

# ALABAMA DEPARTMENT OF TRANSPORTATION

DATE: June 14, 2012

Special Provision No. 12-0321

EFFECTIVE DATE: September 1, 2012

SUBJECT: Traffic Signals.

Alabama Standard Specifications, 2012 Edition, shall be amended by replacing Section 730 and Section 890 as follows:

## SECTION 730 TRAFFIC SIGNALS

### 730.01 Description.

This Section shall cover the work of furnishing and installing of traffic signal control equipment. These requirements may be supplemented or amended by the requirements given elsewhere in the specifications, or on the plans and Special and Standard Highway Drawings.

Descriptions and definitions of the equipment, words and terminology used in the furnishing and installing of traffic signal control equipment are given in the Manual of Uniform Traffic Control Devices (MUTCD) publications of the Institute of Transportation Engineers (ITE), the National Electrical Manufacturers Association (NEMA), the National Electrical Code (NEC), and the International Municipal Signal Association (IMSA).

### 730.02 Materials.

All materials furnished for use shall conform to the requirements given in Section 890 and the requirements shown on the plans. All furnished materials and equipment shall be new and free from defects. Existing equipment shall only be used if shown on the plans to be re-used.

### 730.03 Construction.

#### (a) DESIGN AND CONSTRUCTION CODES AND COORDINATION OF THE WORK.

##### 1. CODES.

All installations shall comply with the regulations of the latest edition of the National Electrical Code and the latest edition of the National Electrical Safety Code, and with the service rules of the Utility Company providing the electricity.

##### 2. STRUCTURE DESIGN AND CONSTRUCTION.

Structures for the support of traffic signal control equipment shall be designed, furnished and installed in accordance with the requirements given in Sections 718 and 891.

##### 3. COORDINATION OF THE WORK.

Coordination of the work with roadway and bridge work will be of prime importance to prevent undue damage to completed items of work and existing facilities. Any damage to existing facilities caused by the installation of the material or equipment required under this Section shall be repaired by the Contractor at no additional cost to the Department.

##### 4. ELECTRICAL POWER.

The entity that will be responsible for the eventual operation and maintenance of the traffic signal unit and intersection lighting will make application for electrical service upon notification that power service will be required. The Contractor shall inform the Engineer when power service is required at least 30 calendar days prior to the need of the power service. This same entity will be responsible for the cost of the service connection and the monthly service billings thereafter. Power shall be single phase, 240 Volt, provided through a transformer that is not tapped to provide power to any other equipment.

(b) TRAFFIC SIGNAL TECHNICIAN.

Technician(s) responsible for the performance of the work shall be certified by the IMSA as an IMSA Traffic Signal Level II Field Technician. The Contractor shall submit a copy of the IMSA certification to the Engineer with the first Material Submittal that is submitted for approval. The technician(s) shall be in possession of the certification at all times and show this certification as often as asked by the Engineer.

Certified Traffic Signal Technicians shall be present and shall have direct involvement with all work required for the installation and operational testing of electrical materials and equipment (conduit, boxes, conductors, etc.). At least one out of every three persons in a crew shall be a certified IMSA Traffic Signal Level II Field Technician.

(c) DRAWINGS AND SPECIFICATIONS.

Omissions from the plans and specifications or the misdescription of details of work which are evidently necessary to carry out the intent of the plans and specifications or which are customarily performed, shall not relieve the Contractor from performing such omissions and details of work. In any case of discrepancy in descriptions on the plans or in these Specifications, the matter shall be promptly submitted to the Engineer, who will make a determination in writing. Any adjustments in the plans, details, specifications, and proposal by the Contractor without written permission of the Engineer shall be at the Contractor's own risk and expense.

(d) MATERIAL AND EQUIPMENT LISTS, SHOP DRAWING AND APPROVAL.

Material and equipment listings shall be submitted to the Engineer for approval within thirty days after the issuance of the "Notice to Proceed". Partial listings and shop drawings will not be accepted for consideration.

Submittals shall be clear and complete. Seven copies of each submittal shall be furnished for review. Material and equipment lists shall include catalog cutouts or published data sheets and a completed Material Submittal form as provided by the Engineer. All components of assembled equipment (cabinets, controllers, etc.) shall be listed on the material submittal form. Unacceptable submittal data will be returned for corrective action. A copy of the approved material and equipment listings will be returned to the Contractor.

Any changes to the approved material and equipment lists must be requested in writing through proper channels.

If requested by the Engineer, the Contractor shall submit for inspection and approval samples of both the specified and proposed substitute items at no cost to the Department. The Department will not be liable for any materials purchased or work done or any delay incurred before such approval. Failure of the Engineer to note unsatisfactory material as received will not relieve the Contractor from responsibility. Manufacturers' warranties and guaranties furnished on equipment used in the work shall be delivered to the Engineer; likewise, instruction sheets and parts lists shall be delivered to the Engineer upon receipt of the equipment.

Throughout the entire project, the same manufacturer shall make all units of any one item, such as poles, signal heads, detectors, controllers, cabinets, etc.

Reference to a particular product by manufacturer, trade name, or catalog number establishes the quality standards of material and equipment required for this installation and is not intended to exclude products equal in quality and similar in design. Whenever any article, material, or equipment is defined by using the name of a manufacturer or vendor, the term "or approved equal" if not inserted, shall be implied.

(e) APPROVED TRAFFIC CONTROL DEVICES AND MATERIALS.

Some materials and equipment required to be furnished under this Section will be standard production type products. Acceptance will be made by the Engineer based on selected confirmation tests, the manufacturer's certification of the materials and equipment, and visual inspection at the job site. The manufacturer shall make available to the Department test data and material samples from the production runs for use in evaluation of these items. Title 32, Chapter 5A, Subsection 36 of the Code of Alabama states that all traffic control devices shall be approved by the Transportation Director before they can be used, sold, or offered for sale. Approved devices are shown on the Department's Approved Traffic Control Devices and Materials list. Information concerning this list is given in Subarticle 106.01(f) and ALDOT-355 concerning this list.

(f) AS-BUILT DRAWINGS.

After all equipment has been installed and the operational check has been instigated, the Contractor shall submit a set of plans showing in detail all changes on construction from the original plan details with special notation given to conduit location and elevation and schematic circuit diagrams.

(g) OPERATIONAL MANUALS.

Operation manuals and as-built wiring diagrams shall be furnished for all equipment and accessories required in the controller cabinet. These manuals and wiring diagrams shall be mounted to the cabinet in an appropriate manner. In addition, two copies of these manuals and wiring diagrams shall be transmitted to the Department's Division Traffic Engineer.

(h) PRE-INSTALLATION TEST AND ACCESSORY TEST.

Before the installation of the traffic control system(s) or unit(s), the Contractor shall perform a pre-installation test. This test shall include the bench testing of all controllers, signals, detectors, etc., under signal load conditions during a 14 consecutive day "burn period".

The Contractor shall secure an acceptable site, approved by the Engineer, for the bench test and shall perform all work required in the performance of the test. The Contractor shall notify the Engineer of the date that the test is to begin a minimum of seven days before that date. The Engineer will schedule an inspection of the equipment with the Maintenance Engineer. The 14 calendar day burn period shall not begin until the Engineer has notified the Contractor that the Maintenance Engineer has approved for this test to begin.

None of the equipment shall be installed on the project until the bench test has been completed and the Contractor has submitted a letter to the Engineer certifying that the equipment performed satisfactorily during the test. The Engineer may shorten the length of time required for the bench testing. There will be no direct payment to the Contractor for the cost of the pre-installation test including the cost of a suitable test site and the setting up of equipment for the test.

(i) REMOVAL OF EQUIPMENT.

All equipment designated or directed to be removed shall be removed in such a manner that the removed equipment will not be damaged. Any damage due to negligence on the part of the Contractor because of lack of proper care of equipment shall be cause for the Engineer to order its replacement. The cost of replacement shall be borne fully by the Contractor. Any equipment or materials not authorized by the Engineer for re-use into a new facility shall be stored by the Contractor until the Engineer directs that they be delivered by the Contractor to the Department at the time and location designated by the Engineer. Storage facilities shall be provided so that the equipment will be protected from the elements and damage by vandalism.

(j) CONCRETE FOUNDATIONS.

The Engineer will inform the Contractor of the exact diameter and depth of concrete foundation required at each signal pole foundation. The Engineer will also inform the Contractor of any changes that are required to the size and number of reinforcing bars required at each signal pole foundation. This information will be given to the Contractor at the completion of the review of the Contractor's submittal of designs and details of the signal pole structures.

All conduit systems, elbows, etc., shall be installed securely and inspected by the Project Manager before concrete is poured.

The Contractor shall contact the utility companies to determine the location of underground utilities in the area where the foundations are to be located and shall be responsible for repairing, to the satisfaction of the utility company, any damaged utilities.

(k) ABANDONING FOUNDATIONS.

All foundations, when abandoned, the top of the foundation, anchor bolts frame and conduit shall be removed to a depth of not less than 6 inches {150 mm} or as directed below the surface of existing pavement. The resulting hole shall be backfilled with material to match the existing surface.

(l) INTERCONNECT CABLE.

1. GENERAL.

Interconnect cable wire shall be installed at locations as shown on the plans or as directed by the Engineer.

Splices shall be made only where shown on the plans or in the controller cabinet.  
A minimum of 6 feet {1.8 m} or as directed, of slack shall be provided at each cabinet.

2. UNDERGROUND INTERCONNECT CABLE.

Underground interconnect cable shall be run in conduit.

3. AERIAL INTERCONNECT CABLE.

Aerial interconnect cable shall be supported on new or existing utility poles and/or signal poles as shown on the plans.

Interconnect support cable wire supporting signal control cable only will be sagged to a vertical distance not greater than 2 percent of the length of the span between poles.

When support cable is not an integral part of the interconnect cable, interconnect cable shall be attached to a support wire.

(m) ELECTRICAL POWER SERVICE ASSEMBLY.

The location of the utility service point and power source shown on the Signalization Plans is approximate. The Contractor shall determine the exact location.

When the service equipment is to be installed on a utility-owned pole, the contractor shall furnish and install conduit, photoelectric control unit, conductors, and other necessary material to complete the installation of the service. The position of the riser and equipment will be determined by the utility.

When a lateral drop is required from the power source to the service pole, the Contractor shall arrange with the serving utility to complete the service connections. The Contractor shall install the conduit, conductors, enclosure and accessories, and service pole.

As a minimum, the electrical power service equipment shall consist of:

- a weatherhead;
- 1 inch {27 mm} metallic conduit from weatherhead to a disconnect switch;
- a disconnect switch installed 6 feet {2 m} high, including, but not limited to the enclosure, load center complete with circuit breaker in a NEMA Type 4 enclosure, Masterlock Size #3, Key #3210 (for Statewide uniform access);
- 1 inch {27 mm} metallic conduit from disconnect switch to a designated depth below the ground line;
- attachment hardware;
- ground rod and related equipment;
- service cables;
- No. 8 AWG service cable for any required luminaires;
- attachment to local utility;
- all incidentals required to provide power service to the controller assembly and luminaires.

(n) SPAN WIRE.

The installation of span wire shall meet all provisions of the National Electric Safety Code (ANSI-C2) regarding clearance from electric lines.

The length of the messenger wire shall be adjusted under the load of traffic control equipment so that the sag at the lowest point shall not be greater than the requirements in Section 718.

(o) VEHICULAR AND PEDESTRIAN SIGNAL HEADS.

Traffic or pedestrian signal heads shall not be installed until all other signal equipment, including the controller, is in place and ready for operation except that signal heads may be installed if no face of the head is directed toward traffic or if the entire assembly is hooded.

Each signal face shall be so adjusted vertically and horizontally in order that its beams will be of maximum effectiveness to the approaching traffic for which it is intended.

