

**UNIFORM STANDARD SPECIFICATIONS
CLARK COUNTY AREA**

SPECIFICATIONS - YEAR 2000 REVISIONS

<u>SPECIFICATION NUMBER AND TITLE</u>	<u>PAGE NUMBER(S)</u>	<u>NATURE OF CHANGE</u>	<u>EFFECTIVE DATE</u>
610 Slope and Channel Protection	610-3	Revision to Subsection 610.02.07 to require filter fabric to comply with AASHTO M288.	2/1/00
709 Metal and Thermoplastic Pipe	709-(5)	Revision to 709.03.08 a,b and 709.03.10 to reference appropriate AASHTO Specifications.	3/1/00
623 Traffic Signals and Streetlighting	623-(1-60)	Entire section revised, emphasis on cabinet and controller specs.	4/1/00
402 Plantmix Bituminous Surface	402-(1-5)	Revision to include requirements for use of profilograph.	5/1/00
403 Plantmix Bituminous Open-Graded Surface	403-3	Revision to Subsection 403.03.03 to include requirements for use of profilograph.	"
623 Traffic Signals and Streetlighting	623-8	Revision to Subsection 623G.03.06 to require bottom 2/3 of a traffic signal foundation to be poured against undisturbed soil.	6/1/00
609 Catch Basins, Manholes and Inlets	609-2	Revision to Subsection 609.03.02 to allow the use of high density polyethylene grade adaptor rings.	8/1/00
109 Measurement and Payment	109-(9-10)	Revision to Subsections 109.06 and 109.07 to conform to changes in the NRS regarding prompt payment of constructors and subcontractors.	10/1/00

Revised December 2000

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**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 2000 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.rtc.co.clark.nv.us, 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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- (e) **Records.** At the end of each day the Contractor's representative and the Engineer shall compare records of the cost of the work to be done as ordered on a force account basis.
- (f) **Documentation.**
 - (1) **Labor.** No payment will be made for labor performed on force account work until the Contractor shall furnish to the Contracting Agency certified copies of payrolls covering that period when the force account work was performed. The payrolls shall indicate name, classification, dates, daily hours, and hourly rate for each workman employed on the force account work.
 - (2) **Materials.** Copies of the suppliers invoices, including transportation charges, shall be furnished the Contracting Agency. However, if materials used on the force account work are not specifically purchased for such work but are taken from the Contractor's stock, then in lieu of invoices, the Contractor shall furnish an affidavit certifying that such materials were taken from his stock, that the quantity claimed was actually used and that the price and transportation claimed represent the actual cost to the Contractor. The Contracting Agency may request additional documents to substantiate his claims.

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

109.05 BLANK

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

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

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

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

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

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

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

Public Works Projects requiring a performance and payment bond and a labor and material bond shall be exempt from the provisions of (c) and (d) immediately proceeding. If materials are not specifically purchased for the work, but are taken from the Contractor's stock, then in lieu of invoices, there shall be submitted to the Engineer, statements accompanied by an affidavit of the Contractor, certifying such materials were taken from his stock and the price and transportation claimed represent the actual cost to the Contractor.

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

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

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

109.07 ACCEPTANCE AND FINAL PAYMENT: When the final inspection and final acceptance have been duly made by the Engineer, as provided in Subsection 105.16, "Final Acceptance," and subject to the terms of Subsection 108.09, "Failure to Complete the Work on Time," the Contractor shall prepare the final estimate of the quantities of the various classes of work performed under the contract. The Engineer shall examine such estimate and notify the Contractor in writing of his agreement or disagreement, including any amounts to be withheld in accordance with NRS 338.525.

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

The acceptance by the Contractor of final payment shall be and shall operate as a release to the Contracting Agency of all claims and all liability by the Contractor for all things done or furnished in connection with this work and for every act and neglect of the Contracting Agency and others relating to or arising out of this work.

Dikes shall be shaped and compacted with an extrusion machine or other equipment capable of shaping and compacting the material to the required correct grade and cross section.

METHOD OF MEASUREMENT

401.04.01 MEASUREMENT: The quantity of bituminous plantmix to be measured for payment shall be the number of tons used in the accepted work, and will be determined by weighing the completed mixture of aggregate, mineral filler if required, and bituminous material.

The quantity of shoulder dikes constructed of bituminous plantmix to be measured for payment shall be the number of linear feet (meters) and will be determined from measurement taken along the top of the completed dikes to the nearest one (1) foot (meter) length.

All measurements will be made in accordance with Subsection 109.01, "Measurement of Quantity." Batch weights will not be permitted as a method of measurement unless the alternate provisions of Subsection 401.03.01(b)1, "Plant Scales," are met, in which case the cumulative weight of all the acceptable batches will be used for payment.

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

BASIS OF PAYMENT

401.05.01 PAYMENT: All accepted work and materials measured as prescribed above will be paid for as provided in the representative sections for each type specified.

Full compensation for furnishing and applying bituminous material or asphaltic emulsion as provided for in Subsection 401.03.06, "Preparation of Existing Surface" including "Tack Coat" and 401.03.14, "Joints" shall be considered as included in the contract price paid for the principal items involved and no further compensation will be allowed.

When bituminous plantmix, Type III, is used in the construction of island areas, or dikes, and there is no separate payment for said mixture, this bituminous plantmix shall be included in the payment for plantmix bituminous surface of the major type shown in the list of bid items and the proposal.

SECTION 402

PLANTMIX BITUMINOUS SURFACE

DESCRIPTION

402.01.01 GENERAL: This work shall consist of constructing one or more courses of bituminous pavement on a prepared base in accordance with these specifications, and in conformity with the lines, grades, thickness, and typical cross sections shown on the plans or established by the Engineer. The prepared base shall be prime coated or tack coated as specified in Section 405 and 406 prior to the placement of any plantmix bituminous surface. The cured prime coat shall have no raw asphalt exposed and shall be cleaned of all loose material.

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

MATERIAL

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

CONSTRUCTION

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

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

Bituminous plantmix surface to be placed on shoulders and other areas of the travelled way having a width of eight (8) feet (2.4 meters) or more, shall be spread as specified in Subsection 401.03.10, "Spreading and Finishing." When the areas are less than eight (8) feet (2.4 meters) in width the material may be deposited and spread in one or more layers by other mechanical means that will provide a uniform smoothness and texture. Stockpiling bituminous mixture on contiguous pavement that might be stained thereby will not be permitted.

402.03.03 SURFACE TOLERANCES:

402.03.03.01: The completed surfacing shall be thoroughly compacted, smooth, and free from ruts, humps, depressions, or irregularities. When a straightedge ten (10) feet (3 meters) long is laid on the finished surface and parallel with the centerline of the highway, the surface shall not vary more than one quarter inch (6 millimeters) from the lower edge of the straightedge.

The transverse slope of the finished surface shall be uniform to a degree such that no depressions greater than one quarter inch (6 millimeters) are present when tested with a straightedge ten (10) feet (3 meters) long laid in a

direction transverse to the centerline and extending from edge to edge of a twelve (12) foot (3.6 meters) traffic lane.

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

402.03.03.02: (When specified in the Contract Special Provisions)

The completed surfacing shall be smooth and free from ruts, humps, depressions, or irregularities. Any ridges, indentations, or other objectionable marks left in the surface by rolling or other means shall be eliminated. The use of any equipment that leaves ridges, indentations, or other objectionable marks in the bituminous surface, or does not consistently produce a surface meeting the profile index requirements shall be discontinued. After final rolling, the smoothness of the final dense-graded surface course shall be measured by the following methods:

- a.) **Straightedge Measurement.** The Contractor will perform this measurement. When a straightedge 12 feet (3.6 m) long is laid on the finished surface and parallel with the centerline of the roadway, the surface shall not vary more than 0.25 inches (6 mm) from the lower edge of the straightedge. When a straightedge 12 feet (3.6 m) long is laid on the finished surface and at right angles with the centerline and extending from edge to edge of traffic lane, the surface shall not vary more than 0.25 inches (6 mm) from the lower edge of the straightedge.

