulled at 20 IPM
25 mil Free Film Bend (180 degrees C) over
1/2" Mandrel

ASTM D 822 Weatherometer 350 hrs.
Cured 7 days at 77 degrees F (25 degrees C) 50%
relative humidity

ASTM B 117, 28 days at 100 degrees F(38 degrees C)
5% NaCl, Die C, pulled at 20 IPM

ASTM D 150

Test Method

ASTM D 471
ASTM D 471
ASTM D 471
ASTM D 471
ASTM D 471

Tests conducted on deaerated, 20 mil (0.020"), dry film liquid immersion. 28 days at 77degrees F (25 degrees C).

(3) **Hot-Melt, Rubberized Asphalt Sealant**

Property and Limits	Measuring Standard and Conditions
Cone Penetration -- 20 - 35 (1/10 mm.) max.	ASTM D5 77 degrees F., 150 g., 5 sec.
Flow -- 5 mm. maximum	ASTM D 3407, Section 6, 140 degrees F.
Property and Limits	Measuring Standard and Conditions
Resilience --60% minimum	ASTM D3405, 77 degrees F.
Softening Point - 20 0 degrees F.	ASTM D 36
Ductility -- 30 - 55 centimeters	ASTM D 113, 77 degrees F., 5 cm./sec.
Flash Point -57 5 degrees F.	ASTM D 92, COC
Viscosity -- 2500 - 3500 centipoise (Brookfield)	ASTM D 3236 375 degrees F.

TRAFFIC SIGNALS AND FITTINGS

623 T.02.05 VEHICLE SIGNAL FACES: All vehicle signal faces shall consist of individual signal sections rigidly fastened together. Each section shall have a separate and complete housing. The actual number and type of sections shall be shown on the plans and in accordance with the Standard Drawings. Vehicle signal face shall be installed as indicated on the plans. All vehicle signal faces shall be mounted onto their supports by mounting assemblies in accordance with the requirements of the Standard Drawings. All new vehicle signal faces installed at any one intersection shall be the product of the same manufacturer.

- (a) **Optical Units.** Each optical unit shall consist of a lens, a reflector or reflector assembly, a lamp receptacle, and a clear traffic signal lamp. Lenses, reflectors, reflector assemblies, lamp receptacles and wiring, and candlepower distribution shall conform to the provisions in ANSI Standard D-10.1. Reflectors shall be made of silvered glass or of specular aluminum with an anodic coating. All reflectors shall conform to the provisions in ANSI Standard D-10.1.

- (b) **Red Light Display Detector.** When specified, a red light display detector shall be provided. The agency will give exact field placement and installation procedures.
- (1) Specifications
- Physical dimensions - 2.5" x 3" x 1.5"
 - Power requirement - 120VAC at 2.5 watts
 - Multi-directional capabilities.
 - Visibility at distance of approximately 150 to 250 yards.
 - One year warranty on all parts from date of installation.
- (2) Installation
- Drill one (1) 25/64 hole in the traffic signal head on which the RLD is to be mounted.
 - Utilizing a 1/8" brass pipe and fitting, mount the RLD and aim toward direction of viewing.
 - Wire into the signal head red indication following standard N.E.C.
 - Seal all openings with an outdoor silicone sealant to prevent moisture and dust from entering the signal head and RLD.
- (c) **Lamp receptacles** shall be as specified in Subsection 623 T.02.05 (d), "Electrical Components." Lenses may be made of either glass or an ultraviolet stabilized polycarbonate plastic conforming to the specifications of ASTM Designation D 2473. Plastic lenses shall not distort due to heat from the highest wattage lamp meeting the requirements specified below. Lamps for vehicular signal faces shall conform to the Institute of Traffic Engineers "Standard for Traffic Signal Lamps" and the following. Lamps for the eight (8) inch (200 millimeters) faces shall be 655 lumen rated initial output, 120 volt (60 watt), 8,000 hour rated life, clear, traffic signal lamps. Lamps for the twelve (12) inch (300 millimeters) faces shall be 1,950 lumen rated initial output, 120 volt (165 watt), 8,000 hour rated life, clear, traffic signal lamps.
- Krypton-filled, energy-saving lamps must have no less than 80% of total fill gas as Krypton. Energy-saving lamps for the eight (8) inch (200 millimeters) faces shall be 610 lumen rated initial output, 120 volt (60 watt), 8,000 hour rated life, clear, traffic signal lamps. Lamps for the twelve (12) inch (300 millimeters) faces shall be 1,750 lumen rated initial output, 120 volt (135 watt), 8,000 hour rated life, clear, traffic signal lamps.
- (d) **Housing.** Each signal section housing shall be either die-cast or permanent mold-cast aluminum conforming to ANSI Standard C-10.1. Maximum height of a signal section shall be ten (10) inches (250 millimeters) for each eight (8) inch (200 millimeters) section and 14-1/16 inches (357 millimeters) for each twelve (12) inch (300 millimeters) section. Each section shall be complete with a one-piece, hinged door mounting for the lens and other parts of the optical system, watertight gaskets, and a simple door-locking device. The optical system shall be so mounted that the various parts may be swung open for ready access or removal. The sections shall be interchangeable and so constructed that sections can be removed or added. There shall be an opening in the top and bottom of each section to receive a 1-1/2 inch (38 millimeters) pipe. All

exposed bolts, screws, hinge pins, and door-locking devices shall be stainless steel. All interior screws and fittings shall be stainless steel or approved non-ferrous, corrosion-resistant material. All gaskets, including door, lens and reflector gaskets, but not including lampholder gaskets, shall be of neoprene. Lampholder gaskets shall be of material not affected by heat. The lampholder gasket will not be required when the lampholder is not in direct contact with the reflector. Each signal section shall be constructed in such a manner that structural failure of the housing will not occur with a wind load pressure of 25 pounds per square foot (1.2 KPa) on the projected area of the complete signal face housing, including backplate and visors. Any fracture within the housing assembly or a deflection of more than half the lens diameter of the signal section will be considered structural failure.

- (e) **Electrical Components.** Lamp receptacles and wiring shall conform to ANSI Standard D-10.1. Each lamp receptacle shall be wired with a white conductor connected to the shell of the lamp receptacle and a black or colored conductor to the bottom or end terminal of the lamp receptacle. These conductors shall, in turn, be connected to a terminal block mounted inside at the back of the housing. The terminal block shall have sufficient screw type terminals to terminate all field conductors and lamp conductors independently, with separate screws. The terminals to which field conductors are attached shall be permanently identified or conductors shall be color coded to facilitate field wiring. Lamp receptacle conductors shall be No. 18, or larger, 600 volt, appliance wiring material (AWM), with 30 mil thickness insulation rated 105 degrees C. or with insulation that conforms to Military Specification MIL W-16878 D, Type B, with vinyl nylon jacket rated 115 degrees C. The manufacturer's name or trademark, conductor size, insulation type letter designation and temperature rating shall be marked on the insulation.
- (f) **Visors.** Each section shall be provided with a removable, full-circle, metal visor conforming to ANSI Standard D-10.1 and the Standard Drawings, unless otherwise shown on the plans.
- (g) **Directional Louvers.** Where shown on the plans, directional louvers shall be furnished and installed in signal visors. Directional louvers shall be so constructed as to have a snug fit in the signal visors. The outside cylinder shall be constructed of 0.030 inch (0.8 millimeters) nominal thickness, or thicker, sheet steel or the cylinder and vanes shall be constructed of 3003 H14 aluminum alloy of equivalent thickness. Dimensions of louvers and arrangements of vanes shall be as shown on the plans.
- (h) **Backplates.** Where shown on the plans backplates shall be furnished and installed on signal heads. Dimensions, materials and installation details shall be as shown in the Standard Drawings. No background light shall show between the backplate and the signal face or between sections. Where a backplate consists of two or more sections, the section shall be fastened with rivets or with aluminum bolts peened after assembly to prevent loosening.
- (i) **Signal Mounting Assemblies.** Assemblies for the mounting of signal faces shall consist of 1-1/2 inch (38 millimeters) standard steel pipe and necessary fittings, slip-fitters and terminal