(p) TRAFFIC DETECTION SYSTEMS.

1. WIRE LOOP.

a. Installation of Loop Wire.

Before cutting required loops into the pavement, any existing loops that are not quadrupole loops shall be sawed in two locations and quadrupole loops shall be sawed in three

locations on the long side to prevent false readings when the required loops are placed into the pavement. Loop wire outside the sawcut shall be twisted 3 turns per foot.

Loop wire shall be one continuous run without splices.

Loop wire shall be pushed to the bottom of the saw cut with a non-metallic tool that will not damage the insulation.

Each loop wire shall be placed in its own individual sawcut to the edge of pavement.

No portion of the loop shall be located within 3 feet {1 m} of any conductive material in the pavement such as manhole covers, water valves, and grates, etc.

After installation of the loops, the slots shall be sealed with an approved sealant manufactured specifically for embedding loop detector wire in concrete or bituminous pavements.

All loop connectors shall be connected to a shielded home-run cable located in junction box or when so directed or shown on plans at base of traffic signal strain pole.

b. Sawcuts for Loops.

Slots for installing the loops shall be formed by sawing with approved equipment designed for sawing pavement, to the width and depth indicated by the plan details or directed.

The slot shall be cleaned of all foreign loose debris using compressed air or other approved means before installation of the loop wires.

Sawcut corners shall be cut at a diagonal. No sharp bends shall be accepted.

Loops shall be tested prior to sealing sawcuts. Loop sealant shall be placed in sawcuts in accordance with manufacturer's recommendations.

Loop sealant will not be permitted when there is moisture on the surface, the air temperature is below 40 °F {4.4 °C}, or other conditions exist that in the opinion of the Engineer would affect the bonding of the material.

c. Loop Detector Lead-In.

A separate run of shielded home-run cable shall be provided for each loop unless otherwise directed.

Lead-in cable installed underground shall be in conduit. The lead-in shall be one continuous run from controller to loop connection with no splices.

d. Testing Loops.

The Contractor shall perform a leakage to ground test on all loops using a MEG-OHM meter with 500 V applied. The loops shall also be tested after the lead-ins are pulled to the amplifier to detect any damage done during installation. A State Inspector will perform this same test to check for leakage. Any loop failing to read 100 MEGS or better shall be replaced by the Contractor at no additional cost to the project.

2. VIDEO DETECTION SYSTEM (VDS).

The Contractor shall furnish and install all equipment, materials, software and other miscellaneous items that are required to provide a fully functional Video Detection System for the control of vehicular and pedestrian traffic signals.

The Contractor shall establish the configuration of the required traffic detection zones within each controller cabinet up to a maximum of 26 detection zones per controller. The Contractor shall notify the Engineer prior to software configuration and detector zone setup in ample time to allow the Engineer to observe this work. There will be no additional payment made for the relocation of cameras that may be required to achieve the required configuration.

The VDS shall detect the presence of a vehicle in the zones with at least 95 % accuracy at any time during the day.

The Contractor shall have a qualified representative of the supplier of the VDS to be present at the site of the installation to verify that all equipment and materials are being installed correctly. The representative of the VDS supplier shall be available to address all issues of concern that the Engineer may have.

All coaxial cable and power cable shall be one continuous pull without splices between the camera mounting location and the traffic controller cabinet.

### 3. PRIORITY CONTROL DETECTION SYSTEM, TRAFFIC SIGNAL PREEMPTION.

A priority control detection system shall provide communication to the traffic signal controller that will allow the controller to run a modified signal timing plan to allow an emergency vehicle or another priority vehicle to pass through a roadway intersection with as little delay as possible. The priority control system shall be either acoustically (sound) activated, optically activated, or GPS (Global Positioning System) activated. The system shall include all mounting hardware, wiring, detection sensors, signal control devices and miscellaneous materials required to provide a fully functional priority control system for traffic signal preemption. The system shall be capable of providing preemption information to the standard NEMA TS1, NEMA TS2, Type 170, and Type 2070 traffic controllers used by ALDOT.

A 4 hour training session shall be provided for as many as ten attendees. The Contractor shall arrange for the training to be provided by a representative of the manufacturer of the priority control detection system. Training shall be instruction in the proper installation, operation, maintenance, and programming of the priority control detection system.

A training course outline shall be submitted to the Engineer for approval by ALDOT Maintenance Bureau Traffic Operations Engineer. Training will not be scheduled by the Engineer until the course outline is approved. Training shall be performed both in the field and in the office. The Contractor shall schedule the training during the time frame designated by the Engineer. The Contractor shall provide a minimum of a 7 calendar day advance written notice of the scheduling of the training to allow the Engineer to arrange attendance. A training notebook shall be provided to each trainee in a labeled 3-ring binder.

#### (q) INSTALLATION OF CONDUIT.

Metallic conduit shall be used above ground and may be used below ground.

Non-metallic conduit shall only be used underground.

Where non-metallic conduits join metal conduits, connection shall be made using appropriate couplings to form a watertight raceway. All conduits entering concrete foundations shall be provided with appropriate bushings at the ends. Conduits shall be stubbed approximately 1 inch {25 mm} above concrete and shall be provided grounding type bushings on conduit ends in base of poles with copper bonding jumpers.

Bends and offsets shall be avoided where possible, but where necessary, shall be made with a proper hickey, pipe bender, or conduit bending machine. Conduit that has been crushed or deformed due to improper bending or handling shall not be installed.

Conduits shall be installed in a manner to insure against trouble from collection of trapped condensation where possible.

Conduits shall be capped to prevent entrance of deleterious materials during construction. For underground conduit adjacent to gasoline service stations or other installations of underground gasoline or diesel storage, piping or pumps, and which lead to a cabinet, circuit breaker panel, service or any enclosure where an arc may occur during normal operation, the Contractor shall refer to the National Electrical Code (NEC) for Class 1, Hazardous Locations.

Conduit for future use shall be threaded and capped.

All conduit installed under paved areas shall be encased.

Encasement shall meet the requirements of Section 756 and shall be a Type 1, Type 2, or Type 5 installation as shown on the plans.

If the Contractor should encounter extraordinary circumstances such as major utilities under existing pavement which the location cannot be accurately determined, he may request in writing permission to open cut a trench in lieu of jacking or boring. This request shall also include detailed proposed sequence of excavating, backfilling, method of handling traffic, etc. for the Engineer's consideration. No such work shall be performed without written permission of the Engineer.

All conduit systems shall be completely installed before the conductors are installed.

#### (r) LUMINAIRES.

The light control surfaces and glassware shall be cleaned after installation.

Cleaning shall be performed in accordance with luminaire manufacturer's recommendations.

Luminaires shall be leveled, plumbed, and installed as per the manufacturer's recommendations and as directed by the Engineer to achieve the most suitable light pattern.

(s) WIRING INSTALLATION REQUIREMENTS.

Wiring within junction boxes shall be neatly arranged and laced.

Powdered soapstone, talc, or other approved lubricant may be used in pulling cable in conduit.

All cables within a single conduit shall be pulled at the same time.

All ends of cable shall be taped to exclude moisture and shall be so kept until splices are made and terminal appliances attached.

The ends of spare conductors shall be taped.

All conductor splices that will be direct buried in earth and all loop detection conductor splices shall be soldered and encased in an approved splicing kit and with sealing tape.

All other signal conductor splices shall be spliced using a twisted connection made by a suitable wire nut or crimp and then properly covered by insulating tape or other insulating materials.

(t) GROUNDING ENCLOSURES.

All metal enclosures containing electric wires and/or equipment shall be bonded to the chassis ground.

Ground rods shall be installed at all service equipment and traffic signal pole foundations.

Single ground rods shall be driven vertically until the top of the rod is at least 12 inches {305 mm} below the finished grade.

Where a grounding conductor passes through a metal conduit, a suitable grounding bushing shall be placed on each end of the conduit and connected to a ground wire.

Each messenger cable shall be attached to the supporting structure with separate span wire clamps.

(u) EXCAVATING AND BACKFILLING.

All excavation required for the installation and placement of conduits, foundations, junction boxes, poles and other appliances shall be performed in such manner as to cause the least possible injury to pavement, curbs or other improvements. All conduits required under pavement, sidewalks, etc. shall be in place prior to commencing of base and paving operations. The trenches shall not be excavated wider than necessary for the proper installation of the electrical appliance and foundations. Excavating shall not be performed until immediately before installation of conduit and other appliances. The material from the excavation shall be placed in a position where the least interference with the surface drainage will occur.

Should large rocks be encountered in conduit trenches, they shall be removed to a depth of 3 inches {75 mm} below the proposed elevation and replaced with a 3 inch {75 mm} layer of suitable material. All suitable material removed from the conduit trenches shall be used in backfilling of the trenches; however, no stone larger than 3 inches {75 mm} shall be in contact with any conduit.

All surplus excavated material shall be removed from and disposed of by the Contractor, as directed by the Engineer.

Excavations, after backfilling, shall be kept well filled and maintained in a smooth and well-drained condition until permanent repairs are made.

Compaction shall be accomplished to the extent necessary to prevent future settlement of the backfill.

The Contractor will be required to restore any areas disturbed by his work to their original condition without additional cost to the State.

(v) INSULATION, CIRCUIT CONTINUITY AND GROUND RESISTANCE TESTING.

1. INSULATION TESTING.

Isolation test for testing insulation resistance shall be performed for each conductor in the cable. Testing shall be made using Article 110-19 of the NEC, as a guide. If resistance measured with all protective devices in place is less than 250,000  $\Omega$ , the contractor shall remove the defective cable, install new cable, and repeat the test.

For interconnect cable, upon completion of run from one controller installation to the next controller installation, the Contractor shall conduct a test for insulation resistance in the presence of the Engineer.

## 2. CIRCUIT CONTINUITY TEST.

Each circuit branch shall be temporarily jumpered at its termination and the temporarily loop circuit measured for continuity to assure that no open circuits exist, that the circuit branch is according to plan, that no high resistance connections exist and that each circuit is properly identified. Each circuit shall be marked with typed labels. Lead-in cable for loop detector wire shall be tested before and after the cable is spliced to the loop wire. As an alternative, circuit continuity testing of signal head cable may be done by applying 120 V to each outgoing circuit and observing that only the proper lamps are lighted.

## 3. GROUND RESISTANCE TEST.

At each ground rod location, a test shall be made. The effectiveness of the ground rod shall be determined by measuring resistance from the pole enclosure to a convenient underground water line, with a 0-50 ohm megger where a water line is available and with auxiliary ground method where the water line is not available. The two auxiliary ground rods shall be not less than 50 feet and 100 feet {15 m and 30 m}, respectively, from the tested rod. If reading is greater than 25 ohms, additional rods shall be installed until a reading of 25 ohms or less is obtained.

### (w) OPERATIONAL CHECK AND ADJUSTMENT OF EQUIPMENT.

A full operational check of the installed traffic control system shall be performed under actual traffic conditions. Before the operational check is allowed to begin the Engineer will arrange for an inspection of the installed traffic control equipment by the Maintenance Engineer. The Engineer will obtain the approval of the Maintenance Engineer to begin the operational check.

The period of operational check shall cover thirty calendar days. During the test period the Contractor shall expeditiously perform any necessary adjustment and replace any malfunctioning parts of the equipment required to place the system in an acceptable operational condition. Once repairs have been started, the Contractor shall have the traffic control equipment in an acceptable operational condition before leaving the project site. No extra compensation will be allowed for any work so required, such being considered incidental to furnishing and installing a complete operational signal system.

During the test period, time charges shall be suspended if all other work has been completed and acceptance of the work is dependent upon the results of the "operational check." The period of the test shall cover thirty continuous calendar days.

