

UNIFORM STANDARD SPECIFICATIONS CLARK COUNTY AREA

SPECIFICATION - YEAR 2005 REVISIONS

Section	Title	Nature of Change	Page Number	Effective Date
101	Definitions And Terms	Revision to add abbreviations and definitions of IQAC, QC and QA.	101-1 - 101-8	1/1/2005
107	Legal Relations And Responsibilities To The Public	Revision to address temporary traffic control in work zones.	107-2 - 107-3	7/1/2005
505	Reinforcing Steel	Revisions to Subsections 505.01.01, 505.02.01, 505.02.02, 505.02.03, 505.03.01, 505.03.04, and 505.03.05 to improve reinforcement requirements and reference ACI standards.	505-1 - 506-1	1/1/2005
623	Traffic Signals And Street Lighting	Revision to Subsection 623 G.03.07 "Wiring" to address the use of gel-filled splice kits for splicing wires at streetlight and traffic signal poles and pull box installations.	623-1 - 624-1	1/1/2005
627	Permanent Signs	Revision to Subsection 627.02.02, "Reflectorization" to change the sign material requirement from Class 4 High Intensity to Class 6 as a minimum standard.	626-1 - 627-3	7/1/2005
702	Concrete Curing Materials And Admixtures	Revision to update to current industry standards and the addition of curing materials and material certification requirements.	701-2 - 703-1	1/1/2005
707	Joint Materials	Revision to Subsection 707.03.04 "Pourable Joint Sealer" to allow the use of pourable joint sealer in concrete channel expansion and weakened plane joints and to remove references to California State Specifications.	707-1 - 707-4	7/1/2005
728	Epoxy	Revision to Subsection 728.03.11, "Binder (Adhesive) Structural Epoxy" of to allow the use of structural epoxy adhesive in lieu of No. 4 dowel bars for securing island curb to existing asphalt cement pavement except at curb noses, and two feet either side of points of curvature.	728-4 - 728-6	1/1/2005

DIVISION I
GENERAL REQUIREMENTS
SECTION 101
DEFINITIONS AND TERMS

Wherever in these specifications or in other contract documents the following terms or pronouns in place of them are used, the intent and meaning shall be interpreted as follows:

101.01 ABBREVIATIONS: Wherever the following abbreviations are used in these specifications or on the plans, they are to be construed the same as the respective expressions represented:

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

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

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

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

101.05 AWARD: The acceptance by the Contracting Agency of a bid.

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

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

101.08 BOARD: The officer or body constituting the awarding authority for the Contracting Agency.

101.09 BRIDGE: A structure, including supports, erected over a depression or an obstruction, as water, highway, or railway, and having a track or passageway for carrying traffic or other moving loads and having a length measured along the center of roadway of more than twenty (20) feet between under copings of abutments or extreme ends of openings for multiple boxes.

Length: The length of a bridge structure is the overall length measured along the line of survey stationing back to back of back walls of abutments, if present, otherwise end to end of the bridge floor; but in no case less than the total clear opening of the structure.

Roadway Width: The clear width measured at right angles to the longitudinal centerline of the bridge between the bottom of curbs or guard timbers or in the case of multiple height of curbs, between the bottoms of the lower risers and in the case of no curbs or guard timbers, between the inner faces of parapet or railing at the bottom.

101.10 CALENDAR DAY: Every day shown on the calendar.

101.11 CONTRACT CHANGE ORDER OR FIELD CHANGE ORDER: A written order issued by the Engineer or Contracting Agency as provided in the contract documents, to the Contractor, covering changes in the plans, specifications or quantities or both, within the scope of the contract and establishing the basis of payment and time adjustments for the work affected by the change.

101.12 CHANNEL: A natural or artificial water course.

101.13 CONTRACT: The written agreement between the Contracting Agency and the Contractor setting forth the obligations of the parties thereunder, including, but not limited to the performance of the work, the furnishing of labor and materials, and the basis of payment.

The contract includes the invitation for bids, proposal, contract form and contract bond, standard specifications, supplemental specifications, special provisions, general and detailed plans, notice to proceed, and any change orders and supplemental agreements that are required to complete the construction of the work in an acceptable manner, including authorized extensions and basis of payment thereof, all of which constitute one instrument.

101.14 CONTRACTING AGENCY: The party of the first part to a contract which may be any of the following entities: Boulder City, Nevada; City of Henderson, Nevada; City of Las Vegas, Nevada; City of North Las Vegas, Nevada; City of Mesquite, Nevada; Las Vegas Valley Water District, Las Vegas, Nevada; Clark County Sanitation District, Las Vegas, Nevada; and Clark County, Nevada.

101.15 CONTRACT ITEM (PAY ITEM): An item of work specifically described and for which a price, either Unit or Lump Sum, is provided. It includes the performance of all work and the furnishing of all labor, equipment, and materials described in the text of a specific item included in the contract or described in the Standard Specifications, Supplemental Specifications or Special Provisions of the contract. Contract items are numbered so that the first three digits of the item number corresponds to the section of the same number. Thus, in Item No. 203.01.00, which is the item number for roadway excavation, the number 203 is the section number and corresponds to Section 203 of the Standard Specifications, Supplemental Specifications and Special Provisions.

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

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

101.17 CONTRACT TIME: The number of days allowed for completion of the contract, including authorized time extensions.

101.18 CULVERT: Any structure not classified as a bridge which provides an opening under the roadway.

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

101.20 DIVIDED HIGHWAY: A highway with separated roadways for traffic in opposite directions.

101.21 EMPLOYEE: Any person working on the project mentioned in the contract of which these specifications are a part, and who is under the direction and control, or received compensation from the Contractor or his subcontractor.

101.22 ENGINEER: The Chief Engineer of the Contracting Agency or other person designated by the Board acting directly and through his duly authorized representative.

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

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

101.25 FRONTAGE ROAD OR FRONTAGE STREET: A local street or road auxiliary to and located generally on the side of an arterial highway for service to abutting property and adjacent areas and for control of access.

101.26 GUARANTEE BOND: The approved form of security executed by the Contractor and his surety of sureties guaranteeing the work against defect and failures.

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

101.28 HOLIDAYS: Any day established by law or agreed as a holiday for employees of the contracting agency.

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

101.30 INTERAGENCY QUALITY ASSURANCE COMMITTEE (IQAC): An ad hoc multi-jurisdictional and agency committee established for the purpose of simplifying the material approval process and promoting the consistent enforcement of the Uniform Standard Specifications and Drawings, Clark County Area, Nevada.

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

101.32 MAJOR CONTRACT ITEM: A "Major Item" shall be construed to be any individual bid item included in the proposal that has a total cost equal to or greater than \$50,000 or 5 percent of the total contract cost, whichever is the lesser amount. The total contract cost shall be computed on the basis of the proposal quantities and contract unit prices.

101.33 MATERIALS: Any substances specified for use in the construction of the project and its appurtenances.

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

101.35 NOTICE TO BIDDERS: The official notice inviting bids for the proposed work or materials.

101.36 NOTICE TO PROCEED: A written notice to the Contractor to proceed with the contract work including, when applicable, the date of beginning of contract time.

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

101.38 LABOR AND MATERIAL BOND: The approved form of security executed by the Contractor and his surety or sureties to guarantee the payment of persons furnishing materials or persons performing labor under the contract.

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

101.40 PLANS: The approved project plans and Standard Drawings, profiles, typical cross sections, working drawings, and supplemental drawings, or exact reproductions thereof, which show the location, character, dimensions, and details of the work to be performed. All such documents are to be considered as a part of the plans whether or not noted in the Special Provisions.

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

- (a) Standard Drawings - The Standard Drawings of the Contracting Agency.
- (b) Project Drawings - The Project Drawings are specific details and dimensions peculiar to the work and are supplemented by the Standard Plans insofar as the same may apply.

101.41 PROFILE GRADE: The trace of a vertical plane intersecting the top surface of the proposed structural section as shown on the plans. Profile grade means either elevation or gradient of such trace according to the context.

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

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

101.44 PROPOSAL FORM: The approved form on which the Contracting Agency requires bids to be prepared and submitted for the work.

101.45 PROPOSAL GUARANTEE: The security furnished with a bid to guarantee that the bidder will enter into the contract if his bid is accepted.

101.46 QUALITY ASSURANCE (QA): Planned and systematic operations conducts to ensure that the operations and/or product meets specifications. QA encompasses the Engineer's review and oversight of the Contractor's "Quality Control"; verifying the results of "Quality Control"; and inspecting for conformance to plans and specifications. QA is the responsibility of the "Engineer".

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

101.48 RIGHT-OF-WAY OR EASEMENT: A general term denoting land, property or interest therein, usually in a strip, acquired for or devoted to a highway or other improvements.

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

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

101.51 ROADSIDE: A general term denoting the area adjoining the outer edge of the roadway. Extensive areas between the roadways of a divided highway may also be considered roadside.

101.52 ROADSIDE DEVELOPMENT: Those items necessary to the complete improvement which provides for the preservation of landscape materials and features; the rehabilitation and protection against erosion of all areas disturbed by construction through seeding, sodding, mulching, and the placing of other ground covers; such suitable planting and other improvements as may increase the effectiveness and enhance the appearance of the improvement.

101.53 ROADWAY: The portion of a highway within limits of construction.

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

101.55 SIDEWALK: That portion of the roadway primarily constructed for the use of pedestrians.

101.56 SPECIAL PROVISIONS: Additions and revisions to the standard and supplemental specifications covering conditions peculiar to an individual project.

101.57 SPECIFICATIONS: The directions, provisions, and requirements contained in the Standard Specifications and supplemental specifications as modified by the Special Provisions. Whenever the term "these specifications" is used in this book, it means the provisions set forth in this book.

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

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

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

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

101.62 SUPERINTENDENT: The Contractor's authorized representative in responsible charge of the work, present on the work at all times during the progress to supervise and direct the construction, to receive and fulfill instructions from the Engineer, and to accept orders for changed and extra work.

101.63 SUPERSTRUCTURE: The entire structure except the substructure.

101.64 SUPPLEMENTAL AGREEMENT: A written agreement within the scope of the project made and entered into by and between the Contractor and the Contracting Agency covering work not otherwise provided for, revisions in or amendments to the terms of the contract, or conditions specifically prescribed in the specifications as requiring supplemental agreements. Such supplemental agreements become a part of the contract when approved and properly executed.

101.65 SUPPLEMENTAL SPECIFICATIONS: Additions and revisions to the Standard Specifications that are adopted subsequent to the issuance of the printed book.

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

101.67 SURFACE COURSE: The top layer of an improvement.

101.68 TRAFFIC LANE: The portion of a traveled way for the movement of a single line of vehicles.

101.69 TRAVELED WAY: That portion of roadway for the movement of vehicles, exclusive of shoulders and auxiliary lanes.

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

101.71: BLANK:

101.72 WORK: Work will mean furnishing all labor, materials, equipment, and other incidentals necessary or convenient to the successful completion of the project and the carrying out of all of the duties and obligations as imposed by the contract.

101.73 WORKING DAY: A day on which weather and other conditions not under the control of the Contractor will permit construction operations to proceed for the major part of the day (five (5) hours) with the normal working force engaged in performing the controlling item or items of work which would be in progress at that time, exclusive, however, of Saturdays, Sundays, holidays and any day that is incumbent upon the Contractor, by means of a labor union, to observe as a holiday. However, if the Contractor elects to work on such days, those days will be considered as a working day.

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

101.74 WORKING DRAWINGS: Stress sheets, shop drawings, erection plans, falsework plans, framework plans, cofferdam plans, bending diagrams for reinforcing steel, or any other supplementary plans or similar data which the Contractor is required to submit to the Engineer for approval.

101.75: In order to avoid cumbersome and confusing repetition of expressions in these specifications, it is provided that whenever anything is, or is to be, done, if, as, or, when, or where "contemplated, required, determined, directed, specified, authorized, ordered, given, designated, indicated, considered necessary, deemed necessary, permitted, reserved, suspended, established, approval, approved, disapproved, acceptable,

unacceptable suitable, accepted, satisfactory, unsatisfactory, sufficient, insufficient, rejected, or condemned," it shall be understood as if the expression were followed by the words "by the Contracting Agency."

foreseen and prevented by the Contractor, the Engineer will determine the extent of the delay, the effect of the delay on the project as a whole, and recommend to the Board any time extension indicated.

107.05 BLANK:

107.06 SANITARY PROVISIONS: The Contractor shall provide and maintain in a neat, sanitary condition, such accommodations for the use of his employees as may be necessary to comply with the requirements and regulations of the District Board of Health and of other bodies or tribunals having jurisdiction thereover. He shall commit no public nuisance.