Defective areas shall be corrected by approved methods.

- b.) **Profilograph Measurement.** The Contractor shall provide the profilograph and measurements under the direction of the Engineer. The profiles shall be measured 3 feet (1 m) from and parallel to either traffic lane line. The profiles shall be measured for the entire length of each traffic lane within 48 hours after each day's placement of plantmix bituminous mixture. Profile Measurements will not be required on roadway segments less than 0.1 mile (0.16 km) in length, single lane utility construction less than 0.25 mile (0.40 km) in length, or in multiple lane utility construction 0.125 mile (0.20 km) in length.

Profile measurements on pavement along horizontal curves having a centerline radius less than 1000 feet (300 m) will not be required. Pavement within 30 feet (10 m) of a concrete bridge deck (including approach slabs) shall not be measured unless the bridge deck also is to be overlaid with plantmix bituminous surface. At locations that tie into existing pavements, the profile shall begin 50 feet (15m) before the starting joint and end 50 feet (15m) after the ending joint. Intersections where there is a grade break, valley gutters, and 50 feet (15m) before and after swales will not be included in the measurements.

Initial runs of the profilograph shall be completed before opening the new pavement to public traffic whenever practical. The profilographs shall be submitted immediately thereafter for evaluation. A profile index will be calculated for each 0.1 mile (0.1 km) of traffic lane measured according to Test Method No. Nev. T446. All costs for traffic control required for running of the profilograph shall be included in the cost of traffic control.

The pavement smoothness type (Type A, B, or C) will be specified in the Special Provisions. The

maximum allowable profile index for each mile (km) section and 0.1 mile (0.1 km) section for the specified pavement type shall be as follows:

Profile Index

Pavement Smoothness Type	Max. per lane mile (per km)	Max. per 0.1 lane mile (per 0.1 km)
Type A*	5 inches (80 mm)	0.5 inches (8 mm)
Type B**	7 inches (110 mm)	0.7 inches (11 mm)
Type C***	10 inches (160 mm)	1.0 inches (16 mm)

*New Arterial and Major Collector

**Removal and Replacement in 80 ft. and greater (arterial and collector) with new curb construction

***Right-of-way less than 80 ft. (collector) or on arterial and collector asphalt removal and replacement projects that contain existing curb

Pavement on horizontal curves having a centerline radius of 1000 feet (300 m) or more, but less than 2000 feet (600 m), and within the superelevation transition of such curves will be evaluated as pavement smoothness Type C.

Areas which exceed the profile index requirements and areas representing high points on the profiles having deviations in excess of 0.3 inches (7.5 mm) as measured according to Test Method No. Nev. T446 shall be ground to conform to requirements. Ground areas shall be remeasured for conformance with the profile index and for no high points in excess of 0.3 inches (7.5 mm).

Additional grinding shall be performed as necessary to extend the ground area laterally to the nearest lane line or edge of pavement and longitudinally to lines normal to the pavement centerline.

Deviations in excess of 0.3 inches (7.5 mm) that cannot be brought into specified surface tolerances shall be corrected by abrasive grinding, by either removal and replacement, or placing an overlay of hot mix asphalt. The Contractor shall obtain approval of the exact method of correction from the Engineer. Seal coat shall be applied to the ground areas after the surface tolerance specifications have been met. The seal coat shall be Emulsified Asphalt, Type SS-1h (Diluted) applied as directed.

The grinding machine for correcting pavement exceeding the profile requirements shall be power driven, self-propelled and specifically designed to remove, profile, smooth, and texture hot mix asphalt. The grinding machine shall have a wheel base of not less than 12 feet (3.6 m) and be equipped with a rotating powered mandrel drum studded with diamond blades with a cutting head not less than 3 feet (0.9 m) wide. The grinding machine shall be equipped with an effective means for controlling dust and other particulate matter.

The grinding machine shall not cause strain or damage to the underlying surface of the pavement. Grinding and texturing equipment that causes ravel, aggregate fractures, spalls, or disturbance of joints shall not be used.

Grinding shall be performed in a longitudinal direction. Grinding shall result in a uniform textured surface over the designated surface areas.

The surface of the ground pavement shall have parallel corduroy-type texture consisting of grooves between 0.1 inch (2.3 mm) and 0.13 inch (3.3 mm) wide. The peaks of the ridges shall be approximately 0.06 inch (1.5 mm) higher than the bottom of the grooves with approximately 52 to 57

evenly spaced grooves per foot (170 to 190 grooves per meter).

The ground material, including water used for the grinding operation, shall be picked up and disposed of outside the right of way according to Subsection 107.14.

402.03.04 PROFILOGRAPH EQUIPMENT:The Contractor shall furnish and operate a California type profilograph for checking riding tolerances at the time and date ordered. The profilograph shall be equipped with a 25 foot (7.6 m) wheel base and the following features:

- (a) 3-Unit Frame Assembly
 - (1) All welded construction of light weight aluminum square tubing.
 - (2) Index frame connections by 4 steel locating pins and secured by 4 quick acting clamps.
- (b) Multiple Wheel Assemblies
 - (1) Wheel supports of square steel tubing and all welded construction.
 - (2) Secure connections by quick acting clamps.
 - (3) Wheels with cast aluminum hubs, ball bearings and cushion rubber tires.
 - (4) Bearing support caster wheel assemblies.
 - (5) Steerable front wheels from the center of the machine.
 - (6) Rear wheels with a quick setting manual adjustment for turning in a short radius, moving sideways, and to prevent rear end crabbing on superelevations.
- (c) Recording Wheel Assembly
 - (1) Frame of all welded construction of light weight rectangular aluminum tubing.
 - (2) Light weight 24 inch (600 mm) minimum diameter recording wheel with heavy duty spokes for maximum rigidity, with a pneumatic tire maintained at 25 psi (170 kPa) air pressure unless otherwise specified by the manufacturer.
- (d) Recorders (if computerized).
 - (1) A high resolution printer capable of printing the profile trace to the specified scale and automatic positioning and marking of the specified "blanking band" and "must grind" bumps. It shall also be capable of printing station numbers, distances, and comments entered by the operator via keypad while measuring the profiles.
 - (2) It shall also calculate the profile index in inches per mile per each 0.1 mile (mm per km per each 0.1 km) section without hand calculations or data reduction.
 - (3) A display screen for instant visual observation of the road profile and "must grind" areas while measurements are being taken.
 - (4) The horizontal chart scale shall be 1 inch equals 25 feet (25mm equals 7.5 m) and the vertical scale shall be 1 inch equals 1 inch (25 mm equals 25 mm). The recorder shall have an adjustment feature to calibrate the scales to these parameters. Calibrate the profilograph before usage to be accurate within 0.1 foot in 100 feet (0.1 m in 100 m) longitudinally.
 - (5) Battery backed up memory shall retain control parameters when the system is powered down.
 - (6) Capable of accurate operation in ambient temperatures from 45° F (7 °C) to 120° F (49°C).