compartments. Each terminal compartment shall be fitted with a terminal block containing a minimum of 12 poles, each with 2 screw-type terminals. Each terminal shall be designed to accommodate at least 5 No. 14 conductors. A cover shall be provided on the compartment to give ready access to the terminal block. Where used to bracket-mount a signal the terminal compartment shall be designed to bolt securely to a pole or standard. The dimensions of mounting assembly members between the axis through the center of the terminal compartment, or slip-fitter, shall not exceed 11 inches (275 millimeters), except where required to provide proper signal face alignment or permit programming of programmed visibility signal faces or when otherwise directed by the Engineer. Each mounting assembly shall be oriented to provide maximum horizontal clearance to the adjacent roadway. All mounting assembly members shall be either plumb or level, symmetrically arranged and securely assembled. Construction shall be such as to permit all conductors to be concealed. Mounting assemblies shall be water-tight and free of sharp edges or protrusions which might damage conductor insulation. For post-top mounting of signals, a slip-fitter shall be used. Slip-fitter shall fit over a 4-1/2 inch (113 millimeters) outside diameter pipe or tapered standard end. Each slip-fitter shall be provided with cadmium-plated steel set screws, arranged as shown on the plans. Each slip-fitter used to post-top mount signals with brackets shall be provided with an integral terminal compartment. Each mounting assembly shall be provided with positive locking, serrated fittings which, when mated with similar fittings on the signal faces, shall prevent faces from rotating. Fittings shall permit fastening at increments of not more than 7 degrees. Signal faces shall not be installed at any intersection until all other signal equipment, including the controller, is in place and ready for operation at that intersection, except that the signal faces may be mounted if they are not directed toward traffic or if they are covered. During the time period between signal assembly erection and system turn-on, all signal assemblies shall be completely covered by use of six (6) mil minimum thickness black plastic bags.

- (j) **Internally Illuminated Street Name Signs.** Internally illuminated street name signs, when specified, shall be 8 feet (2.44 m) long, as indicated on the project drawings, by 22 5/16" (568 mm) high. Sign shall be weather-tight and consist of 6063 T-5 alloy aluminum housing with 0.078" (2 mm) minimum thickness and translucent plastic face plate composed of white wide-angle prismatic translucent reflective sheeting, reverse-screened with manufacturers' recommended green ink and clear coating, applied to a 0.060" (1.5 mm) gage polycarbonate clear substrate. Ballast shall be a 200 ma 120V ballast. Lamps shall be 430 ma cool white. Only one ballast per lamp may be used. Two lamps, spaced six inches apart, are required for each lighted sign.

623 T.02.06 PROGRAMMED VISIBILITY VEHICLE SIGNAL FACES: Each programmed visibility signal face and the installation thereof shall conform to the provision in Subsection 623 T.02.05, "Vehicle Signal Faces," and Subsection 623 T.02.05(g) "Backplates," and Subsection 623 T.02.07(k).05(h), "Signal Mounting Assemblies." Each programmed visibility signal section shall provide a nominal twelve (12) inch (300 millimeters) diameter circular or arrow indication. Color and arrow configuration shall conform to ANSI Standard D-10.1. Each section shall be provided with a sun visor. Each signal section shall be provided with an adjustable connection that permits incremental tilting from 0 to 10 degrees above or below the horizontal while maintaining a common vertical axis through couplers and mountings. Terminal connection shall permit external adjustment about the mounting axis in 5 degree increments. The signal shall be mountable with

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ordinary tools and capable of being serviced without tools. Adjustment shall be preset at 4 degrees below the horizontal, unless otherwise specified. The visibility of each programmed visibility signal face shall be capable of adjustment or programming within the face. When programmed, each signal face's indication shall be visible only in those areas or lanes to be controlled, except that during dusk and darkness a faint glow to each side will be permissible. Prior to programming, each signal section with a yellow indication shall provide a minimum luminous intensity of 3,000 candela on the optical axis, and a maximum intensity of 30 candela at 15 degrees horizontal from the axis. Each such signal section shall be capable of having its visibility programmed to achieve the following luminous intensities: a minimum of 3,000 candela on the optical axis, a maximum of 100 candela at from ½ to 2 degrees horizontal from the axis and a maximum of 10 candela at from 2 to 15 degrees horizontal from the axis. Under the same conditions, the intensities of the red indication and the green indication shall be at least 19 and 38 percent respectively of the yellow indication. Each signal face or each signal section shall include integral means for regulating its luminous intensity between limits in proportion to the individual background luminance. Lamp intensity shall not be less than 97 percent of uncontrolled intensity at 1000 footcandles, and shall reduce to 15 ±2 percent of maximum intensity at less than one footcandle. The dimming device shall operate over an applied voltage range of 95 to 130 volts, 60 Hz. and a temperature range of -40 to 165 degrees F. (-40 to 73.9 degrees C.). The Contractor shall have a manufacturer's representative program the heads.

623 T.02.07 PEDESTRIAN SIGNAL FACES: Each pedestrian signal face shall conform to the following: Messages shall be Lunar White "WALKING PERSON" and Portland Orange "HAND" conforming to the requirements of the Manual on Uniform Traffic Control Devices. Each pedestrian signal face shall be installed at the location and mounted in the manner shown on the plans. All new pedestrian signal faces installed at any one intersection shall be of the same make and type.

(a) **Types.** Pedestrian Signal faces shall be one of the following types:

TYPE A - Type A signals shall consist of internally illuminated symbols formed by painting the message plate except for the area forming the symbols. The message plate on which the symbols are formed shall be either 1/8 inch (3 millimeter) nominal thickness ultraviolet stabilized polycarbonate plastic with external prismatic pattern, or 3/16 inch (5 millimeter) nominal thickness ultraviolet stabilized plastic with extended prismatic pattern, or 1/8 inch (3 millimeter) nominal thickness glass fiber reinforced plastic. Each compartment shall be illuminated by one 69 watt, 120 volt, 69A21/TS incandescent traffic signal lamp with medium screw base.

TYPE B - Type B signals shall consist of internally illuminated symbols formed by painting the message plate except for the area forming the symbols. The message plate on which the symbols are formed shall be either 1/8 inch (3 millimeters) nominal thickness ultraviolet stabilized polycarbonate plastic with external prismatic pattern, or 3/16 inch (5 millimeters) nominal thickness ultraviolet stabilized acrylic plastic with external prismatic pattern, or 1/8 inch (3 millimeters) nominal thickness glass fiber reinforced plastic. The tubing shall extend horizontally across the compartments and be spaced to provide even illumination of letters symbols.

TYPE C - Type C signals shall conform to the provisions for Type B signals, except message plate and tubing shall be formed into an integral weatherproof plug-in module with a molded case of 3/32 inch

(2.5 millimeters) minimum thickness, white acrylonitrile butadiene styrene. The message module shall operate in the Type C pedestrian signal head. The module shall not require the use of tools for insertion or removal.