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

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

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

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

1. Unless otherwise specified in the Special Provisions, no public bus or transit stop shall be temporarily closed without the written consent of the Regional Transportation Commission Director or his designee. The RTC shall be notified at least 10 working days prior to the proposed temporary closure of any bus or transit stop, including those listed in the Special Provisions.
2. No bus stops at transfer points shall be closed during construction. Bus stops at transfer points can, however, be temporarily relocated with the approval of the RTC Director or his designee.
3. If bus or transit stop is temporarily relocated, the existing bus or transit stop sign panels shall be relocated to temporary bus or transit stops and shall remain until temporary stop is removed. Temporary relocation of sign panels shall conform to Subsection 627.03.05, "Relocation."
4. The Contractor shall maintain access which is in conformance to the requirements of the Americans with Disabilities Act to and from bus or transit stops which remain open at all times during construction.

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

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

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

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

the other half shall be conditioned and maintained as a detour.

The Contractor shall absorb in his bid all costs for the above requirements.

Construction materials may not be stored in streets, roads, or highways for more than five (5) days after unloading. All materials or equipment not installed or used in the construction within five (5) days after unloading shall be stored elsewhere by the Contractor at his expense unless he is authorized additional storage time.

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

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

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

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

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

107.08 RELATIONS WITH RAILROADS:

(a) **Definitions.** The following definitions shall apply to the terms as herein used:

Railroad: The railway or railroad company whose tracks are crossed or whose property is adjacent to the work or upon whose property the work is performed.

Chief Engineer: The Chief Engineer of the railroad or his authorized representatives.

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

Grade Separation: A permanent structure to affect the separation of grade between the highway and the railroad.

(b) **Work or Operations.**

- (1) Work or operations on grade separations, railroad crossings, or upon railroad property shall be subject to inspection by the Chief Engineer and shall be conducted and performed in a manner satisfactory to the Chief Engineer.
- (2) Construction operations shall be so arranged and conducted as to insure safe and uninterrupted operation of the railroad traffic. The Contractor shall be responsible for any damages which result either directly or indirectly from the Contractor's operations.

SECTION 505

REINFORCING STEEL

DESCRIPTION

505.01.01 GENERAL: This work shall consist of furnishing and placing reinforcing steel and mesh reinforcing in accordance with ACI 318 Chapter 7 and ACI 315 with the additions or exceptions listed below.

MATERIALS

505.02.01 GENERAL: Materials shall conform to the requirements specified in the following subsections:

Fabricated Steel Bar or Rod Mats Reinforcement	Subsection 713.03.02
Bar Steel Reinforcement	Subsection 713.03.01
Welded Steel Wire Fabric Reinforcement	Subsection 713.03.03

Bar steel reinforcement may be either Grade 300 (40) or Grade 420 (60) bar steel reinforcement unless otherwise specified on the plans.

Spiral Reinforcement may be either Bar Steel Reinforcement or Steel Wire, of the equivalent size of the bar steel.

Epoxy coatings for steel reinforcing bars shall conform to ASTM D2963 Annex. Epoxy coatings listed in the NDOT QPL, latest edition, shall be used.

Tie wire shall be commercial quality 1.5 mm diameter (16 gage) minimum, black annealed soft iron wire, unless otherwise approved. Tie wires used on epoxy coated reinforcing steel shall be coated with plastic or an equal type coating as approved.

505.02.02 SAMPLES: One extra bar of each diameter shall be furnished for each one hundred (100) tons (90 metric tons) or fraction thereof. This bar shall be selected from the longest bar of each size so that the bar, or a portion of it, can be used to replace any bar of that diameter which is selected to be used as a field sample. Supply field sample shall be of sufficient length to provide two (2) thirty, (30) inch (750 millimeters) samples of each diameter. The extra bars shall be indicated on the fabricator's details.

505.02.03 SPECIFICATIONS FOR COATING REINFORCING STEEL: Coating of reinforcing steel shall conform to AASHTO M284. The coating fabricator for epoxy coated reinforcing steel shall be certified by the Concrete Reinforcing Steel Institute's Certification Program for Fusion Bonded Epoxy Coating Applicator Plants. A copy of the Epoxy Coating Certification along with notification starting date of coating application shall be submitted.

Notification shall be given of the date and location of the coating operation, in writing, at least 10 days before the planned date for beginning the coating operation. The Engineer shall be allowed free access to plant of the coating applicator for inspection. If the representative so elects, preparation of the bars, coating and curing of the bars shall be performed in the representative's presence.

Patching or repair material shall be made available from the coating manufacturer, which is in compliance with AASHTO M284.

CONSTRUCTION

505.03.01 REINFORCING STEEL LIST: In accordance with ACI 315, before placing reinforcing steel, the Contractor shall submit shop drawing details and furnish two copies of a list of all reinforcing steel showing sizes, lengths and numbers of pieces and bends required to the Engineer at the site of his use in administering the contract. Furnishing such lists to the Engineer shall not be construed to mean that the lists will be reviewed for accuracy. The Contractor shall be wholly and completely responsible for the accuracy of the lists and for furnishing and placing all bar reinforcing steel in accordance with the details shown on the plans and as specified.

505.03.02 PROTECTION OF MATERIALS: Reinforcing steel shall be protected at all times from damage. When placed in the work, the reinforcing steel shall be free from dirt, detrimental scale, paint, oil, or other foreign substance. However, when steel has on its surface loose mill scale or dust which is easily removable, it may be cleaned by a satisfactory method, if approved by the Engineer.

505.03.03 BENDING: Bent bar reinforcement shall be cold bent to the shape shown on the plans; and unless otherwise provided on the plans or by authorization, bends shall be made in accordance with the ACI Manual of Standard Practice for Detailing Reinforced Concrete Structures.

505.03.04 PLACING AND FASTENING: In accordance with ACI 315, all bar reinforcement shall be accurately placed in the positions shown on the plans and firmly held during the placing and setting of concrete. When the spacing of bars exceeds one (1) foot (30 centimeters) in either direction, all intersections shall be tied.

Distances from the vertical and horizontal forms shall be maintained by means of stays, blocks, ties, hangers, or other approved supports. Blocks used for holding reinforcing bars from contact with the forms or between layers of bars, shall be precast mortar blocks of approved shape and dimensions and shall have a compressive strength of not less than 3,000 psi (20.68 MPa). Metal chairs which are in contact with the exterior surface of the concrete shall be fabricated of either galvanized steel, or have the steel tips plastic coated to at least 3/4 inch (1.91 centimeters) into the concrete, or be of stainless steel conforming to the requirements of ASTM A 493, Type 430. The use of pebbles, pieces or broken stone or brick, metal pipe, and wooden blocks will not be permitted. Reinforcement in any member shall be placed, and then inspected and approved by the Engineer, before the placing of concrete begins. Concrete placed in violation of this provision may be rejected and its removal required.

If mesh reinforcement is shipped in rolls, it shall be straightened into flat sheets before being placed.

505.03.05 SPLICING: In accordance with ACI 315, all reinforcement bars shall be furnished in the full lengths indicated on the plans. Splicing of bars, except where shown on the plans, will not be permitted without the written approval of the Engineer. Splices shall be staggered as far as possible. Unless otherwise shown on the plans, bars near the top of beams and girders having more than twelve (12) inches (30 centimeters) of concrete under the bar shall be lapped thirty-five (35) diameters and all other bars shall be lapped twenty (20) diameters to make the splice. In lapped splices, the bars shall be placed in contact and wired together. Welding of reinforcing steel shall be done only if detailed on the plans or authorized by the Engineer in writing. Welding shall conform to the specifications for Welded Highway and Railway Bridges of the American Welding Society.

Lapped splices in reinforcement shall not be used for sizes larger than No. 11, (3.49 centimeters).

Tensile reinforcement shall preferably not be spliced at points of maximum stress. The length of lap for deformed

bars shall not be less than 24 and 36 bar diameters for Grade 40 and Grade 60, respectively, nor less than 12 inches (30 centimeters).

Where lapped splices are used in reinforcement in which the critical design stress is compressive and with concrete having a strength of 3000 psi (20.68 MPa) or more, the length of lap for deformed bars shall be 20 bar and 24 bar diameters for Grade 40 and Grade 60, respectively, but not less than twelve (12) inches (30 centimeters). When the specified concrete strengths are less than 3000 psi (20.68 MPa), the amount of lap shall be 1/3 greater than the values given above.

Splices in spiral steel shall be made by welding or a lap of one and one-half (1-1/2) turns.

Sheets of mesh reinforcement shall overlap each other sufficiently to maintain a uniform strength and shall be securely fastened at the ends and edges. The edge lap shall not be less than one (1) mesh in width.

505.03.06 SUBSTITUTIONS: Substitution of different size bars will be permitted only with specific authorization by the Engineer. The bars substituted shall have an area equivalent to the design area or larger.

METHOD OF MEASUREMENT

505.04.01 MEASUREMENT: The calculated quantity shown on the plans, plus or minus quantities covered by approved changes, will be the quantity used for payment. The Contractor may request final measurement if a possible error is suspected in the quantities shown on the plans. The Contractor's request for final measurement shall be in writing. Final measurement will be made according to the dimensions shown on the plans plus or minus approved changes and quantities derived therefrom will be the quantity used for payment. Furthermore, when the Contractor requests final measurement and calculations and the quantities thus determined are the same or less than the planned quantities plus authorized changes, the Contractor shall reimburse the Contracting Agency for the agency's expenses incurred by such final measurements and calculations. The quantity of reinforcing steel measured for payment will be the number of pounds complete and in place.

The calculated weights of the plain and deformed bars shall be based on the following table:

Size Number	Nominal Diameter		Weight Per Foot In	
	Inches	Centimeters	Pounds	Meter/Kilograms
2	0.250	.635	0.167	0.249
3	0.375	.953	0.376	0.559
4	0.500	1.270	0.668	0.994
5	0.625	1.588	1.043	1.552
6	0.750	1.905	1.502	2.235
7	0.875	2.223	2.044	3.041
8	1.000	2.540	2.670	3.973
9	1.128	2.865	3.400	5.060
10	1.270	3.226	4.303	6.403
11	1.410	3.581	5.313	7.906
14	1.692	4.298	7.650	11.384
18	2.256	5.730	13.600	20.238

The quality of mesh reinforcement to be measured for payment will be the number of square yards (square meters) complete and in place measured along the plane of placement. No allowance will be made for laps.

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

BASIS OF PAYMENT

505.05.01 PAYMENT: The accepted quantity of reinforcing steel measured as provided in Subsection 505.04.01, "Measurement," will be paid for at the contract unit price bid per pound (kilogram).

The accepted quantity of mesh reinforcement measured as provided in Subsection 505.04.01, "Measurement," will be paid for at the contract unit price bid per square yard (square meter).

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

Payment will be made under:

PAY ITEM	PAY UNIT
Reinforcing Steel	Pound (Kilogram)
Mesh Reinforcing	Square Yard (Square Meter)

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SECTION 506
STEEL STRUCTURES

DESCRIPTION

506.01.01 GENERAL: This item shall consist of furnishing, fabricating, casting, machining, or otherwise preparing, transporting, erecting, and painting structural steel, rivet and eye bar steel, steel forgings, casting, and any other metal of the type, shape, dimensions, and quality, required by these specifications or as shown on the plans.

MATERIALS

506.02.01 GENERAL: Materials shall meet the pertinent requirements of the following sections:

Structural and Eyebars Steel	Section 710
Aluminum for Bridge Rail	Section 711
Miscellaneous Metals	Section 712
Paint	Section 714
Galvanizing	Section 715
Elastomeric Bearing Pads	Section 725

Turned bolts shall meet the material specifications set forth for Structural Rivet Steel. Anchor bolts, nuts, and washers shall be of structural steel, galvanized in accordance with ASTM Designation A 153. Bolts for fastening tubes to the rail posts sockets shall be stainless steel.

Steel bridge and pedestrian railing shall be primed and painted in accordance with Section 714, Subparagraph (a).

Bridge or pedestrian rail and posts made of aluminum shall not be painted.

Shims shall be either aluminum alloy or asbestos sheet packing, at the Contractors's option. Aluminum Alloy Shims shall conform to ASTM Designation B 209, Alloy 1100-0. Asbestos sheet packing shall be composed essentially of asbestos fibers bonded together with a cementing medium rendering it tough and pliable. The deformation of the packing under a load of 10,000 pounds per square inch (69 MPa) shall be less than 16 percent of the thickness and the loss on ignition shall not be more than 25 percent.

Insulating material for insulating the base of aluminum rail posts from concrete and from steel anchor bolts shall be an aluminum impregnated light colored caulking compound of the consistency of putty.

Shims for steel railing shall be galvanized steel plates.

All bolts, nuts and washers shall be either steel galvanized in accordance with ASTM Designation A 153; stainless steel conforming to ASTM Designation A 276; or steel cadmium plated in accordance with ASTM Designation A 165, Type TS.

CONSTRUCTION

506.03.01 SHOP DRAWINGS: Shop drawings shall consist of shop detail, erection and other working plans showing dimensions, size of material, details, and other information necessary for the complete fabrication and

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SECTION 623

TRAFFIC SIGNALS AND STREET LIGHTING

DESCRIPTION

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

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

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

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

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

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

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

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

623 G.01.03 EQUIPMENT LIST AND DRAWINGS: Unless otherwise permitted in writing by the Engineer, the Contractor shall within fifteen (15) days following approval of the contract, submit to the

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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.