- (e) Recorders (if not computerized).
 - (1) Use sealed ball bearings throughout.
 - (2) A low inertia recording pen assembly shall run on hardened and ground guide rods for both sensitive and smooth trace response.
 - (3) The recording pen travel shall be 7 inches (175 mm) in one setting.
 - (4) The recorder reversing mechanism shall be fully automatic and the paper shall reverse direction without manual adjustment of drag clutches.
 - (5) The drag clutches shall be pre-set, sealed from dust, and self-compensating for wear.
 - (6) Integral aluminum case with formed plexiglass viewing windows.
 - (7) The horizontal chart scale shall be 1 inch equals 25 feet (25mm equals 7.5 m) and the vertical scale shall be 1 inch equals 1 inch (25 mm equals 25 mm).
 - (8) A variable roller disc integrator shall be incorporated into the drive system to permit accurate calibration of horizontal chart speed.
 - (9) The profilograph shall be calibrated before usage to be accurate within 0.1 feet in 100 feet (0.1 m in 100m) horizontally.

METHOD OF MEASUREMENT

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

BASIS OF PAYMENT

402.05.01 PAYMENT: The accepted quantity of plantmix bituminous surface will be paid for at the contract unit price bid per ton (metric ton) of plantmix bituminous surface, which price shall include all asphalt cement.

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

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

Partial payments for plantmix bituminous surface may be made as set forth under Subsection 109.06, "Partial Payments."

Payment will be made under:

PAY ITEM	PAY UNIT
Plantmix Bituminous Surface	Ton (Metric Ton)
Plantmix Bituminous Shoulder Dikes	Linear Foot (Linear Meter)

SECTION 403

PLANTMIX BITUMINOUS OPEN-GRADED SURFACE

DESCRIPTION

403.01.01 GENERAL: This work shall consist of placing plantmix bituminous open-graded surface in one course in accordance with these specifications and in conformity with the lines, grades, thickness, and the typical cross sections shown on the plans or established by the Engineer. This shall not be started until the Contractor has completed all motor patrol and power loader equipment work or any other work that could scar or mar the finished open-graded surface.

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

MATERIALS

403.02.01 GENERAL: The materials shall conform to the requirements as specified in Subsections 401.02.02 and 401.02.04, "Plantmix Bituminous Pavements - General."

403.02.02 COMPOSITION OF MIXTURE: The plantmix open-graded mixture shall be composed of aggregates and bituminous material as described in these specifications.

Before starting work, the Contractor shall submit a proposed job-mix formula in writing for use by the Engineer in setting the job-mix formula to be used. The proposed job-mix formula shall be determined by a testing laboratory under the direction and control of a Registered Professional Engineer based on tests required to determine the gradation and surface capacity for coarse aggregate. The initial design asphalt content for open-graded mixes shall be determined in accordance with applicable sections of California Testing Method 303, latest edition (State of California, Department of Transportation, Manual of Test Volume 2), except that the formula shall be:

$$\text{Asphalt content, percent by weight of total mix} = 2.0(K_c) + 4.$$

Modifications in the asphalt content will be made by the Engineer as necessary based on field observations made during construction.

Test reports for determination of the job-mix formula shall include the following information:

- (A) Aggregate Gradation
- (B) Surface Capacity, K_c

The grade of asphalt to be used for all mixes shall be AC-30 or AC-20P as specified in Subsection 703.03.02 unless otherwise stipulated in the Special Provisions.

PLANTMIX BITUMINOUS OPEN-GRADED SURFACE

The formula submitted shall propose definite single values for:

- (A) The percentage of aggregate passing each specified sieve.
- (B) The percentage of bitumen to be added (to 0.1 percent)
- (C) The temperature of the mixture leaving the mixer.

The temperature of the open-graded mixture at the hopper of the paver shall conform to the following table, except the temperature shall not be more than 20°F (11°C) lower than the temperature of the completed mixture leaving the plant.

TEMPERATURES OF PLANTMIX BITUMINOUS OPEN-GRADED MIXTURES
 AT THE PAVER

Grade of Asphalt Cement	Minimum	Maximum
AC-30	225°F 107°C	275°F 135°C
AC-20P	280°F 138°C	350°F 177°C

The mixture furnished shall conform to the job-mix formula within the following range of tolerances:

Aggregate passing the No. 4 and larger sieves	±7%
Aggregate passing the No. 8 sieve	±4%
Aggregate passing the No. 200 sieve, not exceed	3%
Bitumen Content	±0.3% of volume or batch weight of aggregate

Should there be a change in sources of materials, a new job-mix formula shall be established before the new mix is used.

The temperature of the bituminous material just prior to mixing shall conform to the requirements of Subsection 401.02.01.

CONSTRUCTION

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

403.03.02 ROLLERS: There shall be operating with each paver two (2) tandem rollers weighing not less than eight (8) nor more than ten (10) tons (7.25 nor more than 9 metric tons). When two (2) pavers are paving in echelon, within four hundred (400) feet (122 meters) of each other, no additional rollers will be required, and generally not over two passes will be required.

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

403.03.04 SURFACE TOLERANCES:

403.03.04.01: The completed surfacing shall be thoroughly compacted, smooth, and free from ruts, humps, depressions, or irregularities. When a straightedge ten (10) feet (3 meters) long is laid on the finished surface and parallel with the centerline of the highway, the surface shall not vary more than one quarter inch (6 millimeters) from the lower edge of the straightedge. The transverse slope of the finished surface shall be uniform to a degree such that no depressions greater than one quarter inch (6 millimeters) are present when tested with a straightedge ten twelve (12) feet (3.7 meters) long laid in a direction transverse to the centerline and extending from edge to edge of a twelve (12) foot (3.7 meters) traffic lane.

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

403.03.04.02: (When specified in the Contract Special Provisions)

The Contractor shall produce completed surfacing which meets the requirements of Subsection 402.03.03.02 with the following additions and exceptions to the profilograph measurement.

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

The Contractor shall repair, or remove and replace, all areas exceeding the profile index requirements and areas representing high points on the profiles having deviations in excess of 0.4 inches (10 mm) as measured according to Test Method No. Nev. T446. The Contractor shall remeasure repaired or replaced areas for conformance with the profile index and for no high points in excess of 0.4 inches (10 mm).

High points in excess of 0.4 inches (10 mm) may be allowed to remain in place, if requested and approved. Liquidated damages of \$500.00 will be assessed for each such high point that is allowed to remain in place.

Grinding may be utilized for repair to the open-graded surface when approved. Limit grind areas to 25 feet (7.5 m) in length. The grinder and grinding operation shall conform to Subsection 402.03.03.

METHOD OF MEASUREMENT

403.04.01 MEASUREMENT: Plantmix bituminous open-graded surface will be measured as specified in Subsection 401.04.01, "Measurement," or if the contract documents specify payment by area, the quantity of Plantmix Bituminous Surface to be measured for payment shall be the number of square yards (square meters), including the asphalt cement, used in the accepted work.

BASIS OF PAYMENT

403.05.01 PAYMENT: The accepted quantity of plantmix bituminous open-graded surface will be paid for at the contract price bid per square yard (square meter) of plantmix bituminous open-graded surface, which price shall include the bituminous material (asphalt cement) or it will be paid for at the contract unit price bid per ton (metric ton) which price will include the cost of all bituminous material (asphalt cement).

PLANTMIX BITUMINOUS OPEN-GRADED SURFACE

The above prices shall be full compensation for furnishing all the materials, mixing, loading, hauling, placing, compacting, and incidentals necessary for doing all the work involved in constructing plantmix bituminous open-graded surface as shown on the plans or established by the Engineer.

All payments will be made in accordance with Subsection 109.01, "Scope of Payment."

Partial payments for plantmix bituminous open-graded surface may be made as set forth under Subsection 109.06, "Partial Payments."