- (b) **Housing.** The housing shall be made of 3003 H14 die cast aluminum alloy with smooth finish on both sides. Thickness shall be 1/8 inch (3 millimeters) minimum at the points of support. The housing shall be corrosion resistant and shall provide for easy access to and replacement of all components. All machine screws, studs and washers shall be either nickel plated brass, stainless steel or other corrosion resistant material. Gaskets shall be provided as required to make the housing rain tight and dust tight. Gaskets shall conform to the provisions in ASTM Designation D 1056, Grade SBE42. The housing shall be provided with top and bottom openings for 1-1/2 inch (38 millimeters) pipe. Unused openings shall be closed with watertight closures painted to match the housing, as shown on the Standard Drawings. The housing construction design may be compatible with clamshell mounting hardware.
- (c) **Sun Phantoms.** A means to stop sun phantoms while not obscuring the image shall be employed and shall be approved by the Engineer. A full vertical divider strip shall be provided between the "HAND" and the "WALKING PERSON" indications.
- (d) **Conductors.** High voltage wiring between the gas discharge tubes and the secondary side of the transformer shall be made with Gas Tube Sign and Oil Burner Ignition Cable, Type GTO-15 labeled by U.L. Other conductors shall be No. 14, or larger, with 30 mils minimum thickness Type TW insulation.
- (e) **Disconnect Switch.** A fused switch consisting of 2 cartridge fuses and a lever for disconnecting the fuses for pedestrian signals shall be mounted within the signal housing to de-energize the transformer primary circuit.
- (f) **Terminal Block.** A light duty terminal block shall be mounted in the housing for field wiring.
- (g) **Tube Mounting.** Capped ends of gas tubing in Type B signals shall be mounted in approved heat resistant glass electrode housings.
- (h) **Finish.** The outside of the housing and hood shall be painted.
- (i) **Pedestrian Signal Mounting Assemblies.** Pedestrian signal housing may be mounted with clamshell mounting hardware modified to contain a twelve (12) pole terminal block with compression screw terminal pairs. For post top mounting of pedestrian signals a slip-fitter with an integral terminal compartment shall be used. The requirements for the hardware to post top mount pedestrian signals shall be the same as for post top mounting vehicle signals.

623 T.02.08 FLASHERS:

All flasher signal heads shall be a minimum 12 inch diameter lens.

- (a) **Visors.** Each flashing beacon shall be provided with a tunnel type visor.
- (b) **Flashing Beacon Control Assembly.** Each flashing beacon control assembly shall consist of switches, circuit breakers, terminal blocks, flasher, wiring and electrical components necessary to provide proper operation of the beacons, all housed in a single enclosure. The enclosure shall be as specified in the Special Provisions.
- (c) **Circuit Breakers and Switches.** A single-pole 15 ampere circuit breaker shall be installed to control each ungrounded conductor entering the enclosure. A switch to permit manual operation of the sign lighting circuit shall be provided. Switches shall be of the single-hole-mounting toggle type, single-pole, single-throw, rated at 10 amperes, 125 VAC. Switches shall be furnished with an indicating nameplate reading "Auto-Test" and shall be connected in parallel with the load contacts of the photoelectric control circuit. A 15 ampere circuit breaker may be used in place of the toggle switch.
- (d) **Flasher.** A 20 ampere solid state flasher shall provide for a 2 circuit alternate operation of beacons.
- (e) **Terminal Blocks.** Terminal blocks shall be rated at 25 amperes, 600 volts, shall be molded from phenolic material and shall be the barrier type with plated brass screw terminals and integral type marking strips.

623 T.02.09 STANDARD, STEEL PEDESTALS, AND POSTS:

- (a) Standards for traffic signals and roadway lighting, and steel pedestals for cabinets and other similar equipment shall be located as shown on the plans. Workmanship and finish shall be equal to the best general practice of the metal fabrication industry. All welding shall conform to AWS D 2.0, Specification for Welded Highway and Railway Bridges," and to the requirements in this Section.
- (b) Types of poles, length of mast arms and height of poles shall be as indicated on the Contract Drawings.
- (c) Standards and steel pedestals for controller cabinets shall be constructed of 0.120 inch (3 millimeters) or thicker steel or 4 inch (100 millimeters) standard pipe or conduit, with the top designed for post-top slip-fitter. Standard pipe shall conform to the specifications of ASTM Designations A 53 or A 120.

- (d) All ferrous metal parts of standards, with shaft length of 15 feet (4.6 meters) and longer, shall conform to the details shown on the standard drawings, and the following requirements:

Standards fabricated from 0.250 inch (6 millimeters) nominal thickness or thicker materials shall be fabricated from:

- (1) Sheet steel conforming to the specifications of ASTM Designation A 283, Grade D.
- (2) Sheet steel of weldable grade having a minimum yield, after fabrication, of 40,000 pounds per square inch (276 MPa).

Standards fabricated from 0.179 inch (4.5 millimeters) nominal thickness or thinner material shall be fabricated from sheet steel conforming to the specifications of ASTM Designation A 570, Grade C, or from sheet steel conforming to alternative (2) above. When material conforming to alternative (2) above is used, 0.120 inch (3 millimeters) nominal thickness, or thicker, steel may be used in lieu of 0.135 inch (3.5 millimeters) nominal thickness, or thicker steel.

Standards may be fabricated of full-length sheets or shorter sections. Each section shall be fabricated from not more than 2 pieces of sheet metal. Where 2 pieces are used, the longitudinal welded seams shall be directly opposite one another. When the sections are butt-welded together, the longitudinal welded seams on adjacent sections shall be placed to form a continuous straight seam from base to top of standard. The butt-welded transverse joints shall be strengthened by inserting a metal sleeve at each joint. The sleeve shall be 0.135 inch (3.5 millimeters) nominal thickness, or thicker, steel and made from steel having the same chemical composition as the steel in the standard. The metal sleeve shall have a minimum length of one inch (25 millimeters). The sleeve shall be centered at the joint and have the same taper as the standard with the outside of the sleeve in full contact with the inside of the standard throughout the sleeve length and circumference.

All welds shall be continuous.

The weld metal at the transverse joint shall extend to the sleeve, making the sleeve an integral part of the joint. Longitudinal welds in steel tubular sections will be tested for strength. All exposed welds, except fillet welds and welds on top of mast arms shall be ground flush with the base metal. All exposed edges of the plates which make up the base assembly shall be finished smooth and all exposed corners of such plates shall be neatly rounded to 1/8 inch (3 millimeters) radius, unless otherwise shown on the plans. Shafts shall be provided with slip-fitter shaft caps.

Standards shall be straight, with a permissive variation not to exceed one (1) inch (25 millimeters) measured at the midpoint of a 28.5 foot (7.62 meters), 30 foot (9.14 meters), or 35 foot (10.67 meters) standard and not to exceed 3/4 inch (19 millimeters) measured at the midpoint of an 18 foot (5.49

meters), 20 foot (6.10 meters) or 25 foot (7.62 meters) standard.

Mast arms for standards shall be fabricated from standard pipe, reamed, free from burrs, and without intermediate splices or coupling curved to the dimensions shown on the standard drawings and shall be provided with raintight connections to shafts. Standard pipe shall conform to the specifications of ASTM Designations A 53 or A 120.

Tie rods for mast arms for standards shall be manufactured of structural steel and pipe as shown on the Standard Drawings. Structural steel shall conform to the specifications of ASTM Designation A 36. Tie rods shall be provided with 2 nuts and 2 lock washers at each end.

Tie rods shall be installed with no kinks or bends.

- (e) The cast steel option for slip bases shall be fabricated from material conforming to the requirements of ASTM Designation A 27, Grade 70-40. Other comparable material may be used if written permission is given by the Engineer. The casting tolerances shall be in accordance with the Steel Founder's Society of America recommendations (green sand molding).
- (f) Material certifications consisting of physical and chemical properties, and radiographic films of the castings shall be filed at the manufacturer's office. These certifications and films shall be available for inspection upon request.
- (g) Anchor bolts shall conform to manufacturers specifications.
- (h) Handholes in the base of standards shall conform to the details shown on the Standard Drawings. Changes in configuration of mast arms will be permitted provided the mounting height and stability are maintained. Handholes shall face away from oncoming traffic.
- (i) Holes left in the shafts of existing standards, due to removal of equipment or mast arms, shall be repaired by welding in a suitable disk, grinding smooth, and painting as provided for repairing damaged galvanized surfaces. Welding shall be done only after all combustible materials have been removed.
- (j) All standards, steel pedestals and posts required to be galvanized shall be hot-dip galvanized per ASTM A 123.