In case of emergency or failure on the Contractor's part to expeditiously pursue repairs, the Department reserves the right to make such repairs as it deems necessary. The cost for this work will be deducted from the contract bid amount for the project. The Department will not assume responsibility for the repairs or alter any of the requirements of the test period because of the repairs. The aforementioned shall in no way relieve the Contractor of his liability or responsibility related to maintaining the traffic signal as required by these specifications.

## 730.04 Method of Measurement.

### (a) REMOVAL OF TRAFFIC CONTROL UNIT.

The removal of all traffic control equipment at an intersection or other location designated on the plans will be measured as a Lump Sum, Removal of Traffic Control Unit. Removal of only some of the equipment will be measured as a Lump Sum, Removal of Traffic Control Unit (Partial). Removal of a temporary installation of traffic control equipment will be measured as a Lump Sum, Removal of Traffic Control Unit (Temporary). (Pay Item 730-A)

### (b) FURNISHING AND INSTALLING TRAFFIC CONTROL UNIT.

Where separate pay items are not listed for the traffic control equipment required at a single intersection or other location designated on the plans, all of the traffic control equipment, including the electrical power service equipment, will be measured for payment as a Lump Sum, Furnishing and Installing Traffic Control Unit.

### (c) SUMMARY OF TRAFFIC CONTROL EQUIPMENT PAY ITEMS.

Traffic control items of work will be measured for payment in accordance with the following:

Pay items 730-A, C, S, U and Y will be measured per lump sum.

Pay items 730-D, E, F, G, J, K, N, O, P, Q, R, and T will be measured per each.

Pay items 730-H, I, L, and M will be measured per linear foot {meter}.

**730.05 Basis of Payment.**

**(a) UNIT PRICE COVERAGE.**

Item 730-A. The accepted work for the removal of existing traffic control units will be paid for at the contract unit price which shall be full compensation for the satisfactory removal and storage of the equipment and materials ordered removed, and shall include all equipment, tools, labor, services, storage facilities and incidentals necessary to complete the work.

Item 730-C. The furnishing and installing the traffic control unit will be paid for at the contract unit price, which shall be full compensation for the furnishing of the equipment, installation in accordance with these Specifications, plans, proposal, and details, and for all tools, equipment, labor, materials, operational facility connected to the local utility.

Item 730-D. LEDs installed to replace incandescent lamps in existing traffic signals will be paid for at the contract unit price which shall be full compensation for the furnishing all materials, equipment, testing, tools, and labor required to install a fully functional LED in an existing traffic signal head.

Item 730-E. A Metal Traffic Signal Pole Foundation will be paid for at the contract unit price (adjusted to account for changes in size and reinforcement) which shall be full compensation for excavation, backfilling, forming, concrete, reinforcing steel, anchor bolts, ground rods, seeding and mulching of disturbed areas, disposal of debris and for all materials, labor, equipment, tools, testing, services and incidentals necessary to complete this item of work.

The bid price shall be for a 3'-0" {910 mm} diameter by 10'-0" {3.05 m} deep foundation. A larger foundation may be required. The reinforcing steel required for a larger foundation is shown on the plans. Compensation for a larger foundation will be made in accordance with the following cost adjustments.

COST ADJUSTMENT MADE TO BID PRICE FOR CHANGE IN FOUNDATION SIZE *			
("+" plus figures are price increases)			
Foundation Depth	Foundation Diameter		
	3'-0" {910 mm}	3'-6" { 1.07 m}	4'-0" {1.22 m}
10'-0" {3.05 m}	\$0	+\$450	+\$1200
11'-0" {3.35 m}	+\$100	+\$600	+\$1400
12'-0" {3.66 m}	+\$200	+\$750	+\$1600
13'-0" {3.96 m}	+\$300	+\$900	+\$1800
14'-0" {4.27 m}	+\$400	+\$1050	+\$2000
15'-0" {4.57 m}	+\$500	+\$1200	+\$2200
16'-0" {4.88 m}	+\$600	+\$1350	+\$2400
17'-0" {5.18 m}	+\$700	+\$1500	+\$2600
18'-0" {5.49 m}	+\$800	+\$1650	+\$2800

\* Adjustments include compensation for changes to the reinforcing steel that are shown on the plans for larger foundations.

The bid price adjustment shown above includes compensation for all work and materials (including reinforcing steel) necessary to construct the required foundation in accordance with the plan details. The Engineer may increase the amount of reinforcing steel from what is shown in the plan details. When the amount of reinforcing steel is increased from what is shown in the plan details, the bid price will be adjusted. The adjustment will be \$1.00 per pound {\$0.45 per kg} for the amount of reinforcing steel that is increased.

Item 730-F. A Metal Traffic Signal Pole with Mast Arm Assembly will be paid for at the contract unit price which shall be full compensation for furnishing and installing the metal traffic signal pole and mast arm assembly and for all materials, equipment, tools, labor, services, and incidentals necessary to complete this item of work. The required foundation shall be measured separately with payment being made under Item 730-E.

Item 730-G. A Traffic Signal Strain Pole will be paid for at the contract unit price which shall be full compensation for furnishing and installing the traffic signal strain pole, and for all materials, equipment, tools, labor, services, and incidentals necessary to complete this item of work. The required foundation shall be measured separately with payment being made under Item 730-E.

Item 730-H. Loop Wire will be paid for at the contract unit price which shall be full compensation for the saw cutting, loop wire, loop sealant, trenching, backfilling, electrical connections, splicing, and for all materials, labor, equipment, and tools to provide a complete and operational loop detector.

Item 730-I. Loop Detector Lead-In Cable will be paid for at the contract unit price which shall be full compensation for furnishing and installing the shielded home-run cable, including electrical connections and for all materials, equipment, tools, labor, testing, and incidentals necessary to provide a complete and operational detector loop.

Item 730-J. A Vehicle Loop Detector will be paid for at the contract unit price which shall be full compensation for furnishing and installing the loop detector amplifier, electrical connections and for all materials, equipment, tools, labor and incidentals necessary for a complete and operational loop detector amplifier.

Item 730-K. A Traffic Signal Junction Box will be paid for at the contract unit price which shall be full compensation for furnishing and installing the junction box, excavation, concrete, backfilling, and for all materials, labor, equipment, tools, and incidentals necessary to complete this item of work.

Item 730-L. Conduit will be paid for at the contract unit price which shall be full compensation for furnishing and installing the conduit including fittings, trenching, placing, joining, attaching to structure, backfilling, seeding and mulching of disturbed areas, disposal of debris, and all materials, labor, equipment, tools and incidentals necessary to complete this item of work.

Item 730-M. Interconnect Cable will be paid for at the contract unit price which shall be full compensation for furnishing and installing the interconnect cable with the number of conductors and type as designated by the plans, including all hardware for aerial installation, connecting to controller assemblies, splicing, electrical connections, and for all materials, testing, labor, equipment, tools, and incidentals necessary for a complete and functional interconnect cable.

Item 730-N. A Luminaire Extension Assembly will be paid for at the contract unit price which shall be full compensation for furnishing and installing the luminaire arm, sodium vapor luminaire, surge arrestor, connections, ground rod, No. 10 AWG, cable, and for all materials, labor, equipment, tools, and incidentals necessary for a complete and operational luminaire.

Item 730-O. Illuminated School Zone, Speed Limit Signs will be paid for at the contract unit price which shall be full compensation for furnishing and installing the illuminated school zone sign including all attachment hardware, connections, and for all materials, labor, equipment, tools, and incidentals necessary for a complete operational illuminated school zone speed limit sign.

Item 730-P. A Vehicular Signal Head will be paid for at the contract unit price which shall be full compensation for furnishing and installing the vehicular signal head, trunnions, brackets, attachment hardware, connections, splicing, and for all materials, labor, equipment, tools, and incidentals necessary for a complete and operational vehicular signal head.

Item 730-Q. A Pedestrian Signal Head will be paid for at the contract unit price which shall be full compensation for furnishing and installing the pedestrian signal head including attachment hardware, electrical connections, splicing, and for all materials, labor, equipment, tools, and incidentals necessary for a complete and operation pedestrian signal head.

Item 730-R. A Controller Assembly will be paid for at the contract lump sum price which shall be full compensation for furnishing and installing the cabinet, controller unit, auxiliary devices, electrical devices, surge protection, terminals, concrete foundation or side mounting hardware, mounting and wiring of controller assembly, and for all materials, labor, equipment, tools, testing, and incidentals necessary for a complete and operational controller assembly.

Item 730-S. Traffic Signal Preemption will be paid for at the contract lump sum price which shall be full compensation for furnishing and installing all mounting hardware, wiring, detection sensors, signal control devices, software (when required), testing and miscellaneous materials required to provide a fully functional priority control system for traffic signal preemption. If software and training is required it will be shown in the pay item description. Payment for training shall be full compensation for training personnel, supplies, equipment, materials, user manuals, handouts, travel, and subsistence necessary to conduct the training.

Item 730-T. A Wood Pole will be paid for at the contract unit price which shall be full compensation for furnishing and installing the wood pole, excavating, backfilling, attachment

hardware, grounding, weatherhead, guy wire, and for all materials, labor, equipment, tools, and incidentals necessary to complete this item of work.

Item 730-U. A Video Detection System will be paid for at the contract unit price which shall be full compensation for the camera, lens, enclosure, mounting brackets, video and power cabling, power supply, lightning protection; manuals and documentation and for all labor, materials, tools, equipment, transportation and incidentals necessary for a complete and operational vehicle detection system. The contract unit price shall also be full compensation for furnishing and installing the vehicle detection system processor, video interface panel, and for all integration (including software setup and programming and adjusting detection zones).

Item 730-Y. Pedestal Pole and Foundation will be paid for at the contract unit price which shall be full compensation for the following:

1. Installation. Furnishing, fabricating, galvanizing, assembling and erecting a complete and operational roadside flashing beacon or a complete and operational illuminated school zone sign; including sign and vehicular signal head or illuminated school zone sign, installing foundations, furnishing and placing anchor bolts, and hardware; controller; wiring, power source; connection to local utility and equipment, materials, labor, tools and incidentals to provide a complete and operational flashing beacon or illuminated school zone sign assembly.

2. Relocation. Removing the flashing beacon assembly or illuminated school zone assembly, removing existing foundations, installing new foundations; furnishing and placing anchors; hardware; excavation and surface placement; furnishing, fabricating, and installing new components as required and replacing the assembly on its new foundation with all manipulations and electrical work; controller; power source; connection to local utility; loading and hauling; and equipment, materials, labor, tools, and incidentals.

3. Removal. Removing the roadside assembly components including the power service equipment; removing the foundations; storing the component to be reused or salvaged; backfilling and surface placement; loading and hauling, and equipment, materials, tools, labor, and incidentals.

(b) PAYMENT WILL BE MADE UNDER ITEM NO.