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 – L.M.S.A. SPECIFICATIONS – #19-2 OR #19-1

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

CONSTRUCTION

623 G.03.01 MAINTENANCE OF EXISTING AND TEMPORARY ELECTRICAL SYSTEMS:

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

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

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

Where damage is caused by the Contractor's operations, the Contractor shall at his expense, repair or replace, at the direction of the Engineer, damaged facilities promptly in accordance with these specifications. Should the Contractor fail to perform the required repairs or replacements, the cost of performing such repairs or replacements will be deducted from any monies due or to become due the Contractor.

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

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

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

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

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

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

COMMUNICATIONS INFRASTRUCTURE FOR THE FREEWAY AND ARTERIAL SYSTEM OF TRANSPORTATION (FAST): Communications infrastructure installed for the use of the FAST shall meet the following guidelines:

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

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property line. If adjacent property has "FIBER OPTIC" pull box already installed directly adjacent to proposed pull box location, the entity Engineer may waive placement of the new box for this particular location.

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

facilities are required, the appropriate size conduit shall be installed at the lip of gutter with a large sweeping elbow laying sideways under the curb. The angle of the elbow's entry into the "P30" pullbox or "Type 200" communications vault shall be determined in order to provide a straight pull over the lip of the pullbox lid. The spacing of these pullboxes or the inclusion of this conduit shall be determined by the FAST system manager or th appropriate ITS staff during the review/design process and shall be dependent upon the existing infrastructure. All decisions shall be in conjunction with the continually updated master planed approach for the Valley's communication facilities.

- (13) When fiber optic cable is installed, a minimum of thirty (30) feet (9.1 meters) of slack shall be safely coiled into each "P30" pullbox and a minimum sixty (60) feet (18.3 meters) in each "Type 200" vault, hung on the sidewall attachment.

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

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

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

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

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

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

Temporary repairs of damage to an extended length of cable or of damage at more than a single discrete point may consist of placing cable overhead until permanent replacement is completed. Permanent restoration of a damaged interconnect cable shall be made in one (1) of the following methods as approved by FAST personnel:

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

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the installation process.

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

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

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

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

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

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

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

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

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

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

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

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

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

623 G.03.04 EXCAVATING AND BACKFILLING: Excavations required for the installation of conduit, foundations and other facilities, shall be performed in such a manner as to cause the least possible

damage to the streets, sidewalks, and other improvements. Excavations shall not be larger than necessary for the proper installation of conduit, electrical facilities and foundations. Excavating shall not be performed until immediately before installation of conduit, facilities, and foundations.

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

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

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

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

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

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

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

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

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

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

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

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

623 G.03.06 FOUNDATIONS: Foundations for posts, standards, and pedestals shall be concrete conforming to the applicable requirements of Section 501, "Portland Cement Concrete." For posts, standards, and pedestals, a four (4) inches (100 millimeters) minimum foundation cap consisting of grout or concrete as designated by the entity engineer shall be poured after the post, standard, or pedestal is in proper position. Grout shall conform to Subsection 501.03.11, "General Mortar". Arms shall be considered live load and may be mounted only after complying with Subsection 502.03.19. The exposed portions shall be formed to present a neat appearance. The bottom of concrete foundations shall rest on firm undisturbed ground. In addition, for traffic signal installations, the bottom two-thirds (2/3) minimum of the concrete foundation shall be poured against undisturbed soil. If signal foundation is to be placed in area which has been filled, fill shall

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meet compaction requirements as specified in the Standard Specifications or special provisions and bottom two thirds (2/3) minimum of the foundation shall be poured in drilled compacted fill and/or undisturbed soil.

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

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

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

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

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

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

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

Splices for street light cables and traffic signal cables shall be split bolt or "gel-cap" type as designated by the entity Engineer. The "gel-cap" type shall consist of a kit containing a high abrasive and impact resistant clear elastomer cap factory-filled with cross-linked silicon gel for environmental sealing. The silicon gel shall not become hard or brittle and shall have a temperature tolerance of -40°F (-40°C) to +221°F (105°C). The cap, clamp, and gel used for the "gel-type" splice kit shall be UV-resistant. Kits shall contain a split bolt connector and shall accommodate range of cable sizes specified by the entity Engineer. "Gel-cap"-type connection shall also permit removal and re-entry of wiring for maintenance purposes without damage to the splice kit.

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

Conductor insulation shall be well penciled, trimmed to conical shape, roughened and meet manufacturer's recommendations before applying splice. When conductors and cables are pulled into the conduit, all ends of the conductors and cables shall be taped to exclude moisture. Ends of spare conductors shall be taped. When new conduit is installed for future use, it shall have a #8 green (stranded) pull which is secured at both ends.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

The Contractor shall furnish and install conduit and conductors to the service point as shown on the plans

or as required to complete the installation.

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

TRAFFIC SECTION

MATERIAL

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

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

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

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

Cabinets shall have two (2) fluorescent fixtures and lights mounted in the cabinet interior. One mounted over the door, at a location least likely to be damaged. The length shall be determined by the cabinet width. The second, an 8 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.

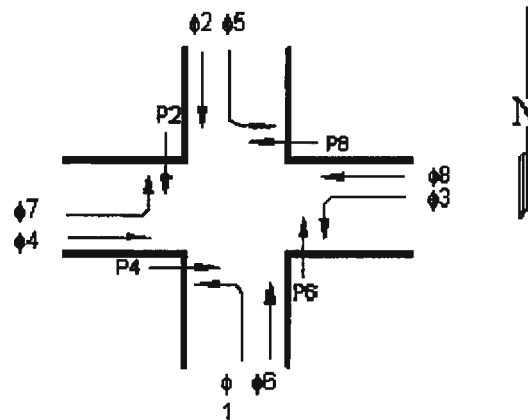
Only cabinets that are designed to use rails with infinite adjustability ('uni-strut' design) on the side of the cabinet that the shelves and panels are connected to will be accepted. These utilize "spring nuts" in the rail channel to tighten the bolts that are used. Cabinets that use carriage bolt assemblies 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-rop or approved equivalent).
- (b) Every terminal shall be numbered and identified in accordance with the cabinet wiring diagrams and prints.
- (c) The cabinet shall contain a plastic envelope that can be sealed, which is attached to the cabinet door.

This will be used to house wiring diagrams. The cabinet wiring diagrams shall show and identify the connectors for all equipment, switches, terminal blocks, relays, flashers and signal control bases. There shall be included three (3) complete sets of wiring diagrams on "D" size paper, along with a complete copy of the cabinet wiring diagram on a 3 ½ " floppy disk drawn in Autocad LT95, Autocad Rev. 12, program or approved equivalent.

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



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

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

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

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of the power supply line. This terminal point shall be in the Buss 16204-3 terminal block, or approved equivalent.

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

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

Overlaps driven flash is:

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

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

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

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

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

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

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

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

623 T.02.02 CABINET EQUIPMENT:

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

and flasher indication.

A minimum of 6 transfer relays shall be delivered with each cabinet. These shall conform to the 1983 NEMA TS1 specifications. Load bay panels shall not exceed 0.125 inches (3 mm) of flex under 5 pounds pressure.

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

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

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

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

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

(2) For Four-Channel Detectors:

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

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

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

(3) For "Rack-Mounted" Detection:

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

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

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

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

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

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

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

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

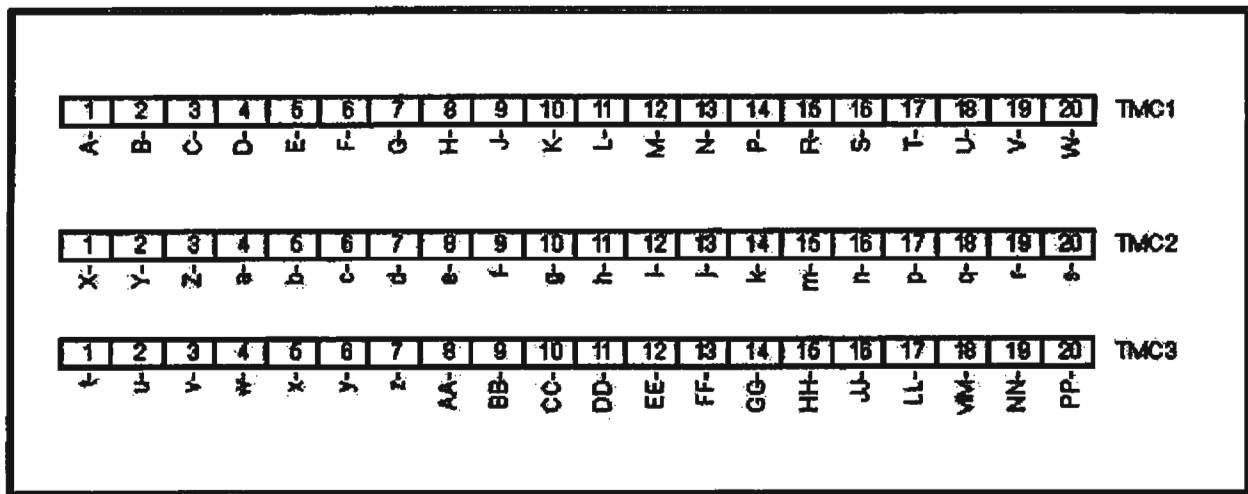
Channel "B" to Controller Plug "A," Pin "y"

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

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

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

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



- (g) **Conflict Monitor Units:** The wiring harness that the conflict monitor plugs use shall have independent termination points. Each and every conductor shall be terminated independently onto a single terminal. There will be no conductors bound, hanging loose, or not terminated.

All conflict monitors shall be NEMA standard, meeting all requirements of section 6 of the 1983 TS1 specifications. In addition, all monitors shall be equipped with the features defined below:

All cabinets shall be equipped with a conflict monitor harness completely wired in the cabinet to a separate panel as shown above for twelve (12) channels of operation. Conflict monitors shall be provided in all cabinets supplied.

Minimum vehicle clearance time monitoring with a time value of 3.0 to 4.0 seconds (able to be selected on a per channel basis).

Separate indicators for activity on each of the red, amber, green and walk inputs of each monitor channel.

Front panel indicators showing active channel(s), date, time and description of the current status, while showing a log of six or more of the most recent failures. All such data shall be stored in a non-volatile memory.

Liquid crystal front panel displays shall be provided.

Failure status indicators for CVM, 24-1, 24-2, conflict, red failure, clearance failure, minimum green failure, dual indication, and program card insertion.

The monitor shall provide a front panel display of the approximate time and date of the occurrence of any power failure in excess of 500 milliseconds duration and the date and time of power restoration. The monitor program shall have computed and logged this data in non-volatile memory by the end of the power restart flash interval.

Front panel connectors "A" and "B" mounted directly to printed circuits will not be accepted.

For every integrated circuit custom-programmed device, or any sole source component, within the unit which is of such special design that replacement units would not be available from any local wholesale electronics distributors, one fully programmed duplicate of each IC/device contained therein shall be furnished directly for each conflict monitor delivered.

All conflict monitors shall have RS-232 capability. The vendor shall supply a software program

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which when run on an IBM compatible computer will communicate with the monitor unit for the downloading of failure event information and any other programmable event including timing, etc.

623 T.02.03 TRAFFIC SIGNAL CONTROLLERS:

(a) General

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

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

- (6) **System Turn-On:** The Contractor must have approval of the date for turn-on, at least five (5) working days prior, from the Traffic Engineer. Systems shall be permitted to be made operational at Agency's direction. Controller manuals shall be available to the Signal Maintenance Division at time of turn-on. The controller manufacturer shall provide a technical representative at the intersection during the turn-on and testing period to provide technical assistance.

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

(b) NEMA Controller Construction Specification.

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

- (1) Phase reversal shall be activated by applying a logic ground to controller connector "B."
Pin B shall reverse phase 1 & 2
Pin W shall reverse phase 3 & 4
Pin X shall reverse phase 5 & 6
Pin y shall reverse phase 7 & 8
- (2) Each controller unit shall be provided complete with all of the following components and timing features:
 - Four keyboard programmable overlaps
 - Three NEMA connectors "A", "B", "C"
 - Two DB25-RS232C ports on the front of each controller. One port shall be for communications and the second port shall be used for occasional connection to a portable computer having priority over port one.
 - Each controller will be menu driven, with keyboard programming for listing program, status, utilities, and special options. Being able to move between programs, menus, and/or sub-menus and having the ability to copy timing data from one phase to another. The controller shall be able to dim phase outputs by phase or individual phase color. Readout on the display to be visible in bright sunlight or in the dark with back lighting.
 - The equipment housing shall be a completely enclosed painted metal fabrication that is easily removed and replaced. The design shall include vent holes. The unit shall consist of a frame and mother board, with separate printed circuit modules (CPU, Memory, I/O, etc.) which will facilitate simple and rapid maintenance. The connectors for interfacing with the controller shall be part of the input/output module and are to be located on the front of the unit for ease of access.
 - The circuit components shall be standard production types that are readily available from any industrial electronics supply house. All components mounted to the circuit boards shall have their circuit reference symbol clearly marked on the board and be identifiable by referencing to the pictorial assembly drawings.
 - The power supply shall be self contained in a separate and removable module.
 - The circuit component design life under continuous duty operation shall not be less than 10 years.
 - All programmed timing and operational parameters shall be retained within electrically erasable and programmable read only memories (EEPROM'S) or equivalent. No batteries for any such backup systems will be acceptable, except as necessary to maintain TOD clock time-keeping during power failure.
- (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-

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by-circuit description of the operation that follows component-by-component with the schematic diagram or block by block with the logic diagram. This requirement may be waived at the discretion of the purchasing Agency.