623 T.02.10.01 LAS VEGAS AREA SYSTEM REQUIREMENTS: (When Specified)

- (a) **General.** The Contractor shall furnish each controller cabinet completely configured and equipped for its intended intersection with a local communications interface unit (LCIU) panel, communication unit,

and harnesses. The LCIU interface panel and harnesses are to be wired in accordance with the listing and wiring diagram shown on the following two (2) pages. The communication unit to be used shall be a Sonex Model PTC-122A configured for the Las Vegas Area Computer Traffic System.

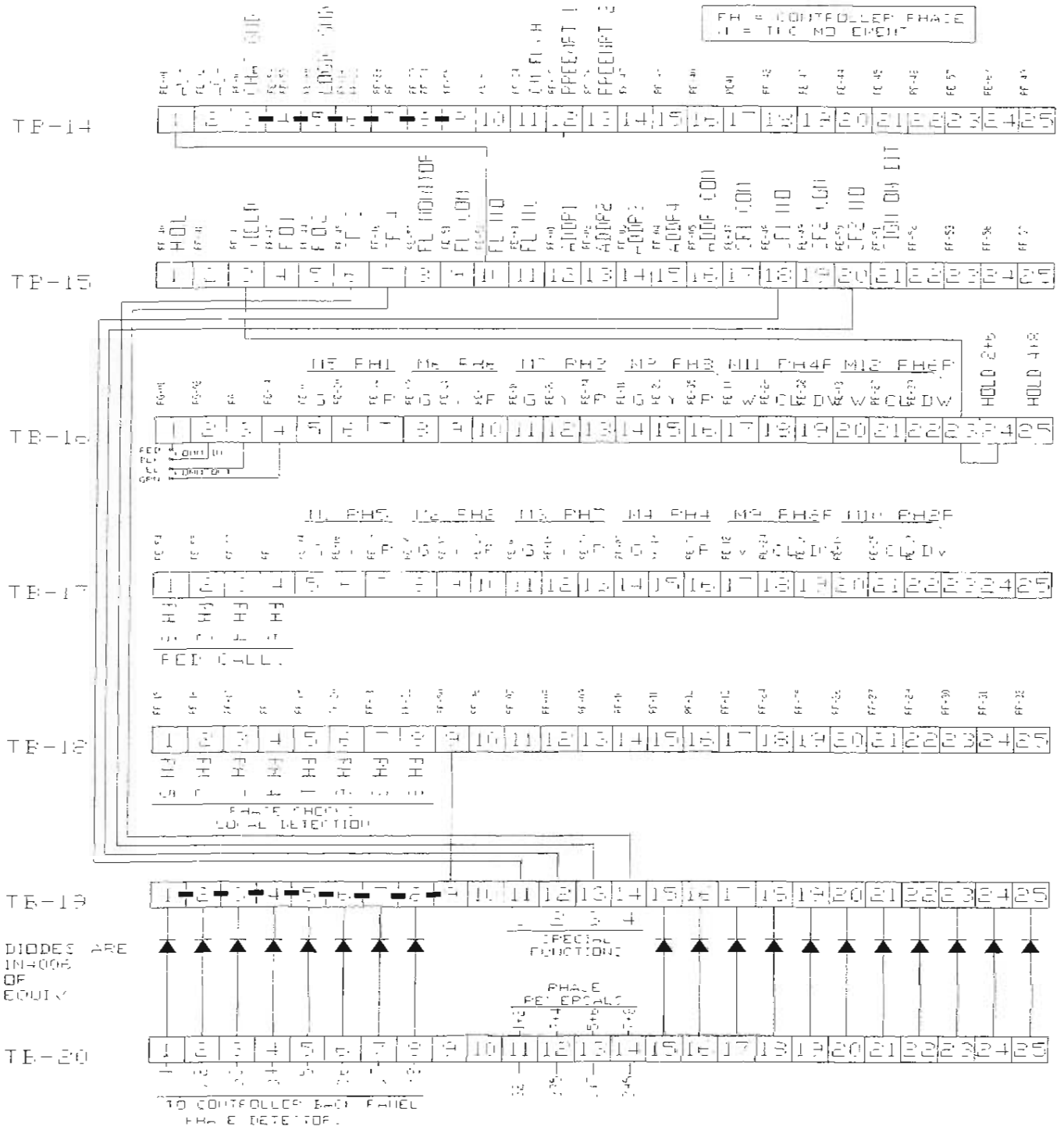
- (b) **LCIU Interface Panel.** The interface panel shall be constructed with the LCIU harnesses wired to the back of the panel, and the cabinet interface wiring to the front of the panel. The interface panel shall have 7 terminal strips having binder screws on the top and solder terminals underneath. All wires of the LCIU harnesses shall be terminated to the solder side of the terminal strips. The terminal strips shall be TRW Cinch Jones series 25-141-Y terminals or equivalent. The LCIU harnesses shall have 3 connector ends to mate with the Sonex PTC-122A unit. The connectors shall be AMP "CPC" series connectors, and wired as shown on LCIU connector plug function tables on the following two (2) pages.
- (c) **Interconnect Cable Termination.** Each controller cabinet shall have a telephone terminal block for terminating the system interconnect cable. The terminal block shall be a Reliable Electric #R66B4-25 or equivalent. The first set of terminals shall be used for the TMC phone; the second set shall be used for the JMC phone. The third set shall be data in, and the fourth set shall be data out. The cabinet shall have an ample number of terminal blocks to terminate all system interconnect cables for a given intersection. Each wire pair from the interconnect cable utilized in the cabinet shall have surge protectors installed to shunt power surges to ground (i.e. RX COMM. IN, TX COMM. OUT, VOICE (TMC), and VOICE (JMC)). The surge protector devices shall be TII #317A protectors or equivalent.