- 730-A Removal of Existing Traffic Control Unit ( 1 ) - per lump sum
- 730-A Removal of Existing Traffic Control Unit (Partial) ( 1 ) - per lump sum
- 730-A Removal of Existing Traffic Control Unit (Temporary) ( 1 ) - per lump sum
- 730-C Furnishing and Installing Traffic Control Unit ( 1 ) - per lump sum
- 730-D LED Replacement Lamp - per each
- 730-E Metal Traffic Signal Pole Foundation - per each
- 730-F Metal Traffic Signal Pole with ( 2 ) Mast Arm Assembly - per each
- 730-G ( 3 ) Traffic Signal Strain Pole - per each
- 730-H Loop Wire - per linear foot {meter}
- 730-I Loop Detector Lead-In Cable - per linear foot {meter}
- 730-J Vehicle Loop Detector - per each
- 730-K Traffic Signal Junction Box - per each
- 730-L ( 4 ) , ( 5 ) , Conduit - per linear foot {meter}
- 730-M Interconnect Cable, ( 6 ) , ( 7 ) AWG, ( 8 ) , ( 9 ) - per linear foot {meter}
- 730-N Luminaire Extension Assembly, ( 10 ) feet {meters} - per each
- 730-O Illuminated School Zone Speed Limit Sign - per each
- 730-P Vehicular Signal Head, ( 11 ) Inch {mm}, ( 12 ) Section, Type ( 13 ) - per each
- 730-Q Pedestrian Signal Head, Type ( 14 ) - per each
- 730-R Controller Assembly, Type ( 15 ) , ( 16 ) phase - per each
- 730-S ( 19 ) Traffic Signal Preemption ( 20 ) ( 21 ) ( 1 ) - per lump sum
- 730-T Wood Pole - per each
- 730-U Video Detection System - per lump sum
- 730-Y ( 17 ) Pedestal Pole and Foundation with ( 18 ) - per lump sum

- (1) Specify Intersection Location
- (2) Specify Length of Mast Arm
- (3) Specify Type (Metal or Concrete)
- (4) Specify Size (1 inch, 2 inch, or 3 inch) {27 mm, 53 mm, or 78 mm}
- (5) Specify Type (metallic or non-metallic)

- (6) Specify Type ( Aerial Self-supporting, Aerial Lashed, or Underground)
- (7) Specify Cable Size ( No. 14 AWG or No. 19 AWG)
- (8) Specify Number of Conductors or Pairs (9 Conductors or 6 Pairs)
- (9) Specify (IMSA 20-1, IMSA 20-3, REA PE-22, REA PE-38, or REA PE-39)
- (10) Specify Arm Length in Feet {Meters}
- (11) Specify Lens Size (12 inch) {305 mm}
- (12) Specify Number of Sections (1, 2, 3, 4, or 5)
- (13) Specify Type (Incandescent, Optically Programmed, or LED)
- (14) Specify Type (Incandescent or LED)
- (15) Specify Type (II or III)
- (16) Specify Number of Phases (2, 4, 8, or Master)
- (17) Specify (Furnishing and Installing, Removal of, or Relocation of)
- (18) Specify (Flashing Beacon, or Illuminated School Zone Sign)
- (19) Specify Type (Acoustical, Optical or GPS)
- (20) Specify Whether or not Software is Required (With Software, or Without Software)
- (21) Specify Whether or not Training is Required (With Training, or Without Training)

## SECTION 890 TRAFFIC SIGNAL EQUIPMENT

### 890.01 General.

The following are the requirements for traffic signal equipment. These requirements may be supplemented or amended by the requirements given elsewhere in the proposal, on the plans, and on the details in the Special and Standard Highway Drawings.

Requirements specified in these specifications shall comply with the latest editions of the NEC, and NESC. All equipment shall conform to the requirements in the NEMA Standards Publication No. TS 1-1989, "Traffic Control Systems" or latest revisions and shall conform to the requirements specified within these specifications. All equipment shall meet the latest NEMA Environmental and Operating Standards. In case of conflict with cited Standard Publications and these specifications, the requirements of these specifications shall govern.

For purposes of these specifications wherever the following terms or abbreviations are used, the meaning shall be interpreted as follows:

A	Amps
AC	Alternating Current
ANSI	American National Standards Institute
ASTM	American Society for Testing Materials
AWG	American Wire Gage
DC	Direct Current
Hz	Hertz
IMSA	International Municipal Signal Association
ITE	Institute of Transportation Engineers
LED	Light Emitting Diode
MUTCD	Manual on Uniform Traffic Control Devices
NEC	National Electrical Code
NEMA	National Electrical Manufactures Association
NESC	National Electrical Safety Code
UL	Underwriters Laboratories
V	Volts
VA	Volt Amps
W	Watts

Descriptions and definitions of the equipment, words, and terminology used in these specifications are given in the MUTCD, the NEMA TS 1-1989 Standards Publication, ITE publications, and the NEC.

## 890.02 Controller Assembly.

### (a) DESCRIPTION.

A controller assembly shall consist of a controller unit, conflict monitor, auxiliary devices, electrical devices and other equipment as specified in these specifications, plans, or proposal mounted and wired into a cabinet to make a complete operational traffic controller assembly.

### (b) CABINET DESIGN.

The cabinet shall be an approved weatherproof enclosure. It shall be designed for base mount or pole mount as shown on the plans. The cabinet shall be clean-cut in design and appearance.

#### 1. FABRICATION MATERIAL.

The cabinet shall be fabricated from cast aluminum or shaped sheet aluminum.

#### 2. CABINET DIMENSIONS.

The cabinet shall be large enough to provide ample space to house the controller unit, conflict monitor, auxiliary devices, electrical devices, and other equipment as specified in these specifications, plans or proposal. The cabinet shall accommodate the largest controller dimensions for the specific number of phases required by the plans or proposal.

The minimum size of pole mounted controller cabinet shall be 41 inches {1025 mm} in height, 28 inches {700 mm} in width, and 16 inches {400 mm} in depth.

The minimum size of base mounted controller cabinet shall be 54 inches {1350 mm} in height, 38 inches {950 mm} in width, and 16 inches {600 mm} in depth.

#### 3. DOORS.

When closed, the doors shall fit closely to gasketing, making the cabinet weather-resistant and dust-tight. Door hinges, bolts, and pins shall be of stainless steel or equivalent corrosion resistant material.

Main Cabinet Door: A hinged main cabinet door shall be provided permitting complete access to the interior of the cabinet. When opened, this door shall be provided with a device designed to hold the door in an opened position.

Auxiliary Cabinet Door: A small, hinged, auxiliary door (police compartment door) shall be provided on the outside of the main cabinet door. The auxiliary door shall permit access to a switch panel, but shall not allow entrance to the controller mechanism nor to exposed electrical terminals.

#### 4. GASKETING.

Gasketing shall be provided on all door openings and shall be dust tight. Gaskets shall be permanently bonded to the metal. The mating surface of the gasketing shall be covered with a silicone lubricant to prevent sticking to the mating.

#### 5. LOCKS AND KEYS.

The main cabinet door shall be equipped with a sturdy brass or stainless steel lock. The lock shall be a traffic industry conventional lock and operate with a No. 2 key. The lock shall be permanently lubricated and shall be covered with a weatherproof tab.

The small auxiliary door (police compartment door) shall be equipped with a lock. The auxiliary door (police compartment door) shall use a standard skeleton key.

Two keys shall be furnished for each lock.

#### 6. SHELVES.

The cabinet shall be supplied with two mounting shelves. One shelf shall be used for storage of the controller and its associated hardware and the other shelf for storage of detectors.

#### 7. FINISH SURFACE PREPARATION.

Unless otherwise shown on the plans, the cabinet shall be aluminum finish.

When painting of the cabinet is specified, the cabinet shall be primed and finished with two coats of high-grade enamel paint, complying with the requirements of Section 855.

#### 8. POLE MOUNT HARDWARE.

A cabinet intended for side-of-pole mounting shall be provided with an adapter (exclusive of lag bolts or banding) necessary to permit mounting to a 4.5 inch {115 mm} diameter or

larger pole. The adapter shall accommodate lag bolts up to 3/8 inch {10 mm} diameter or banding up to 1 inch {25 mm} wide. Mounting holes shall be provided at or near the top and bottom of the cabinet.

9. GROUNDING.

Ground electrodes at controllers shall be a copper clad rod 5/8 inch {16 mm} in diameter, driven to a depth of 8 feet {2.4 m} and bonded by copper wire or strap of the same cross sectional area as No. 6 AWG {4.25 mm} wire.

10. CABINET VENTILATION.

Louvered vents shall be located on the main cabinet door. Vents shall allow the release of excessive heat and any explosive gases that might enter the cabinet.

A cabinet vent air filter, minimum size of 16 inches x 12 inches {406 mm x 305 mm}, shall be mounted on door and held in place by a spring.

A thermostatically controlled power vent and fan shall be provided. The thermostat shall activate the fan at 110 °F {43 °C} and de-activate the fan at 90 °F {32 °C} with an accuracy of + 5 °F {+ 2 °C}.

11. IDENTIFICATION PLATE.

An aluminum identification plate shall be affixed to the cabinet door.

The identification plate shall be sized to provide the message "Alabama Department of Transportation" either etched or embossed in 1 inch {25 mm} high letters.

The letters shall be delineated in black enamel.

12. SERIAL NUMBER.

A serial number shall be engraved or stenciled on the cabinet. The serial number shall be the same number as the controller unit serial number.

13. DATA LABEL.

A data label shall be placed on the inside of the cabinet door to provide the following information:

Manufacturer's name - All equipment installed cabinet  
Date of Manufacture  
Wiring Schematics Number  
Controller Model Number  
Controller Serial Number  
Conflict Monitor Model Number  
Conflict Monitor Serial Number  
Time Base Coordinator Model Number (If applicable)  
Time Base Coordinator Serial Number (If applicable)  
Communication Unit Model Number (If applicable)  
Communication Unit Serial Number (if applicable)  
Master Model Number (If applicable)  
Master Serial Number (If applicable)  
Time Clocks Model Number (If applicable)  
Time Clocks Serial Number (If applicable)  
Project Number or Transportation Department P.O. Number.

(c) AUXILIARY DEVICES.

1. GENERAL.

Auxiliary devices shall conform to the requirements of NEMA Standard Publication No. TS 2-1992, "Traffic Controller Assemblies".

2. SOLID STATE FLASHERS.

The flasher shall be jack mounted.

3. FLASH TRANSFER RELAY.

The flash transfer relay shall be a heavy-duty relay designed for continuous duty. It shall mount on an eight pin spade plug base.

4. SOLID STATE LOAD SWITCH.

The signal load switches and signal load base plate shall be furnished and wired in place for each phase provided.

Load switches shall be triple signal, NEMA input light indicating, rated for 10 A at 165 °F {75 °C}. The actual switching component shall have a minimum 500 V PIV rating.

5. DETECTOR TEST SWITCHES.

When specified, detector test switches shall be furnished to check all detector control circuits.

6. MERCURY CONTACTOR.

A mercury contactor input power relay shall be a 40 A relay for 2 phase and 4 phase controllers and a 60 A relay for 8 phase controllers.

(d) TERMINALS AND FACILITIES.

1. GENERAL.

The following define the performance and construction requirements of cabinet terminals and facilities that are considered to be of the attached or nonplug-in type. These additional specifications cover the physical requirements, electrical requirements, interface, cabling, supporting terminal facilities, and labeling.

2. OPENINGS.

The cabinet shall be provided with necessary openings for mounting and connection as specified.

3. ARRANGEMENT OF DEVICES.

The controller equipment and terminal blocks shall be so arranged within the cabinet that they will not upset the entrance, training, and connection of the incoming conductors.

4. TERMINAL AND PANEL WIRING.

No printed circuit boards will be allowed in the cabinet wiring facility, every panel and terminal shall be hardwired.

Each controller assembly is to be furnished with panels in the cabinet mounted in such a way as to provide visibility and accessibility.

All panel wiring shall be neat, firm, and hardwired.

5. TERMINAL PANEL.

As a minimum, the panel shall be provided with the following terminal blocks:

Terminal block to provide connections for the circuit breaker and power supply line.

Terminal block unfused, for neutral side of power supply line.

Terminal blocks for conductors of signal control cable. One terminal for each signal circuit and one or more terminals for the common conductor shall be provided.

The terminal blocks shall be located at least 6 inches {150 mm} from the bottom of the base mount cabinet and arranged for adequate electrical clearance between terminal blocks.

6. POWER TERMINAL STRIP.

Terminal strip shall be supplied for incoming power.

7. INSERT TERMINALS.

All components, connectors, plug terminals, and insert terminals shall be clearly annotated.