- (4) It shall be possible to perform a series of diagnostic tests of the system, which shall include the following:

Wrap around Input/output check of connectors A, B and C.

Wrap around Input/output check of communications and printer ports.

RAM memory check.

EEPROM check.

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

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

Compatible phases

Conflicting phase

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

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

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

- (8) **Power Up Phase and Interval Sequence:** The controller start up point shall be programmable to be either the start of green or the start of amber of any legal phase combination.
- (9) **Scheduled Flash:** The scheduled flash shall be generated internal to the controller, and blink the load switch driver inputs independently of the cabinet (conflict monitor) flash circuitry. It shall be possible to program the following parameters:

Last phases before scheduled flash begins, along with the first phases after scheduled flash ends.

The monitor's red enable function shall be active whenever the signal bus is energized, including

- periods of controller load switch flash. During a scheduled flash all pedestrian outputs shall remain dark as stated in MUTCD. Scheduled flash may be provided as a form of internal controller preemption, callable for the internal time base coordination schedule, as well as by activation of NEMA test input "A". It shall be possible to specify in every other internal preempt program provided whether or not a call for that preempt overrides scheduled flash operation.
- (10) **Primary Phase Assignments:** It shall be possible to program each detector input for phase assignment and as to whether the input places
- (a) no call
 - (b) call only
 - (c) extension only
 - (d) both call and extension for each phase
 - (e) Upon bulk initialization detector inputs 1 - 8 shall default to the conventional NEMA one to one detector input number to phase number correspondence, placing both call and extensions on those phases. The inputs shall be routed according to these phase assignments provided that the conditions for detector switching are not true.
- (11) **Alternate Phase Assignments:** It shall be possible to program each detector input for phase assignment and as to whether the input places:
- (a) no call
 - (b) call only
 - (c) extension only
 - (d) both call and extension for each phase
 - (e) Upon bulk initialization, detector inputs 1 - 8 shall default to the conventional NEMA one to one detector input number to phase number correspondence, placing both call and extensions on those phases. The inputs shall be routed according to these phase assignments provided that the conditions for detector switching are not true.
- (12) **Detector Switching:** It shall be possible to program the conditions under which each detector input shall switch to the alternate phases assignments. The conditions for each input shall be defined by the condition of phases 1-8 as to whether each phases, (0) not applicable, (1) has a call, (2) is "on".
- (13) **Recall Mode:** Each phase shall be programmable as to (code definitions shall be displayed with each entry screen) the type of recall mode required as listed below:
- (a) Memory off
 - (b) Memory on
 - (c) Minimum recall
 - (d) Maximum recall
 - (e) Minimum and pedestrian recall
 - (f) Maximum and pedestrian recall
 - (g) Non-Actuated
 - (h) Omit
 - (i) Soft recall or No rest w/detector memory off
 - (j) Soft recall or No rest w/detector memory on
- (14) **Max Mode:** Each phase shall be programmable as to (code definitions shall be displayed with each entry screen) the maximum green value required as listed below:
- (a) Max inhibit (code only assignable for background cycle operation)
 - (b) Max I
 - (c) Max II

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

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

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

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

- (1) 0 = Special day program
- (2) 1 = Sunday
- (3) 2 = Monday
- (4) 3 = Tuesday
- (5) 4 = Wednesday

- (6) 5 = Thursday
- (7) 6 = Friday
- (8) 7 = Saturday
- (9) 8 = Special day program
- (10) 9 = Special day program

(c) 2070N Controller Construction Specification.

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

- (1) The 2070N controllers supplied shall conform to the latest published revision of the California Department of Transportation (CALTRANS), Transportation Electrical Equipment Specifications (TEES) requirements, published at time of bid. The following configuration will apply to any controller supplied:
- (2) A 2070-7 "ASYNC SERIAL COMM MODULE" shall be supplied and installed in each controller. The communications interface connection cable incorporated with the 2070-8 shall be supplied with connector DB-9S to mate with the 2070-7 module.
- (3) A communications modem shall be supplied per FAST system requirements. The modem shall be delivered complete with the power cord and a five (5) foot DB25 to DB25 RS232 cable for connection of the EX2 connector on the 2070-8 to the DTE connector on the modem.
- (4) The controller that is provided shall be configured with a short power outage tolerance of at least 400 milliseconds without causing a CPU reset, and a minimum of 4 MB of DRAM memory, 4 MB of FLASH memory, and 512 KB of SRAM.
- (5) Except when waived by the purchasing agency, the proposed supplier or apparent low bidder shall furnish a complete and fully operational 2070-N, along with the associated communications equipment, within 2 weeks of bid opening, but prior to contract award. This unit will be returned to the supplier/bidder following the demonstration test and functional assessment. Contract awards shall be contingent upon obtaining agency approval on all proposed equipment submitted for evaluation, including any proposed "approved equivalents" of supplied equipment.
- (6) The "A," "B," "C," and "D" plugs shall be installed on the front of the controller with the identification letters for the Cannon plugs right-side up. The master key shall be located at the top of the plug, not the bottom.
- (7) The evaluation by the potential purchasing agency will include, but not be limited to:
 - (a) proper implementation of all TEES, and the above, specifications.
 - (b) monitoring the operation in a test cabinet environment.
 - (c) confirming that the LCD display and the display cover shall be environmentally sealed to keep dust and other particles from entering between them.
 - (d) verifying operation with short power outages, and momentary surges.
 - (e) verifying operation with the following provisions of software operation and compatibility.
- (8) All 2070N controller units must be compatible and function properly with the latest revision of the Next Phase Intersection Management Software developed by Gardner Transportation Systems.
- (9) All 2070N controller units must be compatible and function properly with the ICONS communication package developed by Gardner Transportation System for the FAST Traffic

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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		

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CONTROLLER CONNECTOR B

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

*User Assigned

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

CONTROLLER CONNECTOR D	
Pin Function	Pin Function
A	AA
B	BB
C	CC
D	DD
E	EE
F	FF
G	GG
H	HH
I	JJ
J	KK
K	LL
L	MM
M	NN
N	PP
P	
Q	
R	
S	
T	
U	
V	
W	
X	
Y	
Z	
a	
b	
c	
d	
e	
f	
g	
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.
- (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

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suitable for use in both asphalt concrete and Portland cement concrete pavements.

(1) Two Component Epoxy Composition:	
Component A	Parts by Weight
Epoxy Resin, Araldite 6010	100
Nonyl Phenol	20
Alkylbenzene, Alkylate 31	20
Titanium Dioxide, Titanox 2015	1.62
Colloidal Silica, Cabosil	3
Glycerine	0.5
Silicone Anti-foam, G.E. Viscasil	0.01
Component B	Parts by Weight
Poly Mercaptan, Dion 3800 L C	40
N-Aminoethylpiperazine	17
2,4,6 - Tri (dimethylaminomethyl) Phenol	2
Furnance Black	0.03
Nonyl Phenol	34.6
Alkylbenzene, Alkylate 31	34.6
Colloidal Silica, Cabosil	4
Glycerine	0.5
Silicone anti-foam, G.E. Viscasil	0.01
Characteristics of Adhesives:	
Component A	
Viscosity, Poise, Brookfield	150-300
Shear Index	2.5 minimum
Component B	
Viscosity, Poise, Brookfield	100-250
Shear Index	2.0 minimum
Characteristics of Compounded Adhesive:	
Gel Time, Minutes	13 to 16
On 1/8 inch cast sheet, cured 18 hours at 77 degrees F. plus 5 hours at 158 degrees F.:	
Tensile Strength Minimum	700 psi
Elongation, Percent, Minimum	70
Shore D Hardness, Minimum	50
Color shall match Federal Standard No. 595. The color range shall be 26081 to 26173.	

(2) **Polyurethane Sealant****Property and Results**

Hardness (indentation)--65-85

Tensile Strength--500 psi (minimum)

Elongation--400%, minimum

Flex at -40 degrees F--no cracks

Weathering Resistance--

Slight Chalking

Salt Spray Resistance--500 psi,
minimum tensile; 400% minimum
elongationDielectric Constant--Less than
25% change over a temperature
of -30 degrees C to 50 degrees C**Chemical Resistance****Chemical and Results**

De-Icing Chemical--No Effect

Gasoline--Slight Swell

Hydraulic Brake Fluid--No Effect

Motor Oil--No Effect

Calcium Chloride (5%)--No Effect

Measuring Standard and Conditions

ASTM D 2240 Rex Type A, Model 1700

77 degrees F (25 degrees C) 50% relative humidity

ASTM D 412 Die C, pulled at 20 IPM

ASTM D 412 Die C, pulled at 20 IPM

25 mil Free Film Bend (180 degrees C) over 1/2" Mandrel

ASTM D 822 Weatherometer 350 hrs.

Cured 7 days at 77 degrees F (25 degrees C) 50% relative
humidity

ASTM B 117, 28 days at 100 degrees F (38 degrees C)

5% NaCl, Die C, pulled at 20 IPM

ASTM D 150

Test Method

ASTM D 471

ASTM D 471

ASTM D 471

ASTM D 471

ASTM D 471

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

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

Property and Limits	Measuring Standard and Conditions
Cone Penetration -- 20 - 35 (1/10 mm.) max.	ASTM D5 77 degrees F., 150 g., 5 sec.
Flow -- 5 mm. maximum	ASTM D 3407, Section 6, 140 degrees F.
Property and Limits	Measuring Standard and Conditions
Resilience --60% minimum	ASTM D3405, 77 degrees F.
Softening Point -- 200 degrees F.	ASTM D 36
Ductility -- 30 - 55 centimeters	ASTM D 113, 77 degrees F., 5 cm./sec.
Flash Point --575 degrees F.	ASTM D 92, COC
Viscosity -- 2500 - 3500 centipoise (Brookfield)	ASTM D 3236 375 degrees F.

TRAFFIC SIGNALS AND FITTINGS

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

- (a) **Optical Units.** Each optical unit shall consist of a lens, a reflector or reflector assembly, a lamp receptacle, and a clear traffic signal lamp. Lenses, reflectors, reflector assemblies, lamp receptacles and wiring, and candlepower distribution shall conform to the provisions in ANSI Standard D-10.1. Reflectors shall be made of silvered glass or of specular aluminum with an anodic coating. All reflectors shall conform to the provisions in ANSI Standard D-10.1.
- (b) **Red Light Display Detector.** When specified, a red light display detector shall be provided. The agency will give exact field placement and installation procedures.

(1) **Specifications**

Physical dimensions - 2.5" x 3" x 1.5"

Power requirement - 120VAC at 2.5 watts

Multi-directional capabilities.

Visibility at distance of approximately 150 to 250 yards.

One year warranty on all parts from date of installation.

(2) **Installation**

Drill one (1) 25/64 hole in the traffic signal head on which the RLD is to be mounted.

Utilizing a 1/8" brass pipe and fitting, mount the RLD and aim toward direction of viewing.

Wire into the signal head red indication following standard N.E.C.

Seal all openings with an outdoor silicone sealant to prevent moisture and dust 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

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will not be required when the lampholder is not in direct contact with the reflector. Each signal section shall be constructed in such a manner that structural failure of the housing will not occur with a wind load pressure of 25 pounds per square foot (1.2 KPa) on the projected area of the complete signal face housing, including backplate and visors. Any fracture within the housing assembly or a deflection of more than half the lens diameter of the signal section will be considered structural failure.