TRAFFIC SIGNALS AND STREET LIGHTING

PE - J1				PF - J2			
PIN	FUNCTION	FROM	TO	PIN	FUNCTION	FROM	TO
1.02e+08	+115 VAC	TB14-01		01	ADDRESS BIT 1	TB15-12	
	AC-	TB14-02		02	ADDRESS BIT 2	TB15-13	
	CHASSIS GROUND	TB14-03		03	ADDRESS BIT 3	TB15-14	
	1 GREEN (PH 5)	TB17-05		04	ADDRESS BIT 4	TB15-15	
	2 GREEN (PH 2)	TB17-08		05	ADDRESS BIT COM.	TB15-16	
06	3 GREEN (PH 7)	TB17-11		06	SYSTEM DET 1	TB18-10	
07	4 GREEN (PH 4)	TB17-14		07	SYSTEM DET 2	TB18-11	
08	5 GREEN (PH 1)	TB16-05		08	SYSTEM DET 3	TB18-12	
09	6 GREEN (PH 6)	TB16-08		09	SYSTEM DET 4	TB18-13	
10	7 GREEN (PH 3)	TB16-11		10	SYSTEM DET 5	TB18-14	
11	8 GREEN (PH 8)	TB16-14		11	SYSTEM DET 6	TB18-15	
12	9 WALK (PH 8)	TB17-17		12	SYSTEM DET 7	TB18-16	
13	10 WALK (PH 2)	TB17-20		13	SYSTEM DET 8	TB18-17	
14	11 WALK (PH 4)	TB16-17		14	LOGIC GROUND	TB14-06	
15	12 WALK (PH 6)	TB16-20		15	LOCAL DET 1 (PH 5)	TB18-01	
16	1 YELLOW (PH 5)	TB17-06		16	LOCAL DET 2 (PH 2)	TB18-02	
17	2 YELLOW (PH 2)	TB17-09		17	LOCAL DET 3 (PH 7)	TB18-03	
18	3 YELLOW (PH 7)	TB17-12		18	LOCAL DET 4 (PH 4)	TB18-04	
19	4 YELLOW (PH 4)	TB17-15		19	LOCAL DET 5 (PH 1)	TB18-05	
20	5 YELLOW (PH 1)	TB16-06		20	LOCAL DET 6 (PH 6)	TB18-06	
21	6 YELLOW (PH 6)	TB16-09		21	LOCAL DET 7 (PH 3)	TB18-07	
22	7 YELLOW (PH 3)	TB16-12		22	LOCAL DET 8 (PH 8)	TB18-08	
23	8 YELLOW (PH 8)	TB16-15		23	LOGIC GROUND	TB18-06	
24	9 DW FL (PH 8)	TB17-18		24	COUNT DET 1	TB18-18	
25	10 DW FL (PH 2)	TB17-21		25	COUNT DET 2	TB18-19	
26	11 DW FL (PH 4)	TB16-18		26	COUNT DET 3	TB18-20	
27	12 DW FL (PH 6)	TB16-21		27	COUNT DET 4	TB18-21	
28	1 RED (PH 5)	TB17-07		28	LOGIC GROUND	TB14-07	
29	2 RED (PH 2)	TB17-10		29	COUNT DET 5	TB18-22	
30	3 RED (PH 7)	TB17-13		30	COUNT DET 6	TB18-23	
31	4 RED (PH 4)	TB17-16		31	COUNT DET 7	TB18-24	
32	5 RED (PH 1)	TB16-07		32	COUNT DET 8	TB18-25	
33	6 RED (PH 6)	TB16-10		33	LOGIC GROUND	TB14-07	
34	7 RED (PH 3)	TB16-13		34	C.M.FL.(GND=FL)	TB14-11	
35	8 RED (PH 8)	TB16-16		35	PRE-EMT 1 IN	TB14-12	OD1-15
36	9 DW (PH 8)	TB17-19		36	PRE-EMT 2 IN	TB14-13	
37	10 DW (PH 2)	TB17-22		37	11 PED CALL (PH 4)	TB17-03	
38	11 DW (PH 4)	TB16-19		38	12 PED CALL (PH 6)	TB17-04	
39	12 DW (PH 6)	TB16-22		39	LOGIC GROUND	TB14-08	
40	OFFSET COMMAND	TB14-16		40	HOLD ON LINE (HOL)	TB15-01	
41	OFFSET 1	TB14-17		41	ADVANCE	TB15-02	
42	OFFSET 2	TB14-18		42	YIELD	TB15-03	TB16-23
43	OFFSET 3	TB14-19		43	FORCE OFF (R1)	TB15-04	
44	CYCLE COMMAND	TB14-20		44	FORCE OFF (R2)	TB15-05	
45	CYCLE 2	TB14-21		45	S.F. 3 (REV 1+2)	TB15-06	TB19-13
46	CYCLE 3	TB14-22		46	S.F. 4 (REV 5+6)	TB15-07	TB19-14
47	S.F. 1 COMMON	TB15-17	TB14-4	47	PRE-EMT 1 OUT	TB14-14	
48	S.F. 1 N.O. (REV 3+4)	TB15-18	TB19-11	48	PRE-EMT 2 OUT	TB14-15	
49	S.F. 2 COMMON	TB15-19	TB14-4	49	SPARE	TB14-25	
50	S.F. 2 N.O. (REV 7+8)	TB15-20	TB19-12	50	CALL ALL	TB18-09	
51	FLASH COM	TB15-09		51	SIGN ON BIT	TB15-21	
52	FLASH N.O.	TB15-10		52	SPARE	TB15-22	
53	FL.MON.(AC+ = FLASH)	TB15-08		53	SPARE	TB15-23	
54	9 PED CALL (PH 8)	TB17-01		54	LOGIC GROUND	TB14-08	
55	10 PED CALL (PH 2)	TB17-02		55	LOGIC GROUND	TB14-09	
56	AC-	TB14-02		56	SPARE	TB15-24	
57	SPARE	TB14-23		57	SPARE	TB15-25	
58	LOGIC GROUND	TB14-04			PHASE REV 1+2	TB20-11	
59	LOGIC GROUND	TB14-04			PHASE REV 3+4	TB20-12	
60	LOGIC GROUND	TB14-05			PHASE REV 5+6	TB20-13	
					PHASE REV 7+8	TB20-14	
616263	FLASH N.C.	TB15-11		PG - J3			
	+24 VAC	TB14-10		01	COMM INPUT	TB16-01	
	SPARE	TB14-24		02	COMM INPUT	TB16-02	
	HOLD 2+6	TB16-24		03	COMM OUTPUT	TB16-03	
	HOLD 4+8	TB16-25		04	COMM OUTPUT	TB16-04	

TRAFFIC SIGNALS AND STREET LIGHTING

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623T.02.10.02 GENERAL LAS VEGAS AREA SYSTEM REQUIREMENTS:

- (a) **Interconnect cable Termination:** Each controller cabinet shall have a telephone terminal block for terminating the system interconnect cable. The terminal block shall be a Reliable Electric #R66B4-25 or equivalent. The first set of terminals shall be used for the TMC phone, the second set shall be used for the JMC phone, the third set shall be data in, and the fourth set shall be data out.
- (b) The cabinet shall have an ample number of terminal blocks to terminate all system interconnect cables for a given intersection. Each wire pair from the interconnect cable utilized in the cabinet shall have surge protectors installed to shunt power surges to ground i.e. RX COMM. IN, TX COMM. OUT, VOICE (TMC), and VOICE(JMC). The surge protector devices shall be TII #317A protectors or equivalent.
- (c) **Interconnect Junction Cabinet:** The Interconnect Junction Cabinet shall be a Tesco Enclosure Class 22-000-NR (43" x 20" x 11") or approved equal, equipped with one (1) Reliable Electric No. R66B4-25 terminal block, or approved equal, having capacity for 25 pairs of No. 22 AWG wire. The terminal block shall be mounted on a painted wood panel secured to the back of the cabinet. The contractor shall provide and install a door lock with a key and all foundation, anchor bolts and hardware in accordance with instructions of the cabinet manufacturer.
- (d) **Preemption.** Intersection cabinets utilizing preemption equipment shall be wired in such a manner that the outputs wired to controller and cabinet functions which are common to the outputs of the LCIU shall have proper isolation devices (relay or diode) to prevent improper operation of either unit. Vehicular preemption unit output shall also be wired to the PRE-EMPT 1 (TB14-12) input to the LCIU for traffic system surveillance purposes.
- (e) **Controller Phasing.** It should be noted that for the LCIU inputs related to controller phasing (i.e., green, yellow, red, walk, pedestrian clearance, and don't walk), make reference to compass directions of an intersection rather than actual controller phases.

Controller phase outputs to LCIU inputs wiring for each intersection cabinet shall be based on the compass directions for an intersection. See the phasing table below for configuring all cabinets for a given intersection.

Controller Phase	Direction	LCIU Movement
1	North to West	5
2	Southbound	2
3	West to South	7
4	Eastbound	4
5	South to East	1
6	Northbound	6
7	East to North	3
8	Westbound	8
2 Ped	Southbound	10
4 Ped	Eastbound	11
6 Ped	Northbound	12
8 Ped	Westbound	9

Note that the phasing scheme for the LCIU Movement phase inputs DOES NOT correspond to the Standard NEMA Specifications for controller phasing.

For each intersection, a conversion must take place in the wiring of the LCIU phase return inputs vs. the controller phase outputs. This wiring conversion shall take place on the phase return input terminals of the LCIU Interface Panel.

Intersection controller phasing shall be as defined in Subsection 623 T.02.01(e) or the Special Provisions.

(f) System Control Functions.

Hold on line (H.O.L.): The hold on line output shall be wired to the Max Inhibits 1 and 2 of the controller, and the Call to Non-Actuated 1 input of the controller.

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Yield: The yield output shall be wired to the hold inputs for controller phases (2 and 6) or (4 and 8) jumper selectable on the terminal block TB16-23/24/25, refer to communication panel drawing on previous page for proper wiring). The yield output shall be active only when the H.O.L. output is active. The yield condition shall be a release of the hold inputs to the controllers.

Force-Off 1 and 2: The Force-Off outputs shall be wired to the Force-Off inputs 1 and 2 of the controller.

Call All: This output shall be wired through isolation diodes to the Vehicle Call inputs for all phases of the controller. Refer to Subsection 623 T.02.10(e).