Payment will be made under:

PAY ITEM	PAY UNIT
Plantmix Bituminous Open-Graded Surface	Square Yard (Square Meter)
Plantmix Bituminous Open-Graded Surface	Ton (Metric Ton)

SECTION 609

CATCH BASINS, MANHOLES, AND INLETS

DESCRIPTION

609.01.01 GENERAL: This work shall consist of constructing or reconstructing catch basins, manholes, inlets, and similar structures, consisting of Portland cement concrete with necessary reinforcement, metal frames, grates, and lids, including required excavation and backfilling.

MATERIALS

609.02.01 GENERAL: Materials shall conform to the requirements specified in the following sections:

Portland Cement Concrete	Section 501
Reinforcing Steel	Section 505
Miscellaneous Metals.	Section 712
Gray Iron Castings	Subsection 712.03.02

Portland cement concrete shall be Class A or Class AA unless otherwise provided.

Casting shall be true to pattern in form and dimensions, free from pouring faults, sponginess, cracks, blow holes, and other defects in positions affecting strength and value for the service intended. Casting shall be boldly filletted at angles and the arises shall be sharp and perfect. Casting shall be sand blasted or otherwise effectively cleaned of scale and sand so as to present a smooth, clean, and uniform surface.

The Contractor shall obtain from the fabricator of the structural steel grates, frames, and gray iron castings a Certificate of Compliance stating that the fabrications meet the requirements of these specifications, and giving certified shop weights for the fabrications.

Mortar for setting grates shall be mixed in the proportions of one part cement to three parts of fine aggregate.

Pipe crossbars for drop inlets shall be unpainted standard weight black pipe conforming to the requirements of ASTM Designation A 53 or A 120. Straps shall be unpainted A 36 steel.

CONSTRUCTION

609.03.01 GENERAL: Catch basins, inlets, and manholes shall be constructed in accordance with all of the requirements of Section 501, "Portland Cement Concrete." Inlet and outlet pipes shall be placed prior to pouring concrete.

Grates shall be set in full mortar beds or otherwise secured as shown on the plans. Grates shall be set accurately to the final elevations so that no subsequent adjustments will be necessary. Concrete covers, when indicated on the plans, shall be constructed in such manner that they will fit snugly and be readily removable. Structural steel grates shall be painted as specified in Section 614, "Painting."

Pipe or tile placed in masonry for inlet or outlet connections shall extend through the walls and beyond the outside surfaces of the walls a sufficient distance to allow for connections with conduit and the masonry shall be carefully constructed around them so as to prevent leakage around their outer surfaces.

Commercially prefabricated frames and grates of equal or greater capacity and strength may be substituted for the design shown on the plans for drop inlets provided prior approval is obtained in writing from the Engineer.

Frames and grates shall be matchmarked in pairs before delivery to the work and grates shall fit into their frames without rocking.

609.03.02 ADJUSTING CATCH BASIN, MANHOLE, AND INLET COVERS: Unless otherwise provided on the plans or by the contract, existing covers, including frames, grates, or lids shall be adjusted to the required elevation by removing such existing covers and adjusting the top of the existing structures by removing or adding concrete, brick masonry, concrete block masonry or high density polyethylene adaptor rings, or by using steel or cast iron adaptor rings, as the case may be, reinstalling the fixtures by supporting them on a satisfactory collar of Class A concrete constructed as to hold them firmly in place.

609.03.03 CLEAN OUT: All catch basins, manholes, inlets, and similar structures shall be thoroughly cleaned of any accumulations of silt, debris, or foreign matter of any kind, and shall be clean of such accumulations at the time of final inspection.

609.03.04 EARTHWORK: Structure excavation and structure backfill shall conform to the requirements of Section 206, "Structure Excavation" and 207, "Backfill."

METHOD OF MEASUREMENT

609.04.01 MEASUREMENT: The quantities of castings and structural steel grates measured for payment will be the number of pounds (kilograms) complete and in place. The weight of castings shall be computed from the dimensions shown on the approved shop drawings assuming the cast iron to weigh four hundred fifty (450) pounds per cubic foot (7.2 grams per cubic centimeter), with an allowance of ten (10) percent for fillets and overrun. The weight of structural steel grates shall be computed from the dimensions shown on the approved shop drawings, in accordance with Section 506, "Steel Structures." Certified shop weights will be acceptable in lieu of computed weights.

Adjusting covers for catch basins, manholes, and inlets will be measured per each complete and in place.

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

Pipe crossbars and straps for drop inlets shall be included in the measurement for payment by the contract bid price per pound (kilogram) for Structural Steel Grates.

BASIS OF PAYMENT

609.05.01 PAYMENT: The accepted quantities of grates measured as provided in Subsection 609.04.01, "Measurement," will be paid for at the contract unit price bid per pound (kilogram) for types and sizes specified.

The work for adjusting covers measured as specified in Subsection 609.04.01, "Measurement," will be paid for at the contract unit price bid per each for adjusting covers for catch basins, manholes, and inlets, which price shall be full compensation for furnishing all materials, tools, incidentals, and labor required to adjust the covers.

Portland cement concrete used in new structures of catch basins and inlets will be paid for as specified in Section 502, "Concrete Structures."

Reinforcing steel in catch basins and inlets will be paid for as specified in Section 505, "Reinforcing Steel."

The accepted quantity of precast manholes measured as provided in Subsection 609.04.01, "Measurement" will be paid for at the contract unit price bid per each for types and sizes specified. This price shall be full compensation for furnishing all materials including structure excavation and structure backfill, Portland cement concrete, steel, castings, and incidentals necessary to complete the work.

Structure excavation and structure backfill for catch basins and inlets will be paid for as specified in Section 206, "Structure Excavation" and 207, "Backfill."

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

Payment will be made under:

PAY ITEM	PAY UNIT
CastingsPound (Kilogram)
Structural Steel GratesPound (Kilogram)
(Size) Precast Reinforced Concrete Manhole (type)Each
Adjusting CoversEach

SECTION 610

SLOPE AND CHANNEL PROTECTION

DESCRIPTION

610.01.01 GENERAL: This work shall consist of constructing slope and channel protection structures to the lines and grades established by the Engineer using riprap or wire mesh gabions in accordance with the design shown on the plans and these specifications.

Riprap construction shall consist of furnishing and placing riprap (with or without grout), or sacked Portland cement concrete riprap, as the case may be.

Wire mesh gabion construction shall consist of furnishing, assembling, tying, and filling open mesh wire baskets with stone.

MATERIALS

610.02.01 GENERAL: All materials shall conform to the requirements specified in the following sections:

Water	Section 722
Stone for Masonry and Riprap.	Subsection 706.03.05
Portland Cement.	Section 701
Grout and Mortar Sand.	Subsection 706.03.04

When so provided and with prior approval of the engineer, crushed concrete may be substituted for the above designated stone. In such a case, the concrete shall be sound and meet all requirements as specified for stone.

610.02.02 GROUT: Grout shall be composed of one part by volume of Portland cement and three parts by volume of sand and shall be of such consistency that it will fill all voids in the riprap.

610.02.03 SACKED CONCRETE: Sacked concrete shall be composed of sacks filled with Portland cement concrete. The mixed concrete shall contain a minimum of three hundred seventy-six (376) pounds (170 kilograms) (four sacks) of Portland cement per cubic yard. The amount of water added at the time of mixing shall be such as will produce a mixture with a slump of from three (3) inches (75 millimeters) to five (5) inches.

Unless otherwise provided in the special provisions, aggregate for use in sacked concrete riprap shall consist of river run material of a sandy, gravelly nature, clean and free from roots, vegetable matter, and other deleterious substances. When tested on laboratory sieves, river run material shall conform to the following grading requirements.