- (e) **Electrical Components.** Lamp receptacles and wiring shall conform to ANSI Standard D-10.1. Each lamp receptacle shall be wired with a white conductor connected to the shell of the lamp receptacle and a black or colored conductor to the bottom or end terminal of the lamp receptacle. These conductors shall, in turn, be connected to a terminal block mounted inside at the back of the housing. The terminal block shall have sufficient screw type terminals to terminate all field conductors and lamp conductors independently, with separate screws. The terminals to which field conductors are attached shall be permanently identified or conductors shall be color coded to facilitate field wiring. Lamp receptacle conductors shall be No. 18, or larger, 600 volt, appliance wiring material (AWM), with 30 mil thickness insulation rated 105 degrees C. or with insulation that conforms to Military Specification MIL W-16878 D, Type B, with vinyl nylon jacket rated 115 degrees C. The manufacturer's name or trademark, conductor size, insulation type letter designation and temperature rating shall be marked on the insulation.
- (f) **Visors.** Each section shall be provided with a removable, full-circle, metal visor conforming to ANSI Standard D-10.1 and the Standard Drawings, unless otherwise shown on the plans.
- (g) **Directional Louvers.** Where shown on the plans, directional louvers shall be furnished and installed in signal visors. Directional louvers shall be so constructed as to have a snug fit in the signal visors. The outside cylinder shall be constructed of 0.030 inch (0.8 millimeters) nominal thickness, or thicker, sheet steel or the cylinder and vanes shall be constructed of 3003 H14 aluminum alloy of equivalent thickness. Dimensions of louvers and arrangements of vanes shall be as shown on the plans.
- (h) **Backplates.** Where shown on the plans backplates shall be furnished and installed on signal heads. Dimensions, materials and installation details shall be as shown in the Standard Drawings. No background light shall show between the backplate and the signal face or between sections. Where a backplate consists of two or more sections, the section shall be fastened with rivets or with aluminum bolts peened after assembly to prevent loosening.
- (i) **Signal Mounting Assemblies.** Assemblies for the mounting of signal faces shall consist of 1-1/2 inch (38 millimeters) standard steel pipe and necessary fittings, slip-fitters and terminal compartments. Each terminal compartment shall be fitted with a terminal block containing a minimum of 12 poles, each with 2 screw-type terminals. Each terminal shall be designed to accommodate at least 5 No. 14 conductors. A cover shall be provided on the compartment to give ready access to the terminal block. Where used to bracket-mount a signal the terminal compartment shall be designed to bolt securely to a pole or standard. The dimensions of mounting assembly members between the axis through the center of the terminal compartment, or slip-fitter, shall not exceed 11 inches (275 millimeters), except where required to provide proper signal face alignment

or permit programming of programmed visibility signal faces or when otherwise directed by the Engineer. Each mounting assembly shall be oriented to provide maximum horizontal clearance to the adjacent roadway. All mounting assembly members shall be either plumb or level, symmetrically arranged and securely assembled. Construction shall be such as to permit all conductors to be concealed. Mounting assemblies shall be water-tight and free of sharp edges or protrusions which might damage conductor insulation. For post-top mounting of signals, a slip-fitter shall be used. Slip-fitter shall fit over a 4-1/2 inch (113 millimeters) outside diameter pipe or tapered standard end. Each slip-fitter shall be provided with cadmium-plated steel set screws, arranged as shown on the plans. Each slip-fitter used to post-top mount signals with brackets shall be provided with an integral terminal compartment. Each mounting assembly shall be provided with positive locking, serrated fittings which, when mated with similar fittings on the signal faces, shall prevent faces from rotating. Fittings shall permit fastening at increments of not more than 7 degrees. Signal faces shall not be installed at any intersection until all other signal equipment, including the controller, is in place and ready for operation at that intersection, except that the signal faces may be mounted if they are not directed toward traffic or if they are covered. During the time period between signal assembly erection and system turn-on, all signal assemblies shall be completely covered by use of six (6) mil minimum thickness black plastic bags.

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

623 T.02.06 PROGRAMMED VISIBILITY VEHICLE SIGNAL FACES: Each programmed visibility signal face and the installation thereof shall conform to the provision in Subsection 623 T.02.05, "Vehicle Signal Faces," and Subsection 623 T.02.05(g) "Backplates," and Subsection 623 T.02.07(k).05(h), "Signal Mounting Assemblies." Each programmed visibility signal section shall provide a nominal twelve (12) inch (300 millimeters) diameter circular or arrow indication. Color and arrow configuration shall conform to ANSI Standard D-10.1. Each section shall be provided with a sun visor. Each signal section shall be provided with an adjustable connection that permits incremental tilting from 0 to 10 degrees above or below the horizontal while maintaining a common vertical axis through couplers and mountings. Terminal connection shall permit external adjustment about the mounting axis in 5 degree increments. The signal shall be mountable with ordinary tools and capable of being serviced without tools. Adjustment shall be preset at 4 degrees below the horizontal, unless otherwise specified. The visibility of each programmed visibility signal face shall be capable of adjustment or programming within the face. When programmed, each signal face's indication shall be visible only in those areas or lanes to be controlled, except that during dusk and darkness a faint glow to each side will be permissible. Prior to programming, each signal section with a yellow indication shall provide a minimum luminous intensity of 3,000 candela on the optical axis, and a maximum intensity of 30 candela at 15 degrees horizontal from the axis. Each such signal section shall be capable of having its visibility programmed to achieve the following luminous intensities: a minimum of 3,000 candela on the optical axis, a maximum of 100 candela at from 1/2 to 2 degrees horizontal from the axis

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and a maximum of 10 candela at from 2 to 15 degrees horizontal from the axis. Under the same conditions, the intensities of the red indication and the green indication shall be at least 19 and 38 percent respectively of the yellow indication. Each signal face or each signal section shall include integral means for regulating its luminous intensity between limits in proportion to the individual background luminance. Lamp intensity shall not be less than 97 percent of uncontrolled intensity at 1000 footcandles, and shall reduce to 15 ± 2 percent of maximum intensity at less than one footcandle. The dimming device shall operate over an applied voltage range of 95 to 130 volts, 60 Hz. and a temperature range of -40 to 165 degrees F. (-40 to 73.9 degrees C.). The Contractor shall have a manufacturer's representative program the heads.

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

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

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

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

TYPE C - Type C signals shall conform to the provisions for Type B signals, except message plate and tubing shall be formed into an integral weatherproof plug-in module with a molded case of 3/32 inch (2.5 millimeters) minimum thickness, white acrylonitrile butadiene styrene. The message module shall operate in the Type C pedestrian signal head. The module shall not require the use of tools for insertion or removal.

(b) **Housing.** The housing shall be made of 3003 H14 die cast aluminum alloy with smooth finish on both sides. Thickness shall be 1/8 inch (3 millimeters) minimum at the points of support. The housing shall be corrosion resistant and shall provide for easy access to and replacement of all components. All machine screws, studs and washers shall be either nickel plated brass, stainless steel or other corrosion resistant material. Gaskets shall be provided as required to make the housing rain tight and dust tight. Gaskets shall conform to the provisions in ASTM Designation D 1056, Grade SBE42. The housing shall be provided with top and bottom openings for 1-1/2 inch (38 millimeters) pipe. Unused openings shall be closed with watertight closures painted to match

the housing, as shown on the Standard Drawings. The housing construction design may be compatible with clamshell mounting hardware.

- (c) **Sun Phantoms.** A means to stop sun phantoms while not obscuring the image shall be employed and shall be approved by the Engineer. A full vertical divider strip shall be provided between the "HAND" and the "WALKING PERSON" indications.
- (d) **Conductors.** High voltage wiring between the gas discharge tubes and the secondary side of the transformer shall be made with Gas Tube Sign and Oil Burner Ignition Cable, Type GTO-15 labeled by U.L. Other conductors shall be No. 14, or larger, with 30 mils minimum thickness Type TW insulation.
- (e) **Disconnect Switch.** A fused switch consisting of 2 cartridge fuses and a lever for disconnecting the fuses for pedestrian signals shall be mounted within the signal housing to de-energize the transformer primary circuit.
- (f) **Terminal Block.** A light duty terminal block shall be mounted in the housing for field wiring.
- (g) **Tube Mounting.** Capped ends of gas tubing in Type B signals shall be mounted in approved heat resistant glass electrode housings.
- (h) **Finish.** The outside of the housing and hood shall be painted.
- (i) **Pedestrian Signal Mounting Assemblies.** Pedestrian signal housing may be mounted with clamshell mounting hardware modified to contain a twelve (12) pole terminal block with compression screw terminal pairs. For post top mounting of pedestrian signals a slip-fitter with an integral terminal compartment shall be used. The requirements for the hardware to post top mount pedestrian signals shall be the same as for post top mounting vehicle signals.

623 T.02.08 FLASHERS:

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

- (a) **Visors.** Each flashing beacon shall be provided with a tunnel type visor.
- (b) **Flashing Beacon Control Assembly.** Each flashing beacon control assembly shall consist of switches, circuit breakers, terminal blocks, flasher, wiring and electrical components necessary to provide proper operation of the beacons, all housed in a single enclosure. The enclosure shall be as specified in the Special Provisions.
- (c) **Circuit Breakers and Switches.** A single-pole 15 ampere circuit breaker shall be installed to control each ungrounded conductor entering the enclosure. A switch to permit manual operation of the sign lighting circuit shall be provided. Switches shall be of the single-hole-mounting toggle type, single-pole, single-throw, rated at 10 amperes, 125 VAC. Switches shall be furnished with an indicating nameplate reading "Auto-Test" and shall be connected in parallel with the load contacts

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of the photoelectric control circuit. A 15 ampere circuit breaker may be used in place of the toggle switch.

- (d) **Flasher.** A 20 ampere solid state flasher shall provide for a 2 circuit alternate operation of beacons.
- (e) **Terminal Blocks.** Terminal blocks shall be rated at 25 amperes, 600 volts, shall be molded from phenolic material and shall be the barrier type with plated brass screw terminals and integral type marking strips.

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

- (a) Standards for traffic signals and roadway lighting, and steel pedestals for cabinets and other similar equipment shall be located as shown on the plans. Workmanship and finish shall be equal to the best general practice of the metal fabrication industry. All welding shall conform to AWS D 2.0, Specification for Welded Highway and Railway Bridges," and to the requirements in this Section.
- (b) Types of poles, length of mast arms and height of poles shall be as indicated on the Contract Drawings.
- (c) Standards and steel pedestals for controller cabinets shall be constructed of 0.120 inch (3 millimeters) or thicker steel or 4 inch (100 millimeters) standard pipe or conduit, with the top designed for post-top slip-fitter. Standard pipe shall conform to the specifications of ASTM Designations A 53 or A 120.
- (d) All ferrous metal parts of standards, with shaft length of 15 feet (4.6 meters) and longer, shall conform to the details shown on the standard drawings, and the following requirements:

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

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

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

Standards may be fabricated of full-length sheets or shorter sections. Each section shall be fabricated from not more than 2 pieces of sheet metal. Where 2 pieces are used, the longitudinal welded seams shall be directly opposite one another. When the sections are butt-welded together, the longitudinal welded seams on adjacent sections shall be placed to form a continuous straight

seam from base to top of standard. The butt-welded transverse joints shall be strengthened by inserting a metal sleeve at each joint. The sleeve shall be 0.135 inch (3.5 millimeters) nominal thickness, or thicker, steel and made from steel having the same chemical composition as the steel in the standard. The metal sleeve shall have a minimum length of one inch (25 millimeters). The sleeve shall be centered at the joint and have the same taper as the standard with the outside of the sleeve in full contact with the inside of the standard throughout the sleeve length and circumference.

All welds shall be continuous.

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

Standards shall be straight, with a permissive variation not to exceed one (1) inch (25 millimeters) measured at the midpoint of a 28.5 foot (7.62 meters), 30 foot (9.14 meters), or 35 foot (10.67 meters) standard and not to exceed 3/4 inch (19 millimeters) measured at the midpoint of an 18 foot (5.49 meters), 20 foot (6.10 meters) or 25 foot (7.62 meters) standard.

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

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

Tie rods shall be installed with no kinks or bends.

- (e) The cast steel option for slip bases shall be fabricated from material conforming to the requirements of ASTM Designation A 27, Grade 70-40. Other comparable material may be used if written permission is given by the Engineer. The casting tolerances shall be in accordance with the Steel Founder's Society of America recommendations (green sand molding).
- (f) Material certifications consisting of physical and chemical properties, and radiographic films of the castings shall be filed at the manufacturer's office. These certifications and films shall be available for inspection upon request.
- (g) Anchor bolts shall conform to manufacturers' specifications.
- (h) Handholes in the base of standards shall conform to the details shown on the Standard Drawings. Changes in configuration of mast arms will be permitted provided the mounting height and stability

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are maintained. Handholes shall face away from oncoming traffic.

- (i) Holes left in the shafts of existing standards, due to removal of equipment or mast arms, shall be repaired by welding in a suitable disk, grinding smooth, and painting as provided for repairing damaged galvanized surfaces. Welding shall be done only after all combustible materials have been removed.
- (j) All standards, steel pedestals and posts required to be galvanized shall be hot-dip galvanized per ASTM A 123.