8. TERMINAL STRIP SHIELDING.

If terminal points are located adjacent to a shelf so that possible shorting can be accomplished by shifting of components, the terminal strips shall be shielded.

9. TERMINAL POINTS AND TERMINAL STRIPS.

All terminal points and terminal strips shall be the double tie type and shall be clearly annotated.

There shall be no more than two connections made on any terminal point.

Connections shall be made by using ring tongue terminal connections stamped from one piece of pure copper.

The barrel will be formed with a brazed butted seam and shall be pre-insulated with an appropriate sleeve.

The terminal connections shall be required to be the correct size for the wire and terminal strip bolts.

Terminal connections used on solid wire shall be soldered.

10. WIRING.

Wiring with controller cabinet shall be neatly laced and identified.

All wires shall be cut to a proper length before assembly. No wire shall be doubled back to take up slack.

The outgoing traffic control signal circuits shall be of the same polarity as the line side of the power supply; the common return of the signal circuits shall be of the same polarity as the grounded side of the power supply.

All wiring to AC+ shall be colored black. All wiring to AC- shall be colored white. All wiring to chassis ground shall be colored green.

11. CABLES.

All cables shall be self-contained and have continuous jackets from terminal facility into connector.

The jacket shall be solid flexible sleeving or expandable self-fitting polyester sleeving. Spiral wrap type sleeving will not be accepted.

The position of cables between the components must be such that when the door is closed, it does not press against the cables or force the cables against various components inside the cabinet.

All cables shall be self-contained and shall not be split to feed more than one connector.

12. DETECTOR PANEL.

A separate panel shall be furnished for detector wiring with all NEMA functions available and wired to the terminal strips.

The panel shall also include an earth ground buss with terminal points parallel and adjacent to the loop connection terminals for lightning protection.

A twelve-position double tie blank terminal strip shall be mounted on detector panel for future use.

13. SWITCH PANELS.

An internal switch panel shall be mounted on the inside of the main door. All switch functions shall be permanently and clearly labeled.

14. GROUNDING.

All logic ground, AC neutral, and chassis ground within the equipment and cabinet shall be isolated, split with separate ground buses being required for AC neutral and earth ground.

All lightning protection shall be grounded to the chassis ground. Lightning protection shall be installed before the power service to the cabinet is turned on.

All neutral conductors shall be grounded at the controller and at each terminal point.

15. LINE FILTERS.

Line filters shall be furnished to protect the controller from line voltage surges. Line filters for two phase controllers shall be rated at 25 A and four phase controllers shall be rated at 30 A through eight phase shall be rated at 45 A.

16. RADIO INTERFERENCE SUPPRESSION.

Each cabinet shall be equipped with a radio interference suppressor installed. The suppressor shall be connected to filter interference completely from the controller and associated equipment.

17. CONVENIENCE RECEPTACLE.

A convenience outlet shall be provided as part of the terminals and facilities. The convenience receptacle shall be a duplex, three prong, NEMA Type 5 - 15R grounding type outlet and shall have independent ground fault circuit protection.

18. LIGHT FIXTURE.

Each cabinet shall be provided with a florescent lighting fixture mounted on the inside top of the cabinet near the front edge. The fixture shall be provided with an F15T8 cool - white lamp operated from a normal power factor UL or ETL listed ballast.

19. DOOR ACTUATED LIGHT SWITCH.

A cabinet door actuated switch that turns the light off when the door is closed shall be provided.

20. POLICE PANEL SWITCHES.

The police door switch panel shall contain only two switches, a power ON/OFF switch, and a flash ON/OFF switch.

The power ON/OFF switch shall be an equipment power and not an AC power for the cabinet.

The flash ON/OFF switch shall apply a flash mode to the flasher relay and shall not interrupt the controller power. The flash ON/OFF switch shall not interrupt the controller cycling.

21. MAINTENANCE PANEL SWITCHES.

The maintenance panel shall contain a power ON/OFF switch, controller power ON/OFF switch, a flash ON/OFF switch, and a signal ON/OFF switch.

The flash ON/OFF switch shall place the flash relay in flash mode and allow the controller to continue cycling.

22. MAIN CIRCUIT BREAKERS.

A circuit breaker shall be furnished. Circuit breakers shall be rated at 20 A for two phase controllers, shall be rated at 30 A for three and four phase controllers, and shall be rated at 40 A for five through eight phase controllers.

The main circuit breaker shall turn off all power to the cabinet and shall not be used for the power switch, which is located in the service panel.

23. CONTROLLER CABINET POWER SUPPLY.

Unless otherwise specified the controller unit and associated equipment shall operate reliably on 115 V; 60 Hz single phase alternating current.

Any internal DC voltages required to satisfactorily operate a controller assembly shall be from a regulated power supply designed to generate all DC voltages required, constructed as an integral part of the controller assembly.

The grounded side of the power supply shall be carried throughout the controller in a continuous circuit.

24. TIMER CONNECTIONS.

The electrical connections from the timer to the outgoing and incoming circuits shall be made in such a manner that the timer may be replaced with a similar unit, without the necessity of disconnecting and reconnecting the individual wires leading there from. This can be accomplished by means of a multiple plug and jack, a spring-connected mounting, or equivalent arrangement.

25. SIGNAL LOAD SWITCH ARRESTOR.

The load switch output shall have a metal-oxide varistor, Type V150LA20A.

26. REPLACING LIGHTNING PROTECTION.

All lightning protection devices shall be replaceable without removing any panels.

27. INDICATOR LIGHTS.

Controllers having indicator lights with a design or in circuit life of less than 75,000 hours shall have a micro-switch located on the cabinet door that will extinguish the indicators when the door is closed.

28. NEMA INDICATION WIRING.

All NEMA functions plus NEMA coded status bits and voltage monitor outputs as listed in the NEMA Standards Publication No. TS 1-1989. Outputs shall be brought out and wired to an individual tie point of a terminal strip before further routing.

29. PREEMPTION (PRIORITY CONTROL).

When preemption is required by the plans or proposal, electrical devices, logic circuits and special wiring shall be provided which will assume control over local traffic control equipment to require display of special safety modes giving preferential right-of-way to emergency vehicles or protection at railroad crossings.

(e) CONFLICT MONITOR.

1. TYPE.

Conflict Monitor shall be a NEMA Type 12L and conform to the requirements of NEMA Standards Publication No. TS 1-1989 Section 6, "Conflict Monitor Specifications", or any subsequent publication, plus the following features:

2. MONITOR REMOVAL.

The intersection shall remain in flash operation when the monitor has been removed.

3. BLOWN FUSE MONITOR.

The intersection shall go to flashing operation when the monitor fuse blows.

4. POWER SUPPLY MALFUNCTION.

The intersection shall go to flashing operation when the controller power supply malfunctions.

5. CONTROLLER POWER WITH TRIPPED CONFLICT MONITOR.

The conflict monitor shall not interrupt controller power when tripped.

6. STOP TIMING WITH TRIPPED CONFLICT MONITOR.

The conflict monitor shall apply stop timing on the controller when tripped.

7. INDICATION OF DRIVE FAILURE.

The conflict monitor shall indicate which drive failure has occurred (Red Fail).

8. DISPLAY AND PRINTING.

The unit shall have a LCD display, it must also have a printer port, RS232, and be capable of printing all memory-stored failures, with the type failure and date.

9. CLOCK.

The unit shall have a real time clock.

10. EVENT LOG.

The unit shall have an event log that contains the following data:

- AC power interruption/restoration logging;
- Logs reset after failure;
- Log 24 V values;
- Log CVM failure;
- Load switch failure;
- Log all faults with time and date.

11. EXTENDED MONITORING.

The unit shall have the following extended monitoring:

- Dual indication monitoring per channel;
- Short vehicle clearance detection.

12. DISPLAY OF INTERSECTION STATUS.

The unit shall be capable of displaying intersection status.

13. READBACK.

The unit shall have program card readback.

14. TERMINATION OF UNUSED INPUTS.

All unused inputs will be brought out and terminated on a terminal strip.

15. MONITOR INPUT WIRING.

Monitor inputs shall be wired to field output terminals.

(f) WIRING DIAGRAM.

Three copies of cabinet wiring diagram shall be supplied as well as copies of the following:

Three each of:

- Controller circuit diagrams and schematics;
- Controller Operations Manual;
- Conflict Monitor diagrams and schematics.

Two each of:

- Flasher diagrams and schematics;

Load Relay diagrams and schematics;  
Diagrams and schematics of any external hardware supplied;  
Template of Base Mounting if base mounted.

Cabinet prints shall include flash color change instructions for all phases and all overlaps.

Cabinet print shall be keyed to show every input and every output from every terminal. If prints use multiple ground and neutral busses, busses shall be numbered. All grounds and neutrals shall be keyed to the busses that they are connected to.

Cabinet prints shall show every connector.

(g) CONTROLLER UNIT.

1. TYPE.

The phase requirements required on the plans will indicate the physical and electrical construction of the controllers; however, controller unit shall conform to NEMA requirements.

Controller units shall be classified in the following categories:

Type II: Solid State Pre-timed

Type III: Traffic Actuated Solid State Modular (NEMA)

For Type III controller units, controller indicators as outlined in NEMA Standards Publication No. TS 1-1989, Section 14.3.05 shall contain information which shall be displayed simultaneously for both rings in a dual ring controller.

Unless otherwise described in these specifications, or required by the plans or the proposal, the following requirements are applicable to all controller units.

2. CONTROL LOGIC.

Unless otherwise required by the plans or proposal, all control functions shall be performed by microprocessor logic

3. OVERLAPS.

All overlaps shall be internally generated, available, and programmable.

4. INTERCONNECTION AND COORDINATION.

The controller shall be capable of being interconnected and coordinated in accordance with requirements of the plans or proposal. Any phase shall be capable of being coordinated.

5. OPERATIONAL REQUIREMENTS.

Phase Skip: The controller shall provide the ability to automatically skip any phase when there is an absence of demand.

Signal Operation Plan: The signal operating plan in the plans will determine the number of phases required and the necessary phase sequence requirements of the controller in accordance with NEMA standards.

Changing Operation: Changes from flashing to stop-and-go operation shall be made at the beginning of the major street green interval preferably at the beginning of the common major street green interval, (i.e., when a green indication is shown in both directions on the major street). Programmed changes from stop-and-go to flashing operation shall be made at the end of the common major street red interval, (i.e., when a red indication is shown in both directions on the major street).

Programmable Flashing Operations: Flashing operations shall be programmable by terminal strip jumpers for all phases and all overlaps.

Type III Controller Unit: Type III, traffic actuated solid state controller unit, shall feature one or more of the following timing features as required by the plans or proposal.

Standard timing;

Density timing;

Vehicle Occupancy timing;

Pedestrian timing;

Preemption.

Timing for phase modules shall be furnished in accordance with the plans and shall be accomplished by using the digital timing concept.

All phase timing modules shall be provided with dual maximum timing capabilities.

6. TIME BASE COORDINATION.

Electrical devices, logic circuits and special wiring shall be provided which will provide direct supervision of a local controller when time base coordination is shown on the plans.

The time based coordinator shall be a solid state digitally timed microprocessor device.

The unit shall contain a sealed battery capable of maintaining sufficient power to the RAM to protect, intact, any operator programmed data for a period of at least sixty days without AC input to the controller unit. The battery shall be maintained in a fully charged state through a trickle charge during normal operation.

An LED shall be provided to indicate when the voltage of the battery is over or under tolerance levels.

There shall be means for automatic change for daylight savings time.

Local coordination shall be accomplished by utilizing a time base coordinator capable of operating as a (a) yearly programmer with time of day, day of week, week of year programming, (b) sync pulse generator with time of day, day of week, week of year programming, (c) coordinator with time of day, day of week, week of year programming. The unit shall be capable of the following coordination features: four cycle lengths, four split plans, three offsets per cycle, minimum of three permissive periods per split, a minimum of four force-offs per split.