Special Function 1, 2, 3, and 4: Refer to communication panel drawing on previous page for proper wiring.

Flash Command: This output shall be wired to the Flash Control line of the cabinet. When this output is active (AC+), the intersection cabinet shall be put in a "flash" mode.

Walk Rest Modifier: This controller input shall be wired to logic ground in the cabinet.

Terminated Functions: The following LCIU output functions shall be terminated on the LCIU interface panel for the capability of future use: Offset Command, Offset 1, Offset 2, Offset 3, Cycle Command, Cycle 2, Cycle 3, Special Function 1 and 2 relay outputs, and Advance.

- (g) **Controller Sequence Reversal:** Dual ring controllers shall be capable of phase sequence reversal by applying a ground true signal to connector B. Applying ground true signal to pin B shall cause the controller to reverse sequence phases 1 and 2 (lead-lag). Applying ground true signal to pin W shall cause the controller to reverse sequence phase 3 and 4 (lead-lag). Applying ground true signal to pin X shall cause the controller to reverse sequence phase 5 and 6 (lead-lag). Applying ground true signal to pin y shall cause the controller to reverse sequence phase 7 and 8 (lead-lag). Applying ground true signal to both pins B and X simultaneously shall cause the controller to sequence to phases 2 and 6 before phases 1 and 5 (lagging left turns). Applying ground true signal to both pins W and y simultaneously shall cause the controller to sequence to phases 4 and 8 before phases 3 and 7 (lagging left turns).
- (h) **System Control.** A controller operating in a CALL to Non-Actuated mode 1 or 2, with the phase hold active, and the walk rest modifier input active, shall rest in a walk dwell condition until a yield (release of the phase hold input). Upon a yield the controller shall be capable of timing the pedestrian clearance interval followed by the vehicle clearance interval, and all red interval without the need for other input control such as a force-off. The controller shall be capable of responding to yield durations of 500 milliseconds and perform the said function.

- (i) **Inputs and Outputs.** Inputs and outputs related to external devices in the cabinet shall be related to the pin assignments prescribed by NEMA and shall not require cabinet modification for interchangeability with NEMA controllers. Any special functions required for controller operation shall utilize spare pins in the input/output connectors as specified by NEMA.
- (j) **System Monitoring Functions.** Attention should be given to the input signal level for the inputs of the LCIU. Both D.C. and A.C. inputs are used, following is a list of inputs and their required levels:

D.C. Inputs, Ground True

36	Phase Returns (green, yellow, red, pedestrian)
1	Pre-empt 1
1	Pre-empt 2
1	Conflict Flash
4	Pedestrian Calls
8	Local Detectors
8	System Detectors
8	Counter Detectors

A.C. Inputs (115 VAC)

1	Controller Flash
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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.

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).

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- (c) Pre-travel shall be one sixty-fourth (1/64) inch (0.4 millimeter) maximum.
- (d) Over-travel shall be seven thirty-seconds (7/32) inch (5.5 millimeter) minimum.
- (e) Differential travel shall be four ten-thousandths (0.0004) to two one-thousandths (0.002) inch (0.01 to 0.05 millimeter).

Push buttons shall be 2 inch (51 millimeter) minimum diameter.

Where a pedestrian push button is attached to a pole, the housing shall be shaped to fit the curvature of the pole and secured to provide a rigid installation. Saddles shall be provided to make a neat fit when required.

Where a pedestrian push button is to be mounted on top of a two and one-half (2 ½) inch (63 millimeter) diameter post, the housing shall be provided with a slip-fitter fitting and screws for securing rigidly to the post.

Push button and sign shall be installed on crosswalk side of the pole.

Arrows on push button sign shall point in same direction of corresponding crosswalk.

Mounting height of the pedestrian push button shall be per the latest published edition of the ADA Guidelines.

623 T.02.12 EMERGENCY VEHICLE PRIORITY CONTROL SYSTEM (INTERNAL PREEMPTION):

- (a) **System Description.** The system employs data-encoded optical communication to identify the presence of designated priority vehicles, cause the traffic signal controller to initiate a specific preprogrammed preemption procedure, and if required by the Engineer, record the vehicle by classification and identification number at particular intersections. The matched set of components which make up the system will cause the existing traffic controller to be manipulated upon recognition of the signal from the vehicle. This communication is effective to the optical detectors at or near the intersection over a line-of-sight path. The system shall require no action of the vehicle operator other than the operation of the "emitter ON" switch located in the vehicle. The switch is to remain "ON" until the end of the emergency run. The system shall operate on a first-come, first-served basis or on a selected priority. The higher priority requests will override lower priority requests. The system shall be designed to yield to other priority demands such as railroad drawbridge etc. The system shall interface with existing traffic signal controllers without compromising normal operation or existing safety provisions. The Priority Control System shall consist of a data-encoded optical emitter, optical detectors, optical detector cable, and priority control unit.
- (b) **Matched System Components.** To assure desired performance, the system shall provide the synergy of the four principal components, matched and proven through integrated testing and extensive functional experience. The matched component system shall offer compatibility with all types of traffic signal controllers. Matched components provide future compatibility of all priority control elements.

- (1) **Data-Encoded Optical Emitter.** Shall be a compact, lightweight, weatherproof, light-emitting device with internal, regulated power supply designed to produce high intensity optical energy in visible and infrared wavelengths as well as encoded pulses that carry vehicle class and ID number information, from a single source, precisely timed by a crystal controlled circuit.
 - (2) **Optical Detector.** Shall be a light-weight, weatherproof, adjustable, bi-directional optical detector assembly. Internal circuitry shall transform optical energy from the optical emitter assembly into electrical signals for delivery (up to 1000 feet (305 meters) via optical detector cable to the priority control unit.
 - (3) **Optical Detector Cable.** Shall be a durable, shielded, 3-conductor cable with a drain wire and the necessary electrical characteristics to carry power to the optical detector from the priority control unit and to carry the optical detector signal to the priority control unit.
 - (4) **Priority Control Unit.** This equipment shall provide interface between the optical detectors and the cabinet controller unit and provide the following functions while not compromising the existing fail-safe provisions:
 - (a) Sufficient Power to all optical detectors required for the intersection.
 - (b) Differentiation of signals by optical detectors from one or more emitters on a first-come, first-served basis.
 - (c) Output signals to the cabinet controller to cause a preemption sequence to display the desired phase green for the approaching emergency vehicle.
 - (d) All input and output wires of the priority control system to be terminated on a separate panel then wired to the controller back panel.
 - (e) Smooth transition to non-priority operation upon passage of the vehicle through the intersection.
 - (f) As required by the Engineer at designated intersections, storing up to 100 of the most recent priority control calls in non-volatile memory and retaining the record if power terminates.
- (c) **System Operation.**
- (1) Priority control system shall be activated by an optically transmitted signal capable of recognizing and discriminating an Optical Emitter flash rate of (Class II) $14.0359 \text{ Hz} \pm 0.0039 \text{ Hz}$ from a single light source or upon the actuation of a test switch or remote call signal to the phase selector.
If a second class of preemption is used, it shall respond to a flash rate of (Class I) $9.63855 \text{ Hz} \pm 0.0014 \text{ Hz}$.
 - (2) The system shall cause the traffic controller to select from normally available green phases by activation of a combination of its inputs such as:
 - (a) channel "A" active
 - (b) channel "B" active

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- (c) channel "C" active
- (d) channel "D" active
- (3) The system shall not require modification or replacement of the existing controller unit beyond adding the necessary system hardware.
- (4) The system shall maintain adequate minimum traffic signal displays when priority control is active.
- (5) The system shall provide for up to 3 optical detectors to be connected to each channel to accomplish the following:
 - (a) To provide adequate optical emitter detection range to allow sufficient time to deliver the desired traffic signal display in accordance with the minimum times required to terminate non-desired traffic signal displays.
 - (b) To provide continuous line-of-sight contact between the data-encoded emitter and the optical detector units.
- (6) Abnormal sequence of traffic signal displays will not occur.
- (7) Transitions from green to red without the appropriate clearance intervals will not occur.
- (8) The system shall allow the traffic signal controller to resume normal timing operation after the desired signal display is obtained and optical signals have ceased for an appropriate period.
- (9) The system shall not attempt controller manipulation nor retain priority vehicle calls during periods of "Intersection Flash" operation.