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

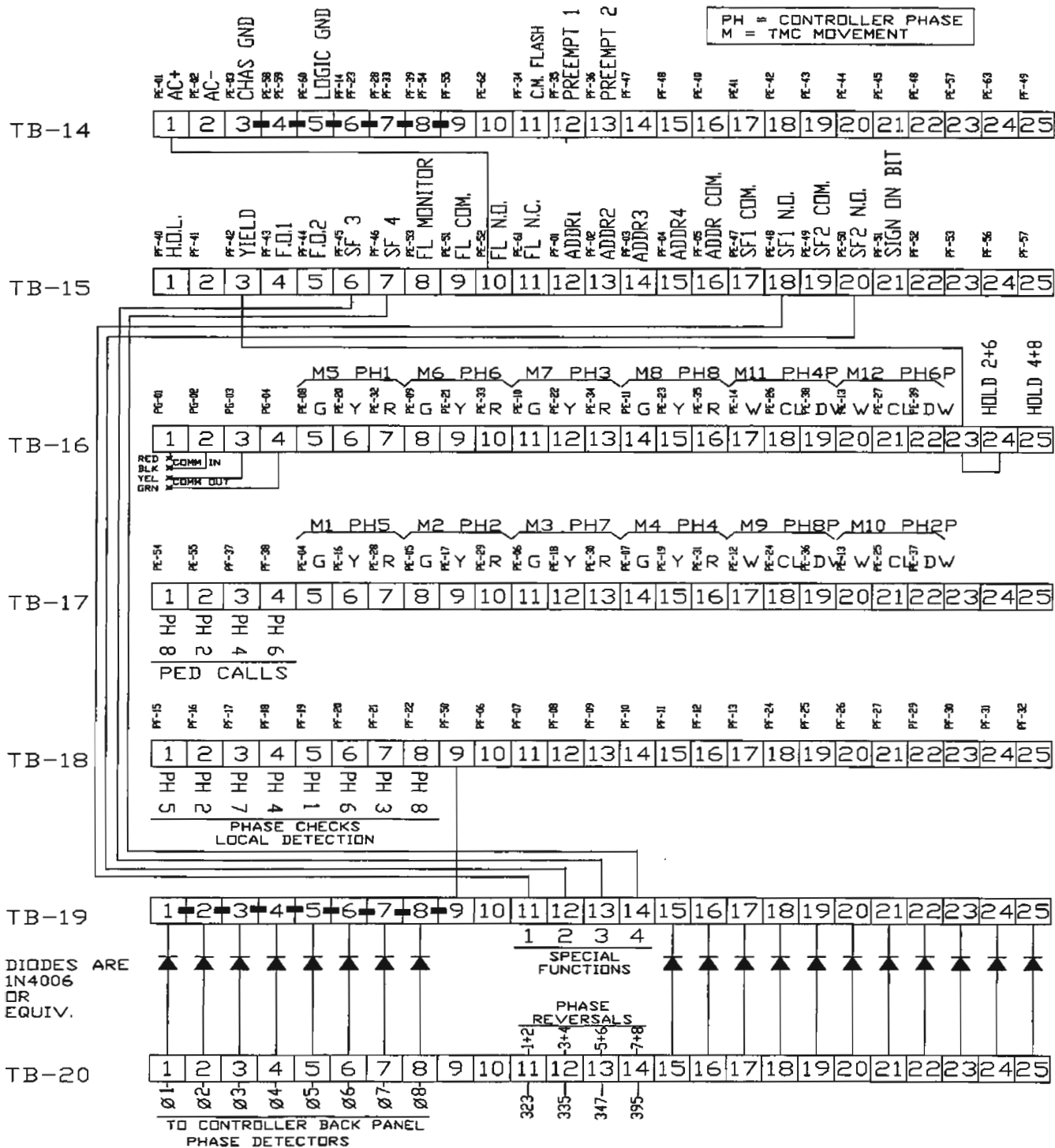
- (a) **General.** The Contractor shall furnish each controller cabinet completely configured and equipped for its intended intersection with a local communications interface unit (LCIU) panel, communication unit, and harnesses. The LCIU interface panel and harnesses are to be wired in accordance with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

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

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623T.02.10.02 GENERAL LAS VEGAS AREA SYSTEM REQUIREMENTS:

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

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

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

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

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

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

(f) System Control Functions.

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

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

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

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

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

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

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

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

- (g) **Controller Sequence Reversal:** Dual ring controllers shall be capable of phase sequence reversal by applying a ground true signal to connector B. Applying ground true signal to pin B shall cause the controller to reverse sequence phases 1 and 2 (lead-lag). Applying ground true signal to pin W shall cause the controller to reverse sequence phase 3 and 4 (lead-lag). Applying ground true signal to pin X shall cause the controller to reverse sequence phase 5 and 6 (lead-lag). Applying ground true signal to pin v shall cause the controller to reverse sequence phase 7 and 8 (lead-lag). Applying ground true signal to both pins B and X simultaneously shall cause the controller to sequence to phases 2 and 6 before phases 1 and 5 (lagging left turns). Applying ground true signal to both pins W and v simultaneously shall cause the controller to sequence to phases 4 and 8 before phases 3 and 7 (lagging left turns).
- (h) **System Control.** A controller operating in a CALL to Non-Actuated mode 1 or 2, with the phase hold active, and the walk rest modifier input active, shall rest in a walk dwell condition until a yield (release of the phase hold input). Upon a yield the controller shall be capable of timing the pedestrian clearance interval followed by the vehicle clearance interval, and all red interval without the need for other input control such as a force-off. The controller shall be capable of responding to yield durations of 500 milliseconds and perform the said function.
- (i) **Inputs and Outputs.** Inputs and outputs related to external devices in the cabinet shall be related to the pin assignments prescribed by NEMA and shall not require cabinet modification for interchangeability with NEMA controllers. Any special functions required for controller operation shall utilize spare pins in the input/output connectors as specified by NEMA.
- (j) **System Monitoring Functions.** Attention should be given to the input signal level for the inputs of the LCIU. Both D.C. and A.C. inputs are used, following is a list of inputs and their required levels:

D.C. Inputs, Ground True

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

A.C. Inputs (115 VAC)

- 1 Controller Flash

The local LCIU detector inputs shall be wired to the respective Phase Check outputs of the controller. Refer to Subsection 623 T.02.01(e) for cabinet controller phasing.

623 T.02.11 PEDESTRIAN PUSH BUTTONS: Where shown on the plans, pedestrian push buttons of substantial tamper-proof construction shall be furnished and installed. The assembly shall be weather-proof and so constructed that it will be impossible to receive any electrical shock under any weather condition.

The pedestrian push button switch shall be a phenolic enclosed precision snap-acting type, switching unit, single-pole, double-throw, with screw-type terminals, rated fifteen (15) amperes at one hundred twenty-five (125) volts, AC, and shall have the following characteristics:

- (a) Switching unit shall have a stainless steel plunger actuator and shall be provided with U-frame to permit recessed mounting in push button housing.
- (b) Switch shall have an operating force of 0.56 to 0.81 lbf (2.5 to 3.6 N) and have a minimum release force of 0.25 lbf (1.1 N).
- (c) Pre-travel shall be one sixty-fourth (1/64) inch (0.4 millimeter) maximum.
- (d) Over-travel shall be seven thirty-seconds (7/32) inch (5.5 millimeter) minimum.
- (e) Differential travel shall be four ten-thousandths (0.0004) to two one-thousandths (0.002) inch (0.01 to 0.05 millimeter).

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

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

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

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

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

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

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

- (a) **System Description.** The system employs data-encoded optical communication to identify the presence of designated priority vehicles, cause the traffic signal controller to initiate a specific preprogrammed preemption procedure, and if required by the Engineer, record the vehicle by classification and identification number at particular intersections. The matched set of components which make up the system will cause the existing traffic controller to be manipulated upon recognition of the signal from the vehicle. This communication is effective to the optical detectors at or near the intersection over a line-of-sight path. The system shall require no action of the vehicle operator other than the operation of the "emitter ON" switch located in the vehicle. The switch is to remain "ON" until the end of the emergency run. The system shall operate on a first-come, first-served basis or on a selected priority. The higher priority requests will override lower priority requests. The system shall be designed to yield to other priority demands such as railroad drawbridge etc. The system shall interface with existing traffic signal controllers without compromising normal operation or existing safety provisions. The Priority Control System shall consist of a data-encoded optical emitter, optical detectors, optical detector cable, and priority control unit.
- (b) **Matched System Components.** To assure desired performance, the system shall provide the synergy of the four principal components, matched and proven through integrated testing and extensive functional experience. The matched component system shall offer compatibility with all types of traffic signal controllers. Matched components provide future compatibility of all priority control elements.
 - (1) **Data-Encoded Optical Emitter.** Shall be a compact, lightweight, weatherproof, light-emitting device with internal, regulated power supply designed to produce high intensity optical energy in visible and infrared wavelengths as well as encoded pulses that carry vehicle class and ID number information, from a single source, precisely timed by a crystal controlled circuit.
 - (2) **Optical Detector.** Shall be a light-weight, weatherproof, adjustable, bi-directional optical detector assembly. Internal circuitry shall transform optical energy from the optical emitter assembly into electrical signals for delivery (up to 1000 feet (305 meters) via optical detector cable to the priority control unit.
 - (3) **Optical Detector Cable.** Shall be a durable, shielded, 3-conductor cable with a drain wire and the necessary electrical characteristics to carry power to the optical detector from the priority

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control unit and to carry the optical detector signal to the priority control unit.

- (4) **Priority Control Unit.** This equipment shall provide interface between the optical detectors and the cabinet controller unit and provide the following functions while not compromising the existing fail-safe provisions:
 - (a) Sufficient Power to all optical detectors required for the intersection.
 - (b) Differentiation of signals by optical detectors from one or more emitters on a first-come, first-served basis.
 - (c) Output signals to the cabinet controller to cause a preemption sequence to display the desired phase green for the approaching emergency vehicle.
 - (d) All input and output wires of the priority control system to be terminated on a separate panel then wired to the controller back panel.
 - (e) Smooth transition to non-priority operation upon passage of the vehicle through the intersection.
 - (f) As required by the Engineer at designated intersections, storing up to 100 of the most recent priority control calls in non-volatile memory and retaining the record if power terminates.

(c) **System Operation.**

- (1) Priority control system shall be activated by an optically transmitted signal capable of recognizing and discriminating an Optical Emitter flash rate of (Class II) $14.0359 \text{ Hz} \pm 0.0039 \text{ Hz}$ from a single light source or upon the actuation of a test switch or remote call signal to the phase selector.
If a second class of preemption is used, it shall respond to a flash rate of (Class I) $9.63855 \text{ Hz} \pm 0.0014 \text{ Hz}$.
- (2) The system shall cause the traffic controller to select from normally available green phases by activation of a combination of its inputs such as:
 - (a) channel "A" active
 - (b) channel "B" active
 - (c) channel "C" active
 - (d) channel "D" active
- (3) The system shall not require modification or replacement of the existing controller unit beyond adding the necessary system hardware.
- (4) The system shall maintain adequate minimum traffic signal displays when priority control is active.
- (5) The system shall provide for up to 3 optical detectors to be connected to each channel to accomplish the following:
 - (a) To provide adequate optical emitter detection range to allow sufficient time to deliver the desired traffic signal display in accordance with the minimum times required to terminate non-desired traffic signal displays.
 - (b) To provide continuous line-of-sight contact between the data-encoded emitter and the optical detector units.
- (6) Abnormal sequence of traffic signal displays will not occur.
- (7) Transitions from green to red without the appropriate clearance intervals will not occur.

- (8) The system shall allow the traffic signal controller to resume normal timing operation after the desired signal display is obtained and optical signals have ceased for an appropriate period.
- (9) The system shall not attempt controller manipulation nor retain priority vehicle calls during periods of "Intersection Flash" operation.

(d) System Component Specification.

(1) Data-encoded Optical Emitter.

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

(2) Optical Detector.

- (a) The optical detector shall be a lightweight, weatherproof device capable of sensing and transforming pulsed optical energy into electrical signals usable by the phase selection equipment.
- (b) The unit shall be high-impact polycarbonate construction with non-corrosive hardware.
- (c) The unit shall be designed for simple mounting at or near an intersection on mast arm, pedestal, pipe, or span wire.
- (d) The unit shall accept optical signals from four directions (northbound, southbound, eastbound, and westbound) and each shall provide an electrical output signal.
- (e) The unit shall include a design feature to allow aiming of the two optical sensing inputs for skewed approaches or slight curves, and may be field verified.
- (f) The unit shall be responsive to the optical emitter at a distance of 1800 feet (550 meters).
- (g) The unit shall be capable of providing the necessary electrical signal to the priority control unit through up to 1000 feet (305 meters) of optical detector cable.

- (3) **Optical Detector Cable.** The cable must guarantee delivery of the necessary quality signal from the optical detector to the phase selector over a non-spliced distance of 1000 feet (305 meters). The cable shall have 3 No. 20 AWG (minimum gage) stranded copper conductors and one bare, individually tinned, copper color coded as follows:
 - (a) Orange for delivery of optical detector power (+)
 - (b) Bare for optical detector power return (-)
 - (c) Yellow for optical detector signal

(d) Blue for a second optical detector signal

(4) **Priority Control Equipment.** The Emergency Vehicle Priority Control System shall be a self-contained stand alone unit which shall recognize input signals for up to four separate channels of emergency vehicle preemption and to contain the following major parts:

(a) A card rack which shall contain the power supply (to be powered from AC mains in cabinet, and contain its own internal power supply to feed Optical Detectors), plug-in card edge connectors, appropriate plugs and connector harnesses to connect the whole unit to the cabinet wiring assembly.