**890.03 Master Controller Assembly and Secondary Controller Assembly.**

(a) MASTER CABINET AND SECONDARY CABINET.

The following additional requirements shall apply to the cabinet for a master controller assembly and a secondary controller assembly.

The master and secondary controller cabinet shall house a hardwire master interconnect panel to provide for seven wire interconnect 120 V to be complete with three NEMA load switches, and complete with 120 V relays. The required functions provided shall consist of three dials; three offsets and flash; outputs and inputs. Panels shall have all components mounted on 0.125 inch {3.2 mm} sheet aluminum. The panel shall be completely wired in-place to include all necessary harness, and shall be wired to conform to the requirements of the MUTCD for system flash.

Terminal block facilities shall be provided for the interconnect.

(b) MASTER CONTROLLER UNIT.

1. GENERAL.

The master controller for an interconnected traffic control signal system shall be the apparatus required to provide supervisory functions under normal operation as described for interconnected controllers.

2. MOTOR.

The master controller shall be driven by a synchronous motor or be provided with a synchronous control mechanism which will maintain a constant time cycle; however, when it is not necessary to keep a traffic control signal system in step with adjacent systems or adjacent non-interconnected controllers, an induction motor driven master controller may be specified.

3. SUPERVISORY FUNCTIONS.

Means for automatically establishing offset time relations of local controllers.

Hand operated switch for turning off completely all traffic control signal lights at interconnected local controllers.

Hand operated switch for transfer of traffic control signal lights at each local controller to give flashing indications.

Hand operated switch for selecting offset at which all interconnected local controllers shall operate in accordance with three distinct timing plans.

Hand operated switch for selecting two or three interval setups on which each of the interconnected local controllers shall operate.

The above requirements of shall be obtainable when specified, by means of an automatic time switch, in which case the automatic switching schedule shall be required.

#### 4. TIME CYCLE.

The variation of the time cycle settings of all interconnected local controllers shall be accomplished by a simple adjustment at the master controller. There shall be at all times an accurate visual indication of the time cycle at which the traffic control signal system is operating.

It shall be possible to accurately set or adjust the time cycle between the limits of 30 and 120 seconds with accurate and definite settings within this range in 5 second steps up to 90 seconds and 10 seconds steps above 90 seconds.

#### 890.04 Surge Protection for Controller Assembly.

##### (a) PROTECTION OF CONTROLLER ASSEMBLY CABINET.

All controller assembly cabinets shall be furnished with a surge protector on the AC service input, which meets or exceeds the following performance requirements.

Unit shall be capable of withstanding repeated 20,000 A surges a minimum of 25 times.

Unit shall have internal follow-current limiters (resistive elements).

Unit shall contain a minimum of three active clamping stages.

Unit shall self-extinguish within 8.3 milliseconds after the trailing edge of surge.

Parallel impedance of limiters shall be less than 0.15 ohms.

Unit voltage shall be to the circuit breaker before cabinet voltage filters.

Electrical connections on the unit shall be durable enough to accommodate a No. 6 AWG {4.25 mm} wire.

The unit shall have a mounting plate for easy removal and replacement and shall be mounted in a neat workmanlike manner in the controller cabinet with as short a run as possible from the power input to the circuit breaker.

##### (b) PROTECTION OF SIGNAL LOAD SWITCHES.

Each load switch shall be furnished with a gas tube or metal-oxide varistor, Type 150LA20A.

Unit shall have an impulse breakdown of less than 1000 V in less than 0.1 microsecond at 10 kV per microsecond.

Unit shall be capable of withstanding 20 A AC for 1 second applied 10 times at 3 minute intervals on either section.

Unit shall have a current rating of 20,000 A (8/impulse) one time.

Unit shall have a striking voltage of 300 to 500 V DC.

Unit shall have a minimum holdover of 155 V DC.

Unit shall be installed across the Triac of each section of the load switch. The center electrode of the gas tube surge protector shall be connected to pin number 12 of the load switch plug. The load switch receptacle pin number 12 shall be wired to a minimum No. 8 {3.35 mm} wire ground buss. The ground buss shall be connected to the chassis ground and a ground rod. Connection terminal shall be provided a minimum distance possible from the physical center of the ground buss.

##### (c) PROTECTION OF CONTROLLER UNIT AND CONFLICT MONITOR.

Power and neutral for controller and conflict monitor shall be wired through a high-speed approved suppressor. The output of the arrester to failsafe, controller, etc., shall be through shielded cable or twisted pair to the units AC plus and AC minus inputs.

The surge protection device shall meet or exceed the following performance requirements.

Protectors, after being subjected to twenty five 20 kA (8 X 20  $\mu$ s) pulses must remain operative and exhibit less than 5 percent plus or minus change in clamp voltage before and after the test.

The protector clamp shall never exceed 250 V when subjected to the 20 kA surge.

The peak current shall be 20,000 A.

The continuous service current shall be, 10 A maximum, 120 V AC, 60 Hz.

FILTERING SPECIFICATIONS, MIL-STD-220 Insertion Loss Test Data		
Insertion Loss Requirements		
Frequency		Insertion Loss (db)
60	Hz	0
10	kHz	34
50	kHz	55
100	kHz	76
500	kHz	68
2	MHz	58
5	MHz	58
10	MHz	58
20	MHz	63

(d) PROTECTION OF REMOTE DETECTOR AND INTERCONNECT CABLE.

Each remote detector input line and interconnect line, as it enters the cabinet shall be furnished with a surge protection device that meets or exceeds the following requirements.

Unit shall be capable of withstanding 10,000 A 10:20 microsecond standard waveform surges a minimum of 50 times.

Unit shall have internal follow-current limiters (resistive elements).

Unit shall self-extinguish within 8.3 milliseconds after the trailing edge of surge.

Unit shall not have thermal circuit breakers in place of limiters.

Limiter resistance shall be between 0.15  $\Omega$  and 0.39  $\Omega$ .

Unit shall have a mounting plate for easy removal and replacement and shall be mounted in the controller cabinet in a neat workmanlike manner.

(e) PROTECTION OF LOOP DETECTORS (EXTERNAL SURGE PROTECTION).

External surge protection for each detector must meet the following requirements.

Unit shall be a three terminal device capable of protecting the detector against differential (between the loop leads) surge, and against common mode (between leads and ground) surges.

Unit shall be of the inductive type with a maximum DC resistance of 150 m $\Omega$ .

Unit inductance shall be able to protect the detector electronics when the detector is subjected to a 400 A surge across the detector leads.

Unit shall be a two stage device.

Unit shall clamp a 250 A surge to 25 V within 40 nanoseconds. Surge shall be applied between the two detector leads.

Unit shall clamp a 250 A COMMON mode (between leads and ground) surge to 35 V. These do not include protector lead IR drop.

Unit shall withstand repeated surges.

Unit and loop terminals to be physically mounted approximately 6 inches {150 mm} from bottom of cabinet.

**890.05 Vehicular Loop Detector.**

(a) GENERAL.

Vehicular detectors shall be capable of providing reliable detection of all vehicles present when the inductance shift of the loop is 0.05 percent of the total inductance of the loop and lead-in when operating in the high sensitivity mode of the detector. Sensitivity of the detector shall remain constant over the operating temperature of -35 °F to +165 °F {-37 °C to 74 °C}.

Vehicular detector operation shall not be affected by changes in the inductance of the loop resulting from environmental changes encountered in the State, nor shall the sensitivity be markedly affected.

Vehicular detector shall have a self-contained power supply, capable of furnishing all necessary power, operate from a 115 V, 60 Hz source.

Vehicular detector shall have a built-in lightning protection device and shall have a built-in fail-safe relay to require a detector call to the controller upon failure of the detector.

Vehicular detector shall have the ability of being connected to multiple loops of various sizes and shall detect vehicles of various sizes with the capability of continuously registering the presence of a conventional passenger car on a 6 foot x 50 foot {2 m x 15 m} two-turn loop for a minimum time of ten minutes when in the presence mode.

Vehicular detector shall operate on loops of various sizes located up to 750 feet {225 m} from the loop.

Vehicular detector circuit boards and power supply shall consist of printed circuit design on a G10 grade or equivalent fiberglass epoxy with 2 ounces {57 g} copper track and coated with protective finish to minimize oxidation.

Vehicular detector boards and power supply shall consist of flow or wavesoldered copper connections, including fixed components.

Vehicular detector shall operate on an electronic tuned resonant circuit composed of lumped capacity and inductance provided by the loop embedded in the roadway. The detector shall provide detection by phase comparison means with accuracy of better than 99 percent of all vehicles passing over the loop at speeds of 1 mile per hour to 80 miles per hour {1 km/hr through 130 km/hr}. The voltage across the loop combination reflecting any change shall be used as a signal for relay operation.

Tuning capacitors shall be ceramic enclosed and epoxy filled.

Vehicular detector shall have the capability to function when loops are shorted or leaking to ground at one point.

Detection indication shall be provided in the form of indicator lamps on the face of the unit.

**(b) SINGLE CHANNEL VEHICULAR LOOP DETECTOR.**

Single channel vehicular loop detectors shall conform to the following additional requirements.

The loop detector shall be a digital solid state unit with the capability of automatic tracking of environmental changes after automatic or manual initial tuning. The unit shall have pulse and presence modes all, which are activated by wire loops embedded in the roadway. Loop influence shall be adjustable so as not to extend beyond the sawcut more than 12 inches {300 mm}.

The loop detector shall have a minimum of two sensitivity modes, two presence modes and two operating frequencies that will enable the detector to accommodate the usual configuration of loops and lead-ins.

Total power consumption shall not exceed 5 W.

The loop detector shall have a tuning inductance range of at least 75 to 400 μHz.

A Type MS-3102A-18-1P with ten male contacts shall be provided. The pin functions of the connector shall be assigned as follows:

Pin No.	Use
A	117 V AC Connection
B	Relay Output Common
C	117 V AC Line
D	Input from Loop
E	Input from Loop
F	Relay Output Normally Open
G	Relay Output Normally Closed
H	117 V AC Ground
I	Not Used
J	Not Used

**(c) TWO CHANNEL VEHICULAR LOOP DETECTOR.**

Two channel loop vehicular detectors shall conform to the following additional requirements.

The loop detector shall be a digital solid state unit with capability of automatic tracking of environmental changes after automatic initial tuning. The two channel unit shall have pulse and presence modes for each channel, which are activated by wire loops embedded in the roadway. Loop influence shall be adjustable so as not to extend beyond the sawcut more than 12 inches {300 mm}.

The loop detector shall have a minimum of two sensitivity modes, two presence modes and two operating frequencies for each channel, which will enable the detector to accommodate the usual configuration of loops and lead-ins. Crosstalk between channels within the detector shall be eliminated by sequential scanning of loops.

Each channel shall be capable of tuning to any effective loop inductance within the range of 0 to 2000  $\mu$ Hz.

Total power consumption shall not exceed 8 W.

Two Type MS-3102A-18-1P connectors with ten male contacts shall be provided. The pin functions of each connector shall be assigned as follows:

Pin No.	Use
A	117 V AC Connection
B	Relay Output Common
C	117 V AC Line
D	Input from Loop
E	Input from Loop
F	Relay Output Normally Open
G	Relay Output Normally Closed
H	117 V AC Ground
I	Not Used
J	Not Used

**(d) FOUR CHANNEL VEHICULAR LOOP DETECTOR.**

Four channel loop vehicular detectors shall conform to the following additional requirements.

The loop detector shall be a digital solid state unit with capability of automatic tracking of environmental changes after automatic initial tuning. The four channels shall have pulse and presence modes for each channel, which are activated by wire loops embedded in the roadway. Loop influence shall be adjustable so as not to extend beyond the sawcut more than 12 inches {300 mm}.