Passing a 2-inch (50 millimeters) Sieve.	80 to 100 Percent
Passing a No. 200 Sieve.	0 to 4 Percent

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

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

Riprap

- D₁₅ shall be a minimum of 6 inches.
- D₅₀ shall be a minimum of 12 inches.
- D₈₅ shall be a minimum of 18 inches.

Heavy Riprap

- D₁₅ shall be a minimum of 9 inches.
- D₅₀ shall be a minimum of 18 inches.
- D₈₅ shall be a minimum of 24 inches.

This stone shall conform to the following requirements:

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

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

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

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

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

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

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

610.02.07 FILTER FABRIC: When filter fabric is specified or shown on the plans, it shall consist of a geotextile that is made from synthetic fibers. The filter fabric shall be in accordance with the requirements of AASHTO M288, Section A4 and shall conform to the requirements specified by the Engineer.

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

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

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

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

(a) **Twisted Wire Mesh Panels**

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

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

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

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

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 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.

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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.

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

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

after complying with Subsection 502.03.19. The exposed portions shall be formed to present a neat appearance. The bottom of concrete foundations shall rest on firm undisturbed ground. 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.

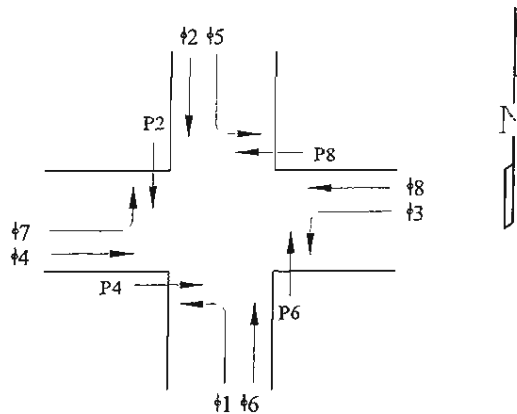
Only cabinets that are designed to use rails with infinite adjustability ('uni-strut' design) on the side of the cabinet that the shelves and panels are connected to will be accepted. These utilize "spring nuts" in the rail channel to tighten the bolts that are used. Cabinets that use carriage bolt assemblies 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 ½ " floppy disk drawn in Autocad LT95, Autocad Rev. 12, program or approved equivalent.

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



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

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

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

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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.

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- (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 wired to logic ground.

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There shall be one (1), single-channel loop amplifier wiring harnesses for each of the phases 2, 4, 6, and 8, for thru-traffic "call loop" operation. These harnesses and plugs conform to the TS-1 1983 specifications. These will be wired not to output a call during the detected phase green service, with each conductor independently terminated onto an individual terminal. The "Relay Common" ("B" pin) must terminate independently, then it must then be wired to the red and yellow output from the controller (this must be diode isolated).

(2) **For Four-Channel Detectors:**

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

4 outputs per each even phase (2, 4, 6, 8)

2 outputs per each odd phase (1, 3, 5, 7)

(3) **For "Rack-Mounted" Detection:**

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

4 outputs per each even phase (2, 4, 6, 8)

2 outputs per each odd phase (1, 3, 5, 7)

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

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

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

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

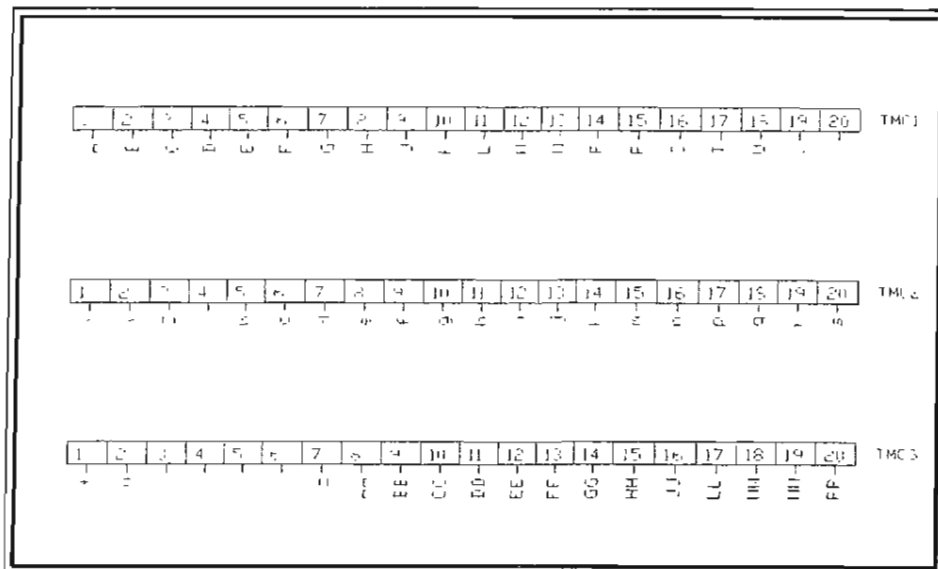
Channel "A" to Controller Plug "A," Pin "q"

Channel "B" to Controller Plug "A," Pin "y"

Channel "C" to Controller Plug "B," Pin "W"

Channel "D" to Controller Plug "B," Pin "X"

- (f) **Supplemental 2070N "D" Plug Interface Panel** (for additional information, see 623 T.02.03)
Every cabinet shall have a "D" panel wired to which the wiring harness for the "D" plug for the controller will terminate. The plug used for the "D" plug on the 2070N controller shall be an MS3116-24-61S. The wiring from this plug's harness shall have independent termination points as shown on the panel below. All wiring on this panel, except for the "D" plug connector wiring harness itself shall be performed by the Agency's staff after delivery and acceptance of the controller cabinet.



- (g) **Conflict Monitor Units:** The wiring harness that the conflict monitor plugs use shall have independent termination points. Each and every conductor shall be terminated independently onto a single terminal. There will be no conductors bound, hanging loose, or not terminated. All conflict monitors shall be NEMA standard, meeting all requirements of section 6 of the 1983 TS1 specifications. In addition, all monitors shall be equipped with the features defined below:
- All cabinets shall be equipped with a conflict monitor harness completely wired in the cabinet to a separate panel as shown above for twelve (12) channels of operation. Conflict monitors shall be provided in all cabinets supplied.
 - Minimum vehicle clearance time monitoring with a time value of 3.0 to 4.0 seconds (able to be selected on a per channel basis).
 - Separate indicators for activity on each of the red, amber, green and walk inputs of each monitor channel.
 - Front panel indicators showing active channel(s), date, time and description of the current status, while showing a log of six or more of the most recent failures. All such data shall be stored in a non-volatile memory.
 - Liquid crystal front panel displays shall be provided.
 - Failure status indicators for CVM, 24-1, 24-2, conflict, red failure, clearance failure, minimum green failure, dual indication, and program card insertion.
 - The monitor shall provide a front panel display of the approximate time and date of the occurrence of any power failure in excess of 500 milliseconds duration and the date and time of power restoration. The monitor program shall have computed and logged this data in non-volatile memory by the end of the power restart flash interval.
 - Front panel connectors "A" and "B" mounted directly to printed circuits will not be accepted.
 - For every integrated circuit custom-programmed device, or any sole source component, within the unit which is of such special design that replacement units would not be available from any local wholesale

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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.

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

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

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

Where special test connectors are required, 2 complete sets of connectors shall be provided per bid order.
- (5) The vendor shall supply a software program to the Agency which when run on an IBM compatible PC connected to the controller will demonstrate to the Agency the controller's communications with respect to baud rates, uploads, downloads, monitoring and activity logging.
- (6) All requisite hardware and software shall be provided fully installed and complete in order to provide the uploading, downloading, monitoring and logging functions required.
- (7) **Double Clearance Overlaps:** The four NEMA required overlap outputs ("A," "B," "C," and "D") shall provide timed double clearance operation. The settings for this type of operation shall include the ability to select which phases and other overlaps may start timing, or commence the display of their green indications, respectively, during the double clearance timer intervals after the terminating parent phase has completed its all red. It shall also be possible to program which phases "on's" and which phases "next's" concurrent output shall cause the double clearance green (lag green interval) to be skipped. It shall be possible to specifically program for each overlap:
 - Compatible phases
 - Conflicting phases

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".