(b) **Priority Control Discriminator Plug-in Module:** This module Unit shall be a plug-in four-channel device designed to be used with optical Emitters and Detectors. It shall be capable of recognizing and discriminating Optical Emitter flash rates, as described in Subsection 623T.02.12 (c), "System Operations", via Optical Detectors connected to each channel. If required by the Engineer in contract provisions at particular intersections, a data-encoded module may be used which is capable of recognizing and distinguishing data-encoded optical signals and shall meet the following requirements:

(1) Programming and retrieving the data stored shall be accomplished using an IBM PC-compatible computer. Unit shall have the capability of storing 100 of the most recent calls.

Each record entry shall include information as follows:

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

(2) Unit shall be capable of three levels of discrimination of data-encoded optical signals as described in 623 T.02.12 (d)(1)(b).

(3) Interface with the cabinet shall be wired as described in 623T.02.02

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

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

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

(a) **General:** Uninterruptible Power Supplies (UPS) are used to operate the traffic signal upon the loss of source power to the traffic signal controller, cabinet, and equipment. These are also referred to as "battery backups." The units shall conform to the following specifications:

- (1) The entire UPS shall be able to installed in its entirety inside a type "R" traffic signal cabinet. It could be a shelf or wall mounted unit, not a rack mounted unit.
 - (2) All units must be rated from -40°C to 74°C. This includes both the batteries and the microprocessing control units.
 - (3) The output of the UPS must be pure, sinusoidal power. "Square Wave Power" or "Step-Wave" power will not be acceptable.
 - (4) All systems must come supplied with maintenance-free batteries that will be used to operate the unit in power outage situations. The typical run time for the batteries supplied shall be 8 hours with a 300 watt load placed on it.
 - (5) The operating mode of any UPS utilized in power failure situations shall be flashing red for the traffic signal, while still providing true sine-wave power for the modem or communication devices.
- (b)
 - (1) AC Line input switch/circuit breaker.
 - (2) DC Battery output switch/circuit breaker.
 - (3) AC Input safety fuse.
 - (4) AC Power pilot light.
 - (5) Load #1 flasher pilot light.
 - (6) Load #2 flasher pilot light.
 - (7) Time Delay dip switches.
 - (8) Battery Event Counter w/Manual Reset.
 - (9) Battery run timer.
 - (10) Battery Voltmeter (optional).
 - (11) Convenience Receptacle (optional).

CONSTRUCTION

623 T.03.01 PAINTING:

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

Directional louvers and backplates shall be painted flat black.

- (e) Cabinets or controller boxes shall conform to Section 623T.02.01.

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- (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

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tapered arms, the luminaire end shall consist of a welded two (2) inch (50 millimeters) schedule 40, 10-1/2 inch (268 millimeters) length pipe with a 7-1/2 inch (190 millimeters) exposed tenon, and the opposite end shall have a welded three bolt weather resistant steel fitting as called for on the Street Light Standard Drawing No. 314. The bolts shall be high strength conforming to ASTM Designation A 325 high strength bolts.

- (f) A four (4) inch (100 millimeters) by six and a half (6-1/2) inch (165 millimeters) handhole reinforced frame and slip-resistant indented type cover located eight (8) inches (200 millimeters) from the base plate shall be provided. The cover shall include a bar with one weather and vandal resistant 1/4 inch (6 millimeters) Hex socket head screw. The pole base cover shall be two or four piece ferrous metal, hot-dip galvanized; shall cover the base plate completely; and shall be firmly secured.
- (g) **Finish.** Pole assemblies and luminaire arms shall be hot-dip galvanized in conformance with ASTM Designation A 123.
- (h) **Tests.** The steel used in standards shall be tested in accordance with ASTM Designation A 370, paragraph 13.1. The supplier of the standards shall furnish certified notarized test reports showing the yield strength after fabrication of material used in the shaft and subsequent standards shall conform to this certification. At the discretion of the Engineer random samples may be selected of the finished product for testing purposes and tests shall be carried out and reports furnished at no additional cost.
- (i) **Tests, Deflection of Standards.** The standard, complete with modification, shall sustain a horizontal test load of 500 pounds (227 kilograms) applied eighteen (18) inches (450 millimeters) from the top of the shaft in any direction without failure of any component part, and with a deflection of not more than 7-1/2% of the pole shaft length measured from point of load application to the base plate.

This deflection includes a maximum allowance of 1/2 inch (13 millimeters) for testing and permanent set.

- (j) **Tests, Deflection, Luminaire Brackets or Mast Arms.** Luminaire brackets or mast arms and related pole attachment devices shall sustain a vertical load of 100 pounds (45 kilograms) applied within three (3) inches (75 millimeters) of the luminaire end of the support with the support attached to a rigid structure. The vertical deflection shall not exceed 5-1/2% of the bracket or mast arm length. The luminaire brackets or mast arms and related pole attachment devices shall sustain a transverse horizontal load of 50 pounds (22.7 kilograms) and a vertical load of 50 pounds (22.7 kilograms) applied within three (3) inches (75 millimeters) of the luminaire end of the support with the support attached to a rigid structure. The horizontal deflection shall not exceed 10% of the bracket or mast arm length, and the pole attached devices shall not develop any looseness within the specified loading range.
- (k) **Tests, Deflection of Davit Standards.** The davit standard, complete with modification shall sustain a horizontal test load of 500 pounds (227 kilograms) applied to the vertical shaft at the point at

which the davit portion becomes tangent. This load may be applied in any direction and the shaft shall sustain this load without failure of any component part, and with a deflection of not more than 7-1/2% of the length of the shaft measured from the point of load application to the base plate. This deflection includes a maximum allowance of 1/2 inch (13 millimeters) for testing methods and permanent set.

- (l) Standards and fittings shall be cleaned and finished as specified in Subsection 623 L.03.01. After erection, all outside surfaces shall be cleaned free from dust, dirt and oil, and all abraded and damaged areas shall be neatly refinished. Tie rods, nuts, washers, and other miscellaneous ferrous parts shall be galvanized before installation by the hot-dip process conforming to ASTM Designation A 153.
- (m) Posts, poles, standards, and cabinets shall not be erected until the foundation has set at least seventy-two hours, and shall be plumbed or raked, as ordered by the Engineer.

623 L.02.02 ANCHOR BOLTS: Anchor bolts shall conform to ASTM Designation A 576, Grade C-1035 for a minimum yield strength of 48,000 psi (331 MPa) and shall be provided with two nuts and two washers of 2-1/2 inch (63 millimeters) minimum O.D. Not less than twelve (12) inches (300 millimeters) of the upper end of the anchor rods and all nuts and washers shall be galvanized by the hot-dip process conforming to ASTM Designation A 153, or cadmium plated with type NS coating conforming to ASTM Designation A 165. After galvanizing or plating, the bolt threads shall accept galvanized or plated standard nuts without requiring tools or causing removal of protective coating.

Unless shown otherwise on the Drawings, anchor bolts for #7 gage standards and posts shall be 1-1/8 inch by 40 inches by 4 inches (3 by 1000 by 100 millimeters) and for standards and posts lighter than #7 gage shall be 1 inch by 36 inches by 4 inches (25 by 900 by 100 millimeters). The upper six (6) inches (150 millimeters) of anchor bolts shall be threaded. Plumbing of standards shall be accomplished by adjusting the nuts before the foundation is finished to one (1) inch (25 millimeters) minimum above final grade. Shims or other similar devices for plumbing or raking will not be permitted.

623 L.02.03 LIGHTING LUMINAIRES: The standard luminaire shall be of the high pressure sodium type, horizontal burning, cobra head style, in wattages specified in the plans. The luminaire shall consist of a precision diecast aluminum housing, globe ring and ballast module door. The lower portion of the luminaire shall be composed of two parts. One part shall contain the optical assembly and the other part shall be the ballast module door. The ballast module door shall contain all the major electrical components and shall be capable of being lowered after loosening one or two non-corrosive captive screws. The ballast shall be 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

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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

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of switching multiple lighting system directly or by a separate contactor as indicated on the plans.

For series lighting systems the photo-electric control shall be capable of switching series lighting systems through a high voltage controller.

Types of photo-electric controls shall be as follows:

- (a) **Type I.** Type I photo-electric control shall consist of a photo-electric unit and a contactor in a single weatherproof housing.
- (b) **Type II.** Type II photo-electric control shall consist of a photo-electric unit installed at the top of the first lighting standard from the service point, and controlling the lighting contactor in the pad mounted service and control cabinet. A by-pass switch shall be included to permit manual operation of the lighting system contactor. Unless otherwise specified in the plans, specifications, or in the Special Provisions, the photoelectric units shall be for 120 volt operation on two or three wire single phase multiple lighting systems.
- (c) **Equipment Details.** The photo-electric unit shall consist of a light sensitive element connected to a control relay. The light sensitive element shall have a spectral response such that it is especially sensitive to north sky illumination and shall have an "ON" level adjustable between minimum limits of 0.6 and 1.1 footcandles.

The unit shall be so designed that a failure of any electrical or electronic component will energize the lighting circuit. The photo-electric unit shall be mounted at the top of the standard designated on the plans and shall be oriented as directed by the Engineer.

- (d) **Contactor.** The contactor shall be constructed in accordance with NEMA standards for lighting contactors and shall have contacts rated to switch the specified lighting load. Contactor shall be the mechanical armature type. The mechanical type shall consist of an operating coil, a laminated core, a laminated armature, contacts and terminals. Contacts shall be silver alloy.
- (e) **Housing.** The contactor may be either integral with the photo-electric unit or may be located externally from it. When located externally, the contactor shall be housed in a suitable NEMA type 3 raintight enclosure with hasp for a padlock. The raintight enclosure shall be mounted on the same standard as the photo-electric unit at a height of approximately 28 feet (8.5 meters) above the base. All contactors housings shall be approved by the Engineer prior to installation.
- (f) **Wiring.** Conductors between the photo-electric unit and an external contactor shall be a minimum No. 12 AWG, and shall be installed inside the lighting standard.

623 L.02.07 PAINT: Unless otherwise specified in Subsection 623 L.02.01(g), all metal parts, fittings, signal heads, posts, pedestals, standards, cabinets, controller boxes, etc., shall be prepared and painted according to these specifications. Types of paints to be used shall be as specified in Section 714, "Paint and Pavement Markings."

CONSTRUCTION

623 L.03.01 GENERAL: The preparation and finishing of new equipment shall be as follows:

Galvanized and non-ferrous surfaces to be painted, shall be cleaned and coated with Vinyl Wash Primer, conforming to the requirements of Subsection 714.03.01(b). Ferrous metal surfaces shall be cleaned and immediately coated with the primer specified above.

If an approved primer coat has been applied by the manufacturer and is in good condition, additional primer application by the Contractor, other than for repairs, will not be required.

Factory enameled equipment and materials shall be examined for damaged paint after installation, and such damaged surfaces shall be repainted to the satisfaction of the Engineer.

Existing equipment and material to be repainted whether remaining in place or to be relocated, shall be cleaned of all rust, scale, grease, dirt, and poorly bonded paint by any method satisfactory to the Engineer. Immediately after cleaning, all bare metal shall be primed as appropriate, or as specified for new material. A finish coat shall be then applied over newly primed areas followed by one or more finishing coats over the entire surface. Blast cleaning of galvanized metal surfaces in good condition, as determined by the Engineer, will not be permitted.

Paint coats may be applied either by hand brushing or by approved spraying machines in the hands of skilled operators, except that no spraying shall be done at the jobsite. The work shall be done in a neat and workman like manner, and the Engineer reserves the right to require the use of brushes for the application of paint should the work done by the paint spraying machine prove unsatisfactory or objectionable, as determined by the Engineer.

The thickness of each paint coat shall be limited to that which will result in uniform drying throughout the film. Skips, holidays, thin areas, or other deficiencies in any one coat of paint shall be corrected to the satisfaction of the Engineer before the succeeding coat is applied.

The final coat shall present a smooth surface, uniform in color, free of runs, sags or excessive brush marks.

Flaws in the appearance of galvanized components (i.e., tiger- or zebra-striped) shall be cause for rejection by the owner.

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

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

623 L.03.03 TESTING: Prior to completion of the work, the Contractor shall cause the following tests to

be made on all lighting circuits, in the presence of the Engineer:

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

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

METHOD OF MEASUREMENT

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

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

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

BASIS OF PAYMENT

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

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

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

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

PAY ITEM

PAY UNIT

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

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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.

SECTION 626**FINAL CLEAN UP****DESCRIPTION**

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

626.02.01 BLANK:**CONSTRUCTION**

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

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

METHOD OF MEASUREMENT

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

BASIS OF PAYMENT

626.05.01 PAYMENT: The lump sum price paid for "Final Clean Up" shall be lump sum price bid for this item.

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

Payment will be made under:

PAY ITEM**PAY UNIT**

Final Clean Up Lump Sum

SECTION 627
PERMANENT SIGNS

DESCRIPTION

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

The work shall generally consist of:

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

This item does not include sign illumination systems.

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

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

MATERIALS

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

Sign Materials Section 716

627.02.02 REFLECTORIZATION: All signs shall utilize Class 6 retroreflective sheeting for sign background, letters, numerals, symbols, borders and accessories. All letters, numerals, symbols, borders and accessories shall be directly applied to the sign background.