The loop detector shall have a minimum of two sensitivity modes, two presence modes and two operating frequencies for each channel which will enable the detector to accommodate the usual configuration of loops and lead-ins. Crosstalk between channels within the detector shall be eliminated by sequential scanning of loops.

Each channel shall be capable of tuning to any effective loop inductance within the range of 0 to 2000  $\mu$ Hz.

Total power consumption shall not exceed 8 W.

A Type MS-3102A-22-14P connector with nineteen male contacts shall be provided.

**890.06 Interconnect Cable.**

**(a) DESCRIPTION.**

Interconnect cable shall be used to transmit information between intersections or other control points in a traffic control system.

**(b) MATERIALS.**

Interconnect cable shall conform to the requirements of this specification unless otherwise specified on the plans or in the proposal. If in such case that the plans designate fiber optic cable material be used for the interconnect cable then Section 734 shall apply.

**(c) UNDERGROUND INTERCONNECT CABLE.**

Underground interconnect cable, for closed loop systems, shall be shielded and conform to the requirements of Rural Electrification Administration (R.E.A.) Specification PE- 39, filled telephone cable, No. 19 AWG, 6 pair.

Underground interconnect cable for time base coordination shall conform to the requirements of IMSA 20-1 No. 14 AWG, 9 conductors.

(d) AERIAL INTERCONNECT CABLE.

Self-supporting aerial interconnect cable, for closed loop systems, shall be shielded and conform to the requirements of Rural Electrification Administration (R.E.A.) Specification PE- 38, No. 19 AWG, 6 pair.

Standard aerial interconnect cable, for closed loop systems, attached to a messenger strand in the field, shall conform to the requirements of Rural Electrification Administration (R.E.A.) Specification PE- 22, No. 19 AWG, 6 pair.

Self-supporting aerial interconnect cable, for time base coordination, shall conform to the requirements of IMSA 20-3, No. 14 AWG, 9 conductors.

Standard aerial interconnect cable, for time base coordination, attached to a messenger strand in the field, shall conform to the requirements of IMSA 20-1, No. 14 AWG, 9 conductors.

(e) INTERCONNECT CABLE SUPPORT WIRE.

A support cable, whether separate or integral to aerial interconnect cable, having a minimum diameter of 0.25 inch {6.35 mm} shall be provided for interconnect cable that is not self-supporting.

Support cable shall be steel wire strand Class A (double galvanized) and conform to the requirements of ASTM Standards Publication No. A 475-89, "Standard Specifications for Zinc-Coated Wire Strand".

(f) CABLE ATTACHMENT HARDWARE.

Attachment hardware shall be stainless steel or non-corrosive material and shall be provided with tensile strength adequate for application.

**890.07 Electrical Power Service Assembly.**

(a) DESCRIPTION.

Electrical power service assembly shall consist of equipment to provide a pole attached raceway and disconnect switch for use with power cable routed from the service entrance to the controller cabinet and nearest supporting structure with luminaire. The electrical power service assembly shall include a weatherhead, conduit and fittings, a disconnect switch with enclosure, and attachment clamps.

Electrical power service shall be in accordance with these specifications, NEC requirements, local utility codes, and on the details shown in the Special and Standard Highway Drawings.

(b) MATERIALS.

Materials shall be tested and approved by a nationally recognized testing laboratory and shall meet the following requirements.

1. SERVICE POLE (WOOD POLE).

Service pole shall be southern yellow pine treated in accordance with the latest American Wood-Preserver's Association (AWPA) standards and shall conform with the requirements given in Section 833.

Unless otherwise noted on the plans, service pole used for service lateral drop shall be a 35 foot Class 3 wood pole and shall conform to the requirements of ANSI Standards Publication No. 05.1-1992, "American National Standards for Wood Poles - Specifications and Dimensions".

The poles shall not have more than 180 degrees of twist in grain over the full length and the sweep shall be no more than 4 inches {100 mm}.

2. ATTACHMENT HARDWARE.

Attachment hardware shall meet the requirements as shown on the details in the Special and Standard Highway Drawings.

3. CONDUIT.

Conduit shall conform to the requirements specified in this Section.

4. WEATHERHEAD.

Weatherhead shall be made of a copper-free aluminum alloy or galvanized ferrous material.

5. ELECTRICAL CABLE.

Phase or current carrying conductors shall be of the type RHH, RHW, USE, or XHHW. Conductors shall be stranded annealed copper with not less than 98 percent conductivity and shall be

insulated for 600 V or more with rubber insulation and a neoprene jacket, or with cross-linked polyethylene insulation. The size of the conductor, voltage rating and type of insulation shall be clearly marked on the conductor in a color that contrasts with the color of the insulation.

Service wire to supply the controller shall be No. 6 AWG, stranded copper, two conductors rated for dry and wet conditions. The equipment grounding conductor shall be a bare conductor or shall be identified by a continuous green insulation. Grounded conductors (neutrals) shall be identified by a continuous white color insulation.

Service wire to supply the traffic signal luminaries shall be No. 8 AWG, stranded copper, three conductors rated for dry and wet conditions. The equipment and pole grounding conductor shall be a bare conductor or shall be identified by a continuous green insulation. Grounded conductors (neutrals) shall be identified by a continuous white color insulation.

#### 6. METER BASE.

When a meter base is required, meter base shall be a meter base approved by the local electric power company.

#### 7. SERVICE DISCONNECT.

Enclosure Cabinet: The cabinet shall conform to NEMA standards, made of galvanized steel, aluminum, stainless steel or other material approved by the Engineer. The enclosure shall have a hinged door with a padlock. Padlock No. 3210 keyed for a No. 3 key shall be provided. One key shall be hung within the controller cabinet.

Circuit Breaker: A manually resettable circuit breaker shall be installed, which has a current rating of the circuit to which electrical power is provided.

Transient Protective Device: A surge lightning arrester rated for a maximum permissible line to ground voltage of (175 V AC) shall be installed, meeting the requirements of NEMA standards for surge arrestors.

#### 8. PHOTOELECTRIC CONTROL UNITS.

The photoelectric control shall meet the design and testing requirements of ANSI C136.10. The photoelectric control unit shall also:

- be a dusk-to-dawn sensor attached to the service pole;
- have relay contacts that are single-pole, single-throw (SPST), normally closed (NC);
- contain built-in surge and lightning protection;
- have a direct load rating of 1000 Watts incandescent load and 1800 volt-amperes for High Pressure Sodium;
- have a rated life at full load of at least 5,000 on-off operations.
- upon failure leave the luminaires turned on as a notification of needed maintenance;
- be able to operate over the range of 105-130V, 60 Hz. AC (120 V Nominal);
- have over voltage protection for the control components and the load circuit by the means of an expulsion type surge arrester capable of passing the surge outlined in ANSI C136.10;
- be calibrated for a "Turn-on" setting of 2.6 footcandles and a "Turn-off" setting not exceeding 0.6 times the "Turn-on" setting;
- have a control housing that is UV resistant.

The photoelectric control shall have a cadmium-sulfide light sensitive element. The base shall have an integral, locking type, brass 3 prong plug according to NEMA SH16-1962 and a neoprene gasket that meets IEEE/NEMA publications.

Photoelectric control units shall be installed facing north; however, if obstructions are such that this is not possible then they shall be installed facing south.

### 890.08 Span Wire Assembly.

#### (a) DESCRIPTION.

Messenger cable shall be attached to supporting structures to support traffic signal heads, signs, and electrical cables.

#### (b) MATERIALS.

##### 1. STEEL WIRE STRAND.

Steel wire strand shall be Class A (double galvanized) and shall conform to the requirements of ASTM A 475-89.

2. MESSENGER CABLE.

Messenger cable used to support signal heads shall be 3/8 inch {9.5 mm} nominal diameter, 7 wires twisted into a single strand.

Messenger cable shall be extra high-strength grade with a minimum breaking strength of 15,400 pounds {68.4 kN}.

3. TETHER CABLE.

Tether cable attached to the bottom of signal heads shall be 1/4 inch {6.4 mm} nominal diameter, 3 wires twisted into a single strand.

Tether cable shall be utilities grade with a minimum breaking strength of 3,150 pounds {14.0 kN}.

**890.09 Vehicular Signal Heads.**

(a) ITE STANDARD PUBLICATIONS.

All signal heads shall conform to the requirements given in the ITE Standards Publications "Adjustable Face Vehicular Traffic Control Signal Heads" and "Vehicle Traffic Control Heads" and the following, assembled in accordance with the latest edition of the MUTCD.

(b) SEPARATE ILLUMINATION.

Each lens of a signal head shall be illuminated by a separate optical unit.

(c) HOUSING, DOOR, and VISOR.

1. HOUSING.

The housing shall be constructed of cast corrosion-resistant, copper free non-ferrous metal of not less than 17,000 psi {117 MPa} with all parts clean, smooth and free from flaws, cracks, blow holes and other imperfections.

The housing shall be of unitized sectional construction of as many sections as are optical levels, rigidly and securely fastened together into one watertight assembly.

Each housing shall be arranged with round openings in the top and bottom so as to be capable of being rotated about a vertical line between the waterproof supporting brackets or trunnions and of being securely fastened at increments of not more than 7 inches {175 mm} of rotation.

2. DOOR.

The door shall also be cast units from similar material to that used for the main section housing suitably hinged and shall be forced tightly against the gasket on the body of the housing by simple stainless steel locking devices.

All other exterior hardware, such as hinge pins, lens, clips, etc., shall be of stainless steel.

Neoprene gaskets shall be provided between the body of the housing and the doors, between the lenses and the doors, and between the lenses and reflectors to exclude dust and moisture.

The lens opening in the doors shall provide a visible diameter of not less than 11 inches {279 mm} nor more than 11.5 inches {292 mm} for a nominal 12 inch {300 mm} round lens. The dimensions of the opening in doors for rectangular lenses shall provide for a visible area of not less than 8 inches x 8 inches {205 mm x 205 mm}, nor more than 8.5 inches x 8.5 inches {215 mm x 215 mm}, for a nominal 9 inch {225 mm} rectangular lens and a visible area of not less than 11 inches x 11 inches {279 mm x 279 mm} nor more than 11.5 inches x 11.5 inches {292 mm x 292 mm} for a nominal 12 inch {300 mm} rectangular lens.

3. VISOR.

Each signal head shall have a tunnel visor for each signal indication. The door shall have an integrally cast collar not less than 3/16 of an inch {4.8 mm} around the lens opening, and the visor shall be designed to fit tightly against the collar and door, and shall not permit any perceptible filtration of light between the door and the visor. The percentage enclosure of the lens shall be as specified by the purchaser. The visor shall be a minimum of 9.5 inches {241 mm} in length for 12 inches {300 mm} diameter lenses, and not less than 0.05 inches {1.27 mm} in thickness, with a minimum downward tilt of 3.5 degrees. The visor shall be of corrosion-resistant nonferrous material. Visors shall be mounted with twist-on slots and stainless steel screws positioned for either vertical or horizontal mounting of the signal.

(d) TRUNNIONS, BRACKETS, AND SUSPENSIONS.

All trunnions, brackets, and suspensions used for assembling and mounting vehicle traffic control signal faces shall be entirely weather-tight.

Wire entrance fittings for signal heads and span wire hangers shall be cast aluminum tritud with aluminum span wire hinge with stainless steel nuts, bolts, and washers.

Wire raceway areas within brackets, trunnions and suspensions shall be of adequate size to carry all necessary wires without crowding, and raceway surfaces shall be free of sharp edges or protrusions that might damage insulation on wires.

Suspensions for mast arm or span wire mounting shall include a device to permit adjustment for proper vertical alignment of the signal head.

(e) EXTERIOR FINISH.