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

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

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

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

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

(c) **2070N Controller Construction Specification.**

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

- (1) The 2070N controllers supplied shall conform to the latest published revision of the California Department of Transportation (CALTRANS), Transportation Electrical Equipment Specifications (TEES) requirements, published at time of bid. The following configuration will apply to any controller supplied:
- (2) A 2070-7 "ASYNC SERIAL COMM MODULE" shall be supplied and installed in each controller. The communications interface connection cable incorporated with the 2070-8 shall be supplied with connector DB-9S to mate with the 2070-7 module.
- (3) A communications modem shall be supplied per 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		

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		
l	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			
W			
X			
Y			
Z			
a			
b			
c			
d			
e			
f			
g			
h			
i			
j			
k			
l			
m			
n			
p			
q			
r			
s			
t			
u			
v			
w			
x			
y			
z			

Pins are user defined, and are to be wired.

623 T.02.04 LOOP DETECTORS:

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

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

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- (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	Measuring Standard and Conditions
Hardness (indentation)--65-85	ASTM D 2240 Rex Type A, Model 1700 77°F (25°C) 50% relative humidity
Tensile Strength--500 psi (minimum)	ASTM D 412 Die C, pulled at 20 IPM
Elongation--400%, minimum	ASTM D 412 Die C, pulled at 20 IPM
Flex at -40°F--no cracks	25 mil Free Film Bend (180° C) over ½" Mandrel
Weathering Resistance-- Slight Chalking	ASTM D 822 Weatherometer 350 hrs. Cured 7 days at 77° (25°C) 50% relative humidity
Salt Spray Resistance--500 psi, minimum tensile; 400% minimum elongation	ASTM B 117, 28 days at 100°F(38°C) 5% NaCl, Die C, pulled at 20 IPM
Dielectric Constant--Less than 25% change over a temperature of -30°C to 50°C	ASTM D 150

Chemical Resistance

Chemical and Results	Test Method
De-Icing Chemical--No Effect	ASTM D 471
Gasoline--Slight Swell	ASTM D 471
Hydraulic Brake Fluid--No Effect	ATSM D 471
Motor Oil--No Effect	ASTM D 471
Calcium Chloride (5%)--No Effect	ASTM D 471

Tests conducted on deaerated, 20 mil (0.020"), dry film liquid immersion. 28 days at 77°F (25°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° F., 150 g., 5 sec.
Flow -- 5 mm. maximum	ASTM D 3407, Section 6, 140° F.

Property and Limits	Measuring Standard and Conditions
Resilience --60% minimum	ASTM D3405, 77° F.
Softening Point -- 200° F.	ASTM D 36
Ductility -- 30 - 55 centimeters	ASTM D 113, 77° F., 5 cm./sec.
Flash Point --575° F.	ASTM D 92, COC
Viscosity -- 2500 - 3500 centipoise (Brookfield)	ASTM D 3236 375° 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.

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- (f) **Visors.** Each section shall be provided with a removable, full-circle, metal visor conforming to ANSI Standard D-10.1 and the Standard Drawings, unless otherwise shown on the plans.
- (g) **Directional Louvers.** Where shown on the plans, directional louvers shall be furnished and installed in signal visors. Directional louvers shall be so constructed as to have a snug fit in the signal visors. The outside cylinder shall be constructed of 0.030 inch (0.8 millimeters) nominal thickness, or thicker, sheet steel or the cylinder and vanes shall be constructed of 3003 H14 aluminum alloy of equivalent thickness. Dimensions of louvers and arrangements of vanes shall be as shown on the plans.
- (h) **Backplates.** Where shown on the plans backplates shall be furnished and installed on signal heads. Dimensions, materials and installation details shall be as shown in the Standard Drawings. No background light shall show between the backplate and the signal face or between sections. Where a backplate consists of two or more sections, the section shall be fastened with rivets or with aluminum bolts peened after assembly to prevent loosening.
- (i) **Signal Mounting Assemblies.** Assemblies for the mounting of signal faces shall consist of 1-1/2 inch (38 millimeters) standard steel pipe and necessary fittings, slip-fitters and terminal compartments. Each terminal compartment shall be fitted with a terminal block containing a minimum of 12 poles, each with 2 screw-type terminals. Each terminal shall be designed to accommodate at least 5 No. 14 conductors. A cover shall be provided on the compartment to give ready access to the terminal block. Where used to bracket-mount a signal the terminal compartment shall be designed to bolt securely to a pole or standard. The dimensions of mounting assembly members between the axis through the center of the terminal compartment, or slip-fitter, shall not exceed 11 inches (275 millimeters), except where required to provide proper signal face alignment or permit programming of programmed visibility signal faces or when otherwise directed by the Engineer. Each mounting assembly shall be oriented to provide maximum horizontal clearance to the adjacent roadway. All mounting assembly members shall be either plumb or level, symmetrically arranged and securely assembled. Construction shall be such as to permit all conductors to be concealed. Mounting assemblies shall be water-tight and free of sharp edges or protrusions which might damage conductor insulation. For post-top mounting of signals, a slip-fitter shall be used. Slip-fitter shall fit over a 4-1/2 inch (113 millimeters) outside diameter pipe or tapered standard end. Each slip-fitter shall be provided with cadmium-plated steel set screws, arranged as shown on the plans. Each slip-fitter used to post-top mount signals with brackets shall be provided with an integral terminal compartment. Each mounting assembly shall be provided with positive locking, serrated fittings which, when mated with similar fittings on the signal faces, shall prevent faces from rotating. Fittings shall permit fastening at increments of not more than 7 degrees. Signal faces shall not be installed at any intersection until all other signal equipment, including the controller, is in place and ready for operation at that intersection, except that the signal faces may be mounted if they are not directed toward traffic or if they are covered. During the time period between signal assembly erection and system turn-on, all signal assemblies shall be completely covered by use of six (6) mil minimum thickness black plastic bags.
- (j) **Internally Illuminated Street Name Signs.** Internally illuminated street name signs, when specified, shall be 8 feet (2.44 m) long, as indicated on the project drawings, by 22 5/16" (568 mm) high. Sign shall be weather-tight and consist of 6063 T-5 alloy aluminum housing with 0.078" (2 mm) minimum thickness and translucent plastic face plate composed of white wide-angle prismatic translucent reflective

sheeting, reverse-screened with manufacturers' recommended green ink and clear coating, applied to a 0.060" (1.5 mm) gage polycarbonate clear substrate. Ballast shall be a 200 ma 120V ballast. Lamps shall be 430 ma cool white. Only one ballast per lamp may be used. Two lamps, spaced six inches apart, are required for each lighted sign.