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

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

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

CONSTRUCTION

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

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

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

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

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

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

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

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

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

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

Care shall be exercised at all times in the handling, storing, transporting, and erecting of the signs. Signs which are damaged shall be repaired or replaced at the Contractor's expense.

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

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

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

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

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

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

METHOD OF MEASUREMENT

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

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

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

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

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

BASIS OF PAYMENT

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

PHYSICAL PROPERTIES AND TESTS

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

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

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

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

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

SECTION 702

CONCRETE CURING MATERIALS AND ADMIXTURES

SCOPE

702.01.01 MATERIALS COVERED: This specification covers concrete curing materials, air-entraining admixtures, water retardants, pozzolans, and hydrated lime. Attention is directed to Section 722, "Water" for mixing and curing. The contractor shall submit a request to use any one of the following for approval by the Engineer as prescribed in Subsection 702.03.07.

702.02.01 BLANK:

PHYSICAL PROPERTIES AND TESTS

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

- a) Burlap Cloth made from Jute or Kenaf AASHTO M 182
- b) Waterproof Paper for Curing Concrete AASHTO M 171
- c) Liquid Membrane-Forming Compounds for Curing Concrete ASTM C 309
- d) Pigmented Curing Compound for Portland Cement Concrete pavement ASTM C 309**
- e) White Pigmented Curing Compound for Bridge Decks ASTM C 309***
- f) Plastic Sheeting ASTM C 171
- g) White Polyethylene Sheeting (film) for Curing Concrete ASTM C 171

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

**Except the loss of water from the surface in the water retention test shall not exceed 1.50 oz/ft² (0.45kg/m²) in seventy-two (72) hours.

*** Type 2 Class B resin type and shall be poly-alpha-methyl-styrene with the loss of water from the surface in the water retention test shall not exceed 0.50 oz/ft² (0.15kg/m²) in twenty four (24) hours or more and 1.50 oz/ft² (0.45 kg/m²) in seventy-two (72) hours.

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

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

702.03.04 POZZOLANS (FLY ASH): Fly Ash admixture shall conform to the requirements of Section 729, "Fly Ash".

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

702.03.06 SUBMITTAL: Curing compounds and admixtures shall be tested and certified per the Table 1 frequency. Prior to the use of these materials, the Contractor shall submit to the Engineer for approval a document certifying that the material meets these specifications and requirements. A test certificate shall be included with the certifying document.

The material supplier for Portland Cement Concrete materials, Plantmix Bituminous materials or any material production that requires the use of admixtures shall attach the certificate to the mix design submittal as indicated in Table 1. All subsequent certificates shall be on file and accessible to the Engineer for audit purposes.

The **Statute of Limitations** duration for the record storage shall be as required by the Nevada Revised Statutes.

Table 1. Submittal Requirements

ITEM	REQUIREMENT	FREQUENCY
All curing materials	Sample and certification	1 per project
All admixture material	Certificate with copy of test for lot used	1 per lot

SECTION 703**BITUMINOUS MATERIALS****SCOPE**

703.01.01 MATERIALS COVERED: This specification covers the quality of asphalt cement, liquid asphalt, emulsified asphalt, cationic emulsion, anionic emulsion and rubber-asphalt crack sealant.

REQUIREMENTS

703.02.01 CONTRACTOR'S RESPONSIBILITY: Bituminous material failing the requirements (including tolerances) of the tests hereinafter prescribed shall be subject to the provisions of Subsection 109.02, "Scope of Payment," and attention is directed thereto.

703.02.02 SHIPPING NOTICE: When shipments of materials arrive on the project after normal working hours, the Contractor shall notify the Engineer sufficiently in advance to make arrangements for an inspector to be present when the material is sampled.

Shipping notices shall be mailed upon making shipment and shall contain the following information:

- (a) Consignee and destination
- (b) Agency contract number
- (c) Delivery point
- (d) Date shipped
- (e) Car initials or number of truck transport delivery ticket number
- (f) Type and grade of material
- (g) Quantity loaded
- (h) Loading temperature
- (i) Net quantity
- (j) Signature of shipper or authorized representative

Three copies of the shipping notice shall be mailed to the Contracting Agency.

PHYSICAL PROPERTIES AND TESTS

703.03.01 REFINERY TEST REPORT: Refinery test reports shall be mailed to the Engineer as soon as tests have been completed, and the report shall contain the following data:

- (a) Date of shipment
- (b) Car initials or number of truck transport delivery ticket number
- (c) Destination and consignee
- (d) Contracting Agency contract number (or purchase order number, if applicable)
- (e) Type and grade of material

SECTION 707

JOINT MATERIAL

SCOPE

707.01.01 MATERIAL COVERED: This specification covers the quality requirements for poured filler, preformed fillers, and resilient and rubber type gaskets used in the construction of bridges, culverts, sidewalks, etc.

707.02.01 BLANK:

PHYSICAL PROPERTIES AND TESTS

707.03.01 JOINT FILLERS: Preformed fillers for joints shall conform to the requirements of AASHTO M 213, or ASTM D 1751, Fiber Type, and shall be punched or drilled to admit the dowels where called for on the plans. The filler for each joint shall be furnished in a single piece for the full depth and width required for the joint unless otherwise specified by the Engineer. When the use of more than one piece is authorized for a joint, the abutting ends shall be fastened securely and held in place, by stapling or other positive fastening satisfactory to the Engineer.

707.03.02 RUBBER GASKETS: The ring gaskets shall conform to the requirements of AASHTO M 198.

707.03.03 WATERSTOPS: Waterstops shall conform to the following requirements:

(a) **Natural Rubber.**

Test	Test Method	Requirements
Tension Testing of Vulcanized Rubber	ASTM D 412	Tensile strength 3,500 lbs. min. psi (24.1 Mpa) - Elongation at breaking of 550 percent. Unit stress (300 percent) 1,100 lbs. psi min. (7.6 MPa). Unit stress (500 percent) 2,800 lbs. psi Min. (19.3 MPa).
Test for Accelerated aging of Vulcanized Rubber by the Oxygen Pressure Method	ASTM D 572	After 7 days in air at 158 degrees (plus or minus 2 degrees) Fahrenheit (70 degrees (plus or minus 1 degree) Celsius) or after 48 hours in oxygen at 158 degrees (plus or minus 2 degrees) Fahrenheit (70 degrees (plus or minus 1 degree) Celsius) and 300 lbs. psi (2.07 MPa), the tensile strength and elongation shall not be less than 65 percent of the original.

Test	Test Method	Requirements
Test for Indentation of Rubber by Means of a Durometer	ASTM D 2240	55 to 65 hardness

Natural rubber waterstops shall be manufactured from a stock composed of a high grade compound made exclusively from new plantation rubber, reinforced carbon black, zinc oxide, accelerators, antioxidants, and softeners. This compound shall contain not less than seventy-two (72) percent by volume of new plantation rubber.

(b) Synthetic Rubber.

Test	Test Method	Requirements
Tension Testing of Vulcanized Rubber	ASTM D 412 (17.26 MPa)	Tensile strength 2,500 lbs. psi min. Elongation at breaking of 425 percent.
Test for Accelerated aging of Vulcanized Rubber by the Oxygen Pressure Method	ASTM D 572	After 7 days in air at 158 degrees (plus or minus 2 degrees) Fahrenheit (70 degrees (plus or minus 1 degree) Celsius) or after 48 hours in oxygen at 158 degrees (plus or minus 1 degree) Fahrenheit (70 degrees (plus or minus 1 degree) Celsius) and 300 lbs psi (2.07 MPa), the tensile strength and elongation shall not be less than 65 percent of the original.
Test for Indentation of Rubber By Means of a Durometer	ASTM D 2240	50 to 70 hardness

(c) Polyvinyl Chloride.

Test	Test Method	Requirements
Polyvinyl Chloride Waterstops	Corp. of Engr. CRD-C 572	Compliance of paragraph 6

707.03.04 POURABLE JOINT SEALER: The pourable joint sealer for bridges, concrete channel expansion and weakened plane joints, shall be a polyurethane sealant furnished and placed as hereinafter specified.

Polyethylene foam shall be commercial quality, with a continuous, impervious, glazed top surface, suitable for retaining the liquid polyurethane sealant in the joint while hardening.

A primer, furnished by the manufacturer of the sealant, shall be applied to the sides of the groove and to all exposed vertical surfaces in the joint prior to placing the polyurethane sealant. The primer shall be dry prior to placing sealant. Contaminated primer shall be removed and replaced.

The sealant shall consist of a 2 component polyurethane sealant, (ACI 504R Table 1, Type IV),

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which will withstand up to plus or minus 25 percent movement.

The sealant shall be self-leveling for flat surfaces and non-sagging for slopes. The sealant shall meet or exceed the requirements of the Table 1 below.

Table 1

Material Characteristics	Self-leveling	Non-sagging
Application Temperature	40 to 100 degrees F (4.4 to 37.8°C)	40 to 100 degrees F (4.4 to 37.8°C)
Service Range	-40 to 170 degrees F (-40.0 to 76.7°C)	-40 to 170 degrees F (-40.0 to 76.7°C)
Curing Rate	Tack-free Time: 1-2 hours Final Cure: 3-5 days	Tack-free Time: 6-8 hours Final Cure: 3 days
Tear Strength (ASTM D624)	-----	45 lbs/in
Shore A Hardness (ASTM D2240)	45 +/- 5 (21 day)	25 +/- 5
Tensile Properties (ASTM D412) Tensile Strength Elongation Modulus of Elasticity (100%)	550 psi (3.79 MPa)(21 day) 700% (at break) 150 psi (1.03 MPa)	120 psi (0.83 MPa)(at break) 500% 70 psi (0.48 MPa)
Adhesion in Peel (Fed Spec TT-00227E)	Concrete Substrate Peel Strength: >30 lbs (133 N) % Adhesion Loss: 0%	Concrete Substrate Peel Strength: 25 lbs (111 N) % Adhesion Loss: 0%

No material shall be used which has skinned over or which has settled in the container to the extent that it cannot be easily redispersed by hand stirring to form a smooth uniform product.

Each container shall be clearly labeled or each delivery of material in the tanks of 2-component equipment shall be accompanied with a ticket showing designation (Component A or B), the manufacturer's name, lot or batch number, date of manufacture, date of packaging, date, if any, beyond which the polyurethane sealant shall not be used without additional testing and approval, and manufacturer's instructions for use.

The sealant shall be machine mixed and placed with equipment which accurately proportions and mixes the 2 components and extrudes the mixed material into the joint. Such equipment shall be of a type approved by the manufacturer of the sealant and all manufacturer's instructions shall be followed. Polyurethane liquid components which have been exposed to the atmosphere for more than 24 hours, shall not be used.

707.03.05 ASPHALT PLANK: Asphalt plank shall conform to the requirements of ASTM Designation D 517 for Plain Asphalt Plant.

707.03.06 PREFORMED ELASTIC JOINT SEALER: Preformed elastic joint sealer and lubricant adhesive shall conform to the requirements of AASHTO Designation M 220 "Preformed Elastomeric Compression Joint Seals for Concrete."

The lubricant adhesive shall be homogeneous and shall remain workable from 5 to 120 degrees

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Fahrenheit (-15 to 49 degrees Celsius). Each lot of the adhesive shall be in containers with the manufacturer's name or trademark and the date of manufacture plainly marked. Adhesive shall be stored at a temperature of 50 to 80 degrees Fahrenheit (10 to 26.7 degrees Celsius) and shall be used within 270 days after the date of its manufacture.

The lubricant adhesive shall conform to the following requirements:

Average new weight per gallon, lbs.	7.84 ±5% (0.94 Kilograms per liter)
Solids content by weight, %	22 - 28

Each lot of the preformed elastic joint sealer, and lubricant adhesive furnished under these specifications shall be identified as specified herein and shall be products which have been tested by a reputable testing laboratory, recognized by the Contracting Agency, who shall certify that the materials meet these specifications and requirements. The Contractor shall furnish the Contracting Agency with these certifications prior to using the material.

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

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

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

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

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

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

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

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

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

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

728.03.09 EPOXY SEALANT FOR INDUCTIVE LOOPS:

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

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

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

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

728.03.10 EPOXY ADHESIVES FOR PAVEMENT MARKERS:

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

728.03.11 BINDER (ADHESIVE), STRUCTURAL EPOXY:

Classification. This specification covers a multipurpose, 2 component, moisture tolerant, structural epoxy adhesive, formulated primarily for bonding new concrete to asphalt cement pavement. This epoxy is formulated for hot weather concrete placements requiring a bonding adhesive and is suitable for minimum substrate and ambient temperature of 40° F (4° C). Physical properties shall meet the criteria a minimum of 2,200 psi (15.2 MPa) and heat deflection temperature at fourteen (14) days shall be a minimum of 108° F (42° C).

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Directions for use. The epoxy shall not be mixed with more material than can be used within sixty (60) minutes at 73° F (23° C) or thirty (30) minutes at 100° F (38° C) from the time mixing operations begin. Surface must be clean and sound. It may be dry or damp, but free of standing water, dust, curing compound and other contaminants.

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