(d) System Component Specification.

(1) Data-encoded Optical Emitter.

- (a) The flash signal shall consist of a frequency base signal and a coded overlay signal that can be used to transmit information.
- (b) The flash sequence generated by the data-encoded emitter shall carry three types of information:
 - (1) The base frequency as established in Subsection 623 T.02.12 (c)(1).
 - (2) The vehicle classification and identification code. The data-encoded emitter shall be capable of setting a minimum of 10 different classifications with 1000 different identification numbers per class for each priority.
 - (3) Intersection detection range setting.
- (c) The data-encoded emitter will conduct self-diagnostics designed to check for missing pulses.
- (d) The data-encoded emitter will be equipped with a disable input that, when activated, will cease unit operation, thereby eliminating the possibility of inadvertent signal transmission after the priority vehicle has arrived at its destination.

(2) Optical Detector.

- (a) The optical detector shall be a lightweight, weatherproof device capable of sensing and transforming pulsed optical energy into electrical signals usable by the phase selection

- equipment.
- (b) The unit shall be high-impact polycarbonate construction with non-corrosive hardware.
 - (c) The unit shall be designed for simple mounting at or near an intersection on mast arm, pedestal, pipe, or span wire.
 - (d) The unit shall accept optical signals from four directions (northbound, southbound, eastbound, and westbound) and each shall provide an electrical output signal.
 - (e) The unit shall include a design feature to allow aiming of the two optical sensing inputs for skewed approaches or slight curves, and may be field verified.
 - (f) The unit shall be responsive to the optical emitter at a distance of 1800 feet (550 meters).
 - (g) The unit shall be capable of providing the necessary electrical signal to the priority control unit through up to 1000 feet (305 meters) of optical detector cable.
- (3) **Optical Detector Cable.** The cable must guarantee delivery of the necessary quality signal from the optical detector to the phase selector over a non-spliced distance of 1000 feet(305 meters).The cable shall have 3 No. 20 AWG (minimum gage) stranded copper conductors and one bare, individually tinned, copper color coded as follows:
- (a) Orange for delivery of optical detector power (+)
 - (b) Bare for optical detector power return (-)
 - (c) Yellow for optical detector signal
 - (d) Blue for a second optical detector signal
- (4) **Priority Control Equipment.** The Emergency Vehicle Priority Control System shall be a self-contained stand alone unit which shall recognize input signals for up to four separate channels of emergency vehicle preemption and to contain the following major parts:
- (a) A card rack which shall contain the power supply (to be powered from AC mains in cabinet, and contain its own internal power supply to feed Optical Detectors), plug-in card edge connectors, appropriate plugs and connector harnesses to connect the whole unit to the cabinet wiring assembly.
 - (b) **Priority Control Discriminator Plug-in Module:** This module Unit shall be a plug-in four-channel device designed to be used with optical Emitters and Detectors. It shall be capable of recognizing and discriminating Optical Emitter flash rates, as described in Subsection 623T.02.12 (c), "System Operations", via Optical Detectors connected to each channel. If required by the Engineer in contract provisions at particular intersections, a data-encoded module may be used which is capable of recognizing and distinguishing data-encoded optical signals and shall meet the following requirements:
 - (1) Programming and retrieving the data stored shall be accomplished using an IBM PC-compatible computer. Unit shall have the capability of storing 100 of the most recent calls. Each record entry shall include information as follows:
 - * Classification
 - * Identification Number

- * Priority level
- * Direction
- * Call Duration
- * Final greens at end of call
- * Duration of final greens
- * Time and date call ended (second, minute, hour, day, month, year)
- * Intersection near or far, indicating passage of the priority vehicle through the intersection

- (2) Unit shall be capable of three levels of discrimination of data-encoded optical signals as described in 623 T.02.12 (d)(1)(b).
- (3) Interface with the cabinet shall be wired as described in 623T.02.02

(e) **Reliability.** All equipment supplied as part of the optical priority remote traffic control system intended for use in the controller cabinet shall meet the electrical and environmental specifications spelled out in the NEMA standards publication TS2, Type 2 or later version.

623T.02.13 TRAFFIC SIGNAL VIDEO IMAGE DETECTION SYSTEMS: (Agency Specified)

623 T.02.14 UNINTERRUPTIBLE POWER SUPPLY SYSTEMS: (When Specified)

- (a) **General:** Uninterruptible Power Supplies (UPS) are used to operate the traffic signal upon the loss of source power to the traffic signal controller, cabinet, and equipment. These are also referred to as "battery backups." The units shall conform to the following specifications:
- (1) The entire UPS shall be able to installed in its entirety inside a type "R" traffic signal cabinet. It could be a shelf or wall mounted unit, not a rack mounted unit.
 - (2) All units must be rated from -40°C to 74°C. This includes both the batteries and the microprocessing control units.
 - (3) The output of the UPS must be pure, sinusoidal power. "Square Wave Power" or "Step-Wave" power will not be acceptable.
 - (4) All systems must come supplied with maintenance-free batteries that will be used to operate the unit in power outage situations. The typical run time for the batteries supplied shall be 8 hours with a 300 watt load placed on it.
 - (5) The operating mode of any UPS utilized in power failure situations shall be flashing red for the traffic signal, while still providing true sine-wave power for the modem or communication devices.
- (b) (1) AC Line input switch/circuit breaker.
(2) DC Battery output switch/circuit breaker.
(3) AC Input safety fuse.
(4) AC Power pilot light.

- (5) Load #1 flasher pilot light.
- (6) Load #2 flasher pilot light.
- (7) Time Delay dip switches.
- (8) Battery Event Counter w/Manual Reset.
- (9) Battery run timer.
- (10) Battery Voltmeter (optional).
- (11) Convenience Receptacle (optional).

CONSTRUCTION

623 T.03.01 PAINTING:

- (a) The stainless steel latching devices shall not be painted. The preparation and finishing of new equipment shall be as follows:
- (b) Galvanized and non-ferrous surfaces to be painted, shall be cleaned and coated with Vinyl Wash Primer. Ferrous metal surfaces shall be cleaned and immediately coated with the primer specified in Subsection 714.03.01(b).
- (c) If an approved primer coat has been applied by the manufacturer and is in good condition, additional primer application by the Contractor, other than for repairs, will not be required.
- (d) All traffic signal standards shall be steel poles which have been hot-dip galvanized by the manufacturer in accordance with Subsection 715.03.01. If required in the Special Provisions, standards shall also be painted as specified therein.

Directional louvers and backplates shall be painted flat black.

- (e) Cabinets or controller boxes shall conform to Section 623T.02.01.
- (f) Factory enameled equipment and materials shall be examined for damaged paint after installation, and such damaged surfaces shall be repainted to the satisfaction of the Engineer.
- (g) Existing equipment and material to be repainted whether remaining in place or to be relocated, shall be cleaned of all rust, scale, grease, dirt and poorly bonded paint by any method satisfactory to the Engineer.
Immediately after cleaning, all bare metal shall be primed as appropriate, or as specified for new

material. A finish coat shall then be applied over newly primed areas followed by one or more finishing coats over the entire surface.

- (h) Blast cleaning of galvanized metal surfaces in good condition, as determined by the Engineer, will not be permitted.
- (i) Paint coats may be applied either by hand brushing or by approved spraying machines in the hands of skilled operators, except that no spraying shall be done at the jobsite. The work shall be done in a neat and workmanlike manner, and the Engineer reserves the right to require the use of brushes for the application of paint should the work done by the paint spraying machine prove unsatisfactory or objectionable, as determined by the Engineer.
- (j) The thickness of each paint coat shall be limited to that which will result in uniform drying throughout the film. Skips, holidays, thin areas, or other deficiencies in any one coat of paint shall be corrected to the satisfaction of the Engineer before the succeeding coat is applied.
- (k) The final coat shall present a smooth surface, uniform in color, free of runs, sags, excessive brush marks and tiger-stripping.