623 T.02.06 PROGRAMMED VISIBILITY VEHICLE SIGNAL FACES: Each programmed visibility signal face and the installation thereof shall conform to the provision in Subsection 623 T.02.05, "Vehicle Signal Faces," and Subsection 623 T.02.05(g) "Backplates," and Subsection 623 T.02.07(k).05(h), "Signal Mounting Assemblies." Each programmed visibility signal section shall provide a nominal twelve (12) inch (300 millimeters) diameter circular or arrow indication. Color and arrow configuration shall conform to ANSI Standard D-10.1. Each section shall be provided with a sun visor. Each signal section shall be provided with an adjustable connection that permits incremental tilting from 0 to 10 degrees above or below the horizontal while maintaining a common vertical axis through couplers and mountings. Terminal connection shall permit external adjustment about the mounting axis in 5 degree increments. The signal shall be mountable with ordinary tools and capable of being serviced without tools. Adjustment shall be preset at 4 degrees below the horizontal, unless otherwise specified. The visibility of each programmed visibility signal face shall be capable of adjustment or programming within the face. When programmed, each signal face's indication shall be visible only in those areas or lanes to be controlled, except that during dusk and darkness a faint glow to each side will be permissible. Prior to programming, each signal section with a yellow indication shall provide a minimum luminous intensity of 3,000 candela on the optical axis, and a maximum intensity of 30 candela at 15 degrees horizontal from the axis. Each such signal section shall be capable of having its visibility programmed to achieve the following luminous intensities: a minimum of 3,000 candela on the optical axis, a maximum of 100 candela at from ½ to 2 degrees horizontal from the axis and a maximum of 10 candela at from 2 to 15 degrees horizontal from the axis. Under the same conditions, the intensities of the red indication and the green indication shall be at least 19 and 38 percent respectively of the yellow indication. Each signal face or each signal section shall include integral means for regulating its luminous intensity between limits in proportion to the individual background luminance. Lamp intensity shall not be less than 97 percent of uncontrolled intensity at 1000 footcandles, and shall reduce to 15 ± 2 percent of maximum intensity at less than one footcandle. The dimming device shall operate over an applied voltage range of 95 to 130 volts, 60 Hz. and a temperature range of -40 to 165 degrees F. (-40 to 73.9 degrees C.). The Contractor shall have a manufacturer's representative program the heads.

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

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

TYPE A - Type A signals shall consist of internally illuminated symbols formed by painting the message plate except for the area forming the symbols. The message plate on which the symbols are formed shall be either 1/8 inch (3 millimeter) nominal thickness ultraviolet stabilized polycarbonate plastic with external prismatic pattern, or 3/16 inch (5 millimeter) nominal thickness ultraviolet stabilized plastic with extended prismatic pattern, or 1/8 inch (3 millimeter) nominal thickness glass fiber reinforced plastic. Each

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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.

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- (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.

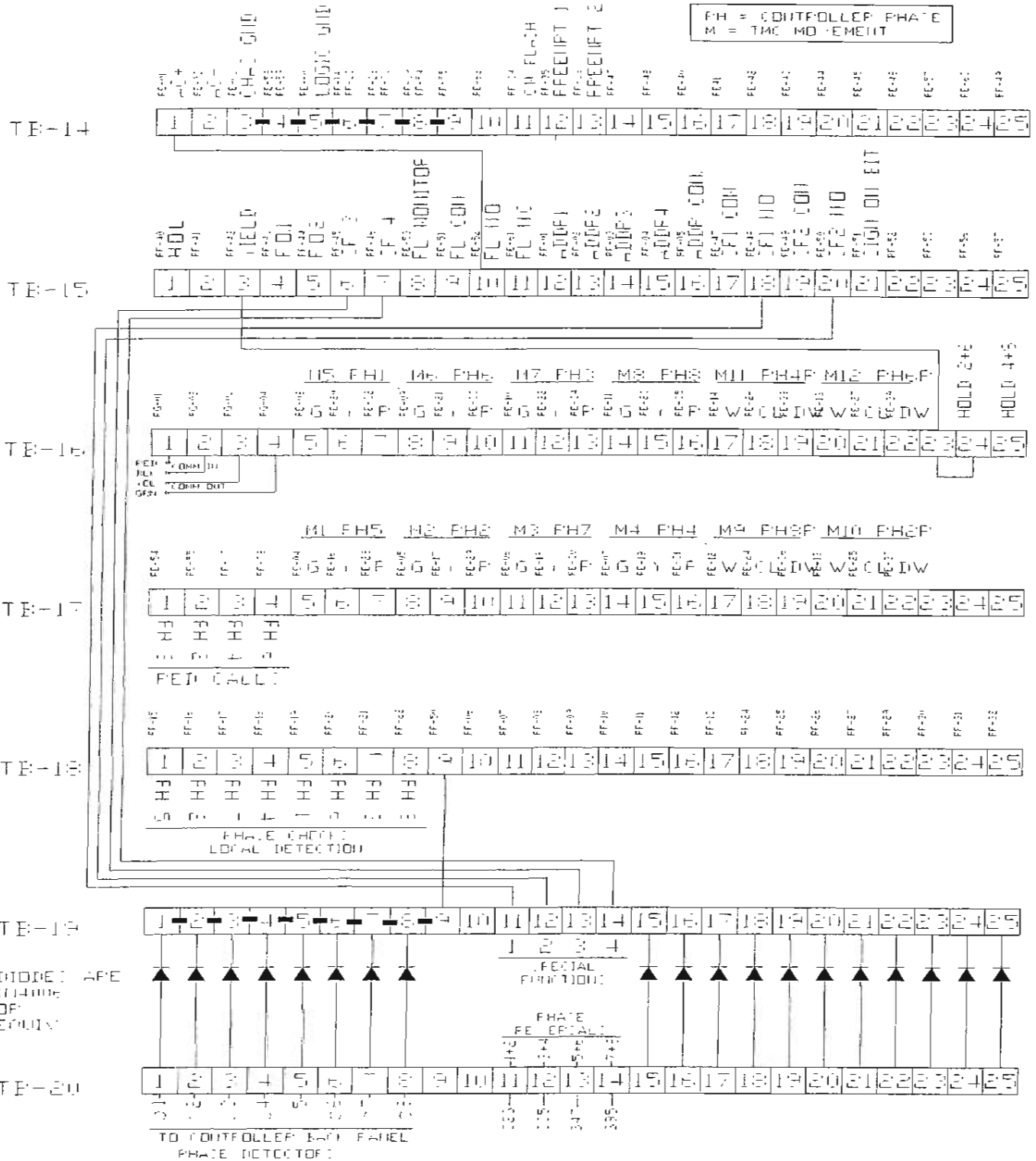
- (c) **Interconnect Cable Termination.** Each controller cabinet shall have a telephone terminal block for terminating the system interconnect cable. The terminal block shall be a Reliable Electric #R66B4-25 or equivalent. The first set of terminals shall be used for the TMC phone; the second set shall 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.

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PE - J1				PF - J2			
PIN	FUNCTION	FROM	TO	PIN	FUNCTION	FROM	TO
1.02e+0	+115 VAC	TB14-01		01	ADDRESS BIT 1	TB15-12	
8	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	

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623 T.02.10 .02 GENERAL LAS VEGAS AREA SYSTEM REQUIREMENTS:

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

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

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

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

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

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

(f) **System Control Functions.**

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

Yield: The yield output shall be wired to the hold inputs for controller phases (2 and 6) or (4 and 8) jumper selectable on the terminal block TB16-23/24/25, refer to communication panel drawing on

previous page for proper wiring). The yield output shall be active only when the H.O.L. output is active. The yield condition shall be a release of the hold inputs to the controllers.

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

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

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

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

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

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

- (g) **Controller Sequence Reversal:** Dual ring controllers shall be capable of phase sequence reversal by applying a ground true signal to connector B. Applying ground true signal to pin B shall cause the controller to reverse sequence phases 1 and 2 (lead-lag). Applying ground true signal to pin W shall cause the controller to reverse sequence phase 3 and 4 (lead-lag). Applying ground true signal to pin X shall cause the controller to reverse sequence phase 5 and 6 (lead-lag). Applying ground true signal to pin 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.

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- (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).
- (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.

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- (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
 - (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 623 T.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.
- (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

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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 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.

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)

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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.