STREET LIGHTING SECTION

MATERIALS

623 L.02.01 MATERIALS, STANDARDS AND POSTS:

- (a) Standards and posts for street lighting standards, cabinets, etc. shall be as specified in the Special Provisions or as shown on the plans or the Standard Drawings and shall conform to the following requirements:

The street lighting standard shall consist of a continuous tapered round steel pole assembly, base cover, mast arm, pole top, anchor rods and necessary bolts, nuts and washers. Workmanship and finish shall be equal to the best general practice of modern metal fabrication.

- (b) **Pole Assembly.** The pole shaft shall be of round cross section with a minimum outer diameter of eight (8) inches (200 millimeters) at the base and shall uniformly decrease in diameter at the rate of 0.14 inches per foot (3.5 millimeters per 300 millimeters) of length. The shaft shall be formed from not more than three (3) pieces of sheet steel. Only one (1) piece of sheet steel shall be used for each section.

A maximum of two (2) circumferential welds and one (1) longitudinal weld will be permitted in assembling the shaft. Where the sections are butt welded together, the welded seams of adjacent sections shall be placed to form a continuous weld from the base to top of standard. After welding, all surplus weld material or protrusions shall be ground off smooth to present an indiscernible joint.

Ground joints shall maintain the strength of the surrounding unwelded metal. Butt joints shall be reinforced in the corresponding gage by three (3) inch (75 millimeters) wide tapered sleeves of the same composition as the steel in the standard. The sleeves shall be centered at the joint and have the same taper as the standard so that the outside of the sleeve is in full contact throughout its length and circumference. All welds shall be continuous. Welding shall be done by A.W.S. certified welders and shall conform to the best accepted practice. Longitudinal welds shall be performed by the submerged arc process. Exposed welds, except fillet welds, shall be ground flush with the base metal.

Standards shall be straight, with a permissive variation not to exceed 3/4 inch (19 millimeters) measured at the midpoint of 30 foot (9.1 meters) standards or poles, or 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.

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- (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 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

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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.

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 contactor 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.

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623 L.03.02 BONDING AND GROUNDING: Metallic cable sheaths, steel conduit, metal poles, pedestals, pull boxes, and other metal enclosures shall be metallically joined together and made mechanically and electrically secure to form a continuous electrical conducting path and shall be effectively grounded as required by the National Electrical Code. All non-metallic conduit shall contain a green grounding conductor as specified herein, except if none is specified, this conductor shall be sized according to Article 250 of the National Electrical Code.

Bonding and grounding jumpers shall be copper wire or copper strap of the same cross-sectional area as No. 4 AWG for series and multiple lighting circuits. Bonding of standards and foundations shall be accomplished by means of a bare No. 4 copper wire attached to each anchor bolt and to a ½ inch (13 millimeters), or larger, brass, cadmium-plated or bronze bolt installed on the lower lip of the lighting standard handhole as shown on the Standard Drawings. The No. 8 green grounding conductor from the conduit and the No. 10 luminaire ground shall be connected to the No. 4 grounding conductor. Grounding of conduit and neutral at the service point shall comply with the applicable sections of Article 250 of the National Electrical Code.

623 L.03.03 TESTING: Prior to completion of the work, the Contractor shall cause the following tests to be made on all lighting circuits, in the presence of the Engineer:

- (a) Test for continuity of each circuit
- (b) Test for grounds in each circuit with a 500 volt megohmmeter with a minimum acceptable reading of 200 megohms
- (c) A functional test in which it is demonstrated that each and every part of the system functions as specified or intended herein
- (d) A high-pot test when specified
- (e) Before acceptance of the work and after adjusting the luminaire lamp sockets to produce the I.E.S. light distribution patterns specified in the plans, the Contractor shall provide the Engineer with footcandle readings showing average to minimum ratios in accordance with I.E.S. standards recommended for Average Maintained Horizontal Illumination for roadways shown in Standard Drawing No. 300.

Any fault in any material or in a part of the installation revealed by these tests shall be replaced or repaired by the Contractor in a manner approved by the Engineer, and the same test shall be repeated until corrected.

METHOD OF MEASUREMENT

623.04.01 MEASUREMENT: The unit of measurement for "Traffic Signal Systems," "Street Lighting Systems," and "Traffic Signal and Street Lighting Systems," will be lump sum or unit price.

The quantity of "Conduit for Future Conductors," will be measured for payment by the linear foot (linear meter) of conduit complete and in place.

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

BASIS OF PAYMENT

623.05.01 PAYMENT: The lump sum price or unit prices paid for traffic signal systems, street lighting systems, sign illumination systems, modifying existing systems, or any combination thereof, shall be full compensation for doing all the work complete and in place as indicated in the contract documents, and as directed by the Engineer, including excavation and backfill, concrete foundations, restoring sidewalk, pavement, and appurtenances damaged or destroyed during construction, salvaging existing materials, and making all required tests.

Full compensation for all additional materials and labor, not shown on the plans or specified, which are necessary to complete the installations of the various systems, shall be considered as included in the prices paid for the systems, or units thereof, and no additional compensation will be allowed therefor.

The accepted quantities of "Conduit for Future Conductors," measured as provided in Subsection 623.04.01, "Measurement," will be paid for at the contract unit price bid per linear foot (linear meter) for conduit.

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

PAY ITEM

PAY UNIT

Traffic Signal Systems (may include sign lighting)	Lump Sum or Unit Price
Street Lighting Systems (may include sign lighting)	Lump Sum or Unit Price
Conduit for Future Conductors Linear Foot	(Linear Meter)

SECTION 624

ACCOMMODATIONS FOR PUBLIC TRAFFIC

DESCRIPTION

624.01.01 GENERAL: This work shall consist of providing for traffic by constructing detours or special detours, permitting traffic to pass through construction, and using flaggers or pilot cars and maintaining the base, or a combination of these methods as indicated in the contract documents or as directed in writing by the Engineer.

MATERIALS

624.02.01 GENERAL: The materials used for the construction and maintenance of facilities required for the free flow of public traffic and for protection of the work shall be those prescribed for the several items which constitute the finished work and shall conform to all the requirements for such materials as set forth herein.

CONSTRUCTION

624.03.01 SPECIAL DETOURS: Special detours shall be constructed as shown on the plans or as specified. Detour locations indicated on the plans may be approximate only; the exact location shall be as staked by the Engineer.

Grading for special detours shall consist of motor grader work, supplemented where necessary by other mechanical equipment, to provide the specified roadbed width and a grade line free from breaks or rolls of sufficient magnitude to be hazardous to traffic. This work shall conform to the requirements of Section 107.21, "Dust Control."

When grading of special detours has been completed and approved by the Engineer and, if required on the plans or in the Special Provisions, the special detours shall receive surfacing materials of the kind and type specified, and they shall be placed and constructed in accordance with the requirements for the particular materials used.

Water shall be applied to detours in amounts necessary to attain the compaction of graded sections and of surfacing materials.

Maintenance on special detours shall consist of performing any work necessary to maintain the detour satisfactorily, as ordered by the Engineer.

Eradication of special detours shall consist of blade grader and scraper work supplemented by other equipment if needed. Eradication will be performed to the extent that the ground will be restored as nearly as feasible to the original, and material disposed of, all as directed by the Engineer.

624.03.02 FLAGGERS: If, in the opinion of the Engineer, controlled traffic is necessary for protection of the work or for safety of public traffic, flaggers shall be employed by the Contractor.

Flaggers shall have completed an approved instructional course in flagging procedures. A prospective flagger shall possess a valid flagger card attesting satisfactory completion of said instructional course conducted by the Highway Department or some other approved course given by another entity of government within the State.

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