709.03.08 BITUMINOUS COATED CORRUGATED METAL PIPE FOR UNDERDRAINS: This pipe shall conform to the requirements of AASHTO M 36 and shall be coated with the bituminous material to meet requirements of AASHTO M 190, Type A coating, except that minimum coating thickness shall be 0.03 inch (8 millimeters). Coupling bands shall be full coated. The specified minimum diameter for perforations shall apply after coating.

709.03.09 THERMOPLASTIC, PLASTIC PIPE CULVERTS AND DRAINS:

MATERIALS

- (a) **Corrugated Polyethylene Pipe, Type C** - Type C corrugated polyethylene pipe shall be manufactured from high density polyethylene (HDPE) virgin compounds and shall conform to AASHTO Designation M 252 for pipe sizes 3 inches (76 mm) to 10 inches (254 mm) , AASHTO Designation M 294 for pipe sizes 12 inches (305 mm) to 48 inches (1200 mm), and AASHTO Designation MP7-97 for pipe sizes 54 inches (1350 mm) and 60 inches (1500 mm), unless otherwise specified herein or in the special provisions. Both the inside and outside surface of the pipe shall be corrugated.
- (b) **Corrugated Polyethylene Pipe, Type S** - Type S corrugated polyethylene pipe shall be manufactured from high density polyethylene (HDPE) virgin compounds and shall conform to AASHTO Designation M 252 for pipe sizes 4 inches (102 mm) to 10 inches (254 mm) , AASHTO Designation M 294 for pipe sizes 12 inches (305 mm) to 48 inches (1200 mm), and AASHTO Designation MP7-97 for pipe sizes 54 inches (1350 mm) and 60 inches (1500 mm), unless otherwise specified herein or in the special provisions. The pipe wall shall be corrugated exterior construction with a smooth inner liner.
- (c) **Corrugated Polyethylene Pipe, Type D** - Type D corrugated polyethylene pipe shall be manufactured from high-density polyethylene (HDPE) virgin compounds. Nominal sizes of 42 inches (1050 mm) and 48 inches (1200 mm) shall conform to AASHTO Designation M-294, and nominal sizes of 54 inches (1350 mm) and 60 inches (1500 mm) shall conform to AASHTO Designation MP7-97, unless otherwise specified herein or in the Special Provisions.

The pipe shall consist of an essentially smooth waterway braced circumferentially or spirally with projections or ribs joined to an essentially smooth outer wall. Both walls shall be fused to, or continuous with, the internal supports.

- (d) **Ribbed Profile Wall or Spiral Wound Polyethylene Pipe** - Ribbed wall polyethylene pipe shall be manufactured from high density polyethylene (HDPE) virgin compounds and shall conform to ASTM Designation F 894. The pipe wall shall be of either solid or hollow rib exterior construction with a smooth inner surface.
- (e) **Ribbed Profile Wall or Spiral Wound Polyvinyl Chloride Pipe** - Ribbed profile wall polyvinyl chloride pipe shall be manufactured from polyvinyl chloride (PVC) virgin compounds and shall conform to AASHTO Designation M 304, unless otherwise specified herein or in the special provisions. The pipe wall shall be of solid rib exterior construction with a smooth inner surface.

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- (f) **Solid Wall Polyvinyl Chloride Pipe** - Solid wall polyvinyl chloride (PVC) pipe and fittings shall be type PSM Poly(vinyl chloride) pipe and fittings in accordance with ASTM D 3034, SDR 35, or ASTM F 679 with a T-1 wall thickness or Class P550 Polyvinyl Chloride Pipe and fittings conforming to the requirements of AASHTO M 278.
- (g) **Special Fittings.** Special fittings such as elbows, tees and wyes for these conduits shall be of the same material as the conduits to which they are joined, and shall conform to applicable requirements for type of material being used.

When thermoplastic pipe end sections are required, the following requirements shall pertain:

- (1) End fittings shall be of the sizes shown on the plans.
- (2) The end of the pipe shall be furnished with corrugation to conform to the end fittings. However, other designs may be used if approved by the Engineer.
- (3) Where connector fittings are used, the connector fittings shall be helical or annular as required to match the type of pipe used.

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

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

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

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

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

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

The cell classification for each individual property of PVC compounds shall conform to ASTM Designation D 1784 and the following:

Property	Cell Classification
Base Resin	1
Impact Strength (Izod)	2 through 6
Tensile Strength	3 or 4
Modulus of Elasticity	5 or 6
Deflection Temperature	4 or 5
Chemical Resistance	A, B, or C

709.03.10 CORRUGATED POLYETHYLENE PIPE FOR PERFORATED UNDERDRAINS: Type CP pipe shall conform to the requirements of AASHTO M 252 for nominal sizes of 3 inches (76 mm) through 10 inches (254 mm), AASHTO M 294 for nominal sizes of 12 inches (305 mm) through 48 inches (1200 mm), and AASHTO MP7-97 for nominal sizes of 54 inches (1350 mm) and 60 inches (1500 mm). Type SP pipe shall conform to the requirements of AASHTO M 252 for nominal sizes of 4 inches (102 mm) through 10 inches (254 mm), AASHTO M 294 for nominal sizes of 12 inches (305 mm) through 48 inches (1200 mm), and AASHTO MP7-97 for nominal sizes of 54 inches (1350 mm) and 60 inches (1500 mm).

709.03.11 STRUCTURAL PLATE PIPE AND PIPE ARCHES: This pipe shall conform to the requirements of AASHTO M 167.

709.03.12 CAST IRON PIPE: This pipe shall conform to the requirements of ASTM 74, "Sewer Pipe" or AWWA 106, 108 "Water Pipe" as applicable.

709.03.13 STEEL WATER PIPE: This pipe shall conform to the requirements AWWA C 201, C 202.

SECTION 710

STRUCTURAL AND EYEBAR STEEL

SCOPE

710.01.01 MATERIAL COVERED: This specification covers the quality of structural and eyebar steel used in highway structures.

REQUIREMENTS

710.02.01 DEFECTS: Finished rolled material shall be free from cracks, flaws, injurious seams, laps, blisters, ragged and imperfect edges, and other defects. It shall have a smooth, uniform finish, and shall be straightened in the mill before shipment.

Material shall be free from loose mill scale, rust pits, or other defects affecting its strength or durability.

The Engineer reserves the right to reject material which he deems unsuitable for the purpose intended even though the material meets the requirements of the mill tolerances.

710.02.02 CHARPY V-NOTCH TEST: All steels used in and designated as main load carrying members subject to tensile stress, shall comply with all the requirements specified for Charpy V-notch test in the various AASHTO Designations for the steels involved. Sampling and testing procedures shall be in accordance with the requirements of the applicable AASHTO Designations.

PHYSICAL PROPERTIES AND TESTS

710.03.01 STANDARD STEEL: This steel shall conform to the requirements of AASHTO M 183.

710.03.02 HIGH STRENGTH-LOW ALLOY STRUCTURAL MANGANESE VANADIUM STEEL: This steel shall conform to the requirements of ASTM A 441.

710.03.03 HIGH TENSILE STRENGTH BOLTS: This steel shall conform to the requirements of ASTM A 325.

710.03.04 STAINLESS STEEL BOLTS: This steel shall conform to the requirements of ASTM A 276.

710.03.05 WELDED SEAMLESS STEEL PIPE: This steel shall conform to the requirements of ASTM A 53 (Grade B).

710.03.06 COLD-FORMED WELDED AND SEAMLESS CARBON STEEL STRUCTURAL TUBING IN ROUNDS AND SHAPES: This steel shall conform to the requirements of ASTM A 500 (Grade B) except the minimum tensile strength shall be 55,000 psi (379 MPa).

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