All exterior parts of the signal head except the lens, the insides of visors, and the entire surface of louvers or fins shall be finished of the best quality of synthetic resin enamel that is colored black or federal highway yellow. A combination color scheme may be used in lieu of either an all black or an all federal highway yellow. A combination color scheme may consist of an all black face with an all federal highway yellow body. No other combination color schemes or the mixing of allowed color schemes shall be used within an intersection or project unless noted otherwise on the plans.

The inside of the visors and the entire surface of louvers or fins shall be painted dull black using best quality synthetic resin enamel. All enamel shall conform to the appropriate requirements of Section 855.

(f) BACK PLATES.

Backplates shall be installed if shown on the plans. Backplates shall have a 5 inch {127 mm} border constructed of black metal.

(g) BACKING FOR ARROW LENSES.

The arrow shall be the only illuminated portion of the lens. The arrow lenses shall be covered (except for the arrow) with dull or dark gray enamel of a thickness sufficient to totally hide the light from a 200 watt lamp placed behind it.

The enamel shall be baked or fired into the glass. The enamel shall be hard and durable and shall not peel or flake when subjected to the heat of a signal lamp when the lens is either in use or when the lens is washed.

(h) SIGNAL HEAD COVER.

Signal head covers shall be opaque, black, and cover the entire face of the signal head. The cover shall be weather and ultra violet resistant.

The Contractor shall submit the proposed method of attaching a cover over the signal head to the Engineer for approval.

(i) PROGRAMMED VEHICULAR SIGNAL HEAD.

Programmed vehicular signal heads shall provide an optical system of such design that will permit the required visibility zone of the indication to be determined optically. The projected signal may be visible or selectively veiled anywhere within 15° of the optical axis. Indication shall not result from external illumination nor shall one indication illuminate a second.

The optical system shall provide an imaging surface, at focus on the optical axis for objects 900 feet to 1200 feet {275 m to 365 m} in distance and permit an effective veiling system to be variously applied as determined by the desired visibility zone.

Lamps shall be nominal 150 W, 120 V AC, three prongs, sealed beam type with integral reflector having a rated life of 6000 hours.

The objective lens may be glass or hermetically sealed plastic within a flat lamination of weather-resistant acrylic. The lens shall be symmetrical in outline allowing rotation to any 90° orientation about the optical axis.

The limiter and/or diffuser shall be provided with a positive means of indexing and shall be formed of heat resistant material.

Signal intensity controls shall be provided for each signal indication (color).

All other components of the Programmed Vehicular signal heads shall conform to the requirements specified in this Article.

(j) OPTICAL UNIT FOR INCANDESCENT LAMPS.

1. LAMPS.

Lamps used in traffic signal heads shall conform to the standards set forth in the ITE latest Standard for Traffic Signal Lamps, not smaller than 125 V, 8000+ hour rated life clear bulb in accordance with the following:

12 inch	{300 mm}	Red lens	150 or 165 W	3 inch light center length
12 inch	{300 mm}	Yellow lens	69 W	3 inch light center length
12 inch	{300 mm}	Green lens	116 W	3 inch light center length

2. WIRING.

Each lamp receptacle shall be provided with coded No. 18 AWG {1.06 mm} or larger wires type TEW, 600 V, securely fastened to the socket.

A suitable terminal block for connection of the wires from the socket and the incoming wires to the traffic signal head shall be provided in the signal housing.

3. REFLECTORS.

Reflectors shall be specular Alzak finished aluminum or an approved equal.

Reflectors shall be mounted in a cast aluminum reflector support attached to the housing, or shall be an integral reflector and support of formed sheet aluminum.

The reflector assembly shall be pivoted to the housing, and shall be designed so that it can be swung out or easily removed without the use of any tools.

The method of mounting and fastening reflectors shall be sufficiently rigid to secure proper alignment between the lens and reflector when the door is closed.

The construction of the signal head and its components shall be such that the fit between the reflector and the lens will eliminate all possibility of false indicators.

Reflectors shall have an opening in the back for the lamp socket.

4. LENSES.

Lenses shall be of glass; the quality and processing of which shall be the best for the purpose. The composition must be durable on prolonged exposure to weather; all lenses shall be uniformly colored throughout the body, true to size and form, and free from any streaks, wrinkles, chips, or bubbles that in any way detract from their efficiency or use.

Each lens shall have pressed on its flange the word "TOP" to indicate the proper positioning of the lens in the door for obtaining the light distribution required, together with the diameter and other designations including the name or trademark of the manufacturer needed for proper application and help in purchasing replacements.

A nominal 12 inch {300 mm} circular convex lens shall have an outside diameter of from 11.938 inches to 12.031 inches {303 mm to 306 mm}.

A nominal 9 inch {225 mm} rectangular lens shall have minimum over-all dimensions of 9 inches by 8.75 inches {228 mm by 222 mm}.

A nominal 12 inch {300 mm} rectangular lens shall have minimum over-all dimensions of 12 inches by 12 inches {305 mm by 305 mm}.

All lenses shall comply with the design designated by ITE for the use intended.

The color of the lens shall be of a color approved for use by ITE for the use shown on the plans.

(k) OPTICAL UNITS FOR LEDS.

1. LED TECHNOLOGY.

The LEDs shall be manufactured using AlInGaP (Aluminum-Indium-Gallium-Phosphorous) technology or other LEDs with lower susceptibility to temperature degradation than AlGaS (Aluminum-Gallium-Arsenic). AlGaS LEDs will not be allowed.

2. PHOTOMETRIC REQUIREMENTS.

Each LED traffic signal lamp (including replacements for incandescent lamps) shall produce 115 % of the light intensity values shown in the following tables of Minimum Luminous Intensity Values. Each LED shall also meet the color (chromaticity), and light output distribution described in ITE VTC SH (Vehicle Traffic Control Signal Head Standard) part 2 of the specifications 6.4.2.1, 6.4.4.1, 6.4.4.2, 6.4.4.3, 6.4.5, and 6.4.6.

The following tables of Minimum Luminous Intensity Values shall replace the values given in Table 1 of Section 4.1.1 of the ITE VTCSH. The 6.4.2.1 tests shall include an expanded view with the required minimum luminous intensity values.

MINIMUM LUMINOUS INTENSITY VALUES (IN CANDELAS) FOR 12 INCH DIAMETER RED LEDS												
GRID VALUES IN BOLD TEXT, 2.5D THROUGH 17.5 D, ARE ITE REQUIREMENTS FOR LIGHT INTENSITY												
	27.5	22.5	17.5	12.5	7.5	2.5	-2.5	-7.5	-12.5	-17.5	-22.5	-27.5
22.5U												
17.5U			3			10	10			3		
12.5U			14			20	20			14		
7.5U			20			54	54			20		
2.5U			58			220	220			58		
2.5D			<b>77</b>	<b>141</b>	<b>251</b>	<b>339</b>	<b>339</b>	<b>251</b>	<b>141</b>	<b>77</b>		
7.5D	<b>16</b>	<b>38</b>	<b>89</b>	<b>145</b>	<b>202</b>	<b>226</b>	<b>226</b>	<b>202</b>	<b>145</b>	<b>89</b>	<b>38</b>	<b>16</b>
12.5D	<b>16</b>	<b>22</b>	<b>34</b>	<b>44</b>	<b>48</b>	<b>50</b>	<b>50</b>	<b>48</b>	<b>44</b>	<b>34</b>	<b>22</b>	<b>16</b>
17.5D	<b>16</b>	<b>20</b>	<b>22</b>	<b>22</b>	<b>22</b>	<b>22</b>	<b>22</b>	<b>22</b>	<b>22</b>	<b>22</b>	<b>20</b>	<b>16</b>
22.5D			7			10	10			7		
27.5D												

MINIMUM LUMINOUS INTENSITY VALUES (IN CANDELAS) FOR 12 INCH DIAMETER GREEN AND YELLOW LEDS												
GRID VALUES IN BOLD TEXT, 2.5D THROUGH 17.5 D, ARE ITE REQUIREMENTS FOR LIGHT INTENSITY												
	27.5	22.5	17.5	12.5	7.5	2.5	-2.5	-7.5	-12.5	-17.5	-22.5	-27.5
22.5U												
17.5U			7			20	20			7		
12.5U			27			41	41			27		
7.5U			41			108	108			41		
2.5U			115			441	441			115		
2.5D			<b>154</b>	<b>283</b>	<b>501</b>	<b>678</b>	<b>678</b>	<b>501</b>	<b>283</b>	<b>154</b>		
7.5D	<b>32</b>	<b>77</b>	<b>178</b>	<b>291</b>	<b>404</b>	<b>452</b>	<b>452</b>	<b>404</b>	<b>291</b>	<b>178</b>	<b>77</b>	<b>32</b>
12.5D	<b>32</b>	<b>44</b>	<b>69</b>	<b>89</b>	<b>97</b>	<b>101</b>	<b>101</b>	<b>97</b>	<b>89</b>	<b>69</b>	<b>44</b>	<b>32</b>
17.5D	<b>32</b>	<b>41</b>	<b>44</b>	<b>41</b>	<b>32</b>							
22.5D			14			20	20			14		
27.5D												

Arrow indications shall be the light intensity shown in the following table.

ARROW INDICATION LIGHT INTENSITY (IN CANDELLAS PER SQUARE METER)			
	Red	Yellow	Green
Arrow Indication	5500	11000	11000

LEDs for arrow indications shall be spread evenly across the illuminated portion of the arrow area. The chromaticity of LED signal modules shall conform to the requirements given in the following table, for a minimum period of 60 months, over an operating temperature range of -40°C to +74°C. Each LED traffic signal lamp unit shall meet the minimum requirements for light output for the entire range of voltage from 80 to 135 volts.

CHROMATICITY REQUIREMENTS*	
Red	Y: greater than 0.280 and less than 0.308 for $Y = 0.998 - X$
Yellow	Y: greater than 0.411 and less than 0.452 for $Y = 0.995 - X$
Green	Y: greater than $0.506 - 0.519X$ ( $0 < X \leq 0.2243$ ) and greater than $0.150 + 1.068X$ ( $0.2243 \leq X \leq 0.2804$ ) and less than $0.730 - X$ ( $0 < X \leq 0.2804$ )

\* Taken from the ITE VTCSH Standard, Chapter 2, Paragraph 8.02, Figure 1.

3. LED PRODUCTION TESTING REQUIREMENTS.

Each new LED traffic signal lamp unit shall be energized for a minimum of 24 hours at operating voltage and at a temperature of +60 °C in order to cause any electronic infant mortality to occur, and to ensure electronic component reliability prior to shipment. Each LED traffic signal lamp unit shall be tested for initial luminous intensity at rated operating voltage.

4. QUALITY ASSURANCE.

LED signal modules tested or submitted for testing shall be representative of typical production units. Optical testing shall be performed with LED signal modules mounted in standard traffic signal sections without visors or hoods attached to the signal sections.

After burn-in, LED signal modules shall be tested for rated initial luminous intensity in conformance with the preceding photometric requirements. Before measurement, LED signal modules shall be energized at rated voltage, with 100 percent on-time duty cycle, for a time period of 30 minutes. The current, voltage, total harmonic distortion (THD) and power factor (PF) associated with each measurement shall be recorded and made available for future reference.

Photometrics, luminous intensity, and color measurements for yellow LED signal modules shall be taken immediately after the modules are energized. The ambient temperature for these measurements shall be 25 °C. The current, voltage, total harmonic distortion (THD) and power factor (PF) associated with each measurement shall be recorded and made available for future reference.

5. PHYSICAL AND MECHANICAL REQUIREMENTS.

The assembly and manufacturing process for the LED traffic signal lamp unit assembly shall be configured to assure all internal LED and electronic components are adequately supported to withstand mechanical shock and vibration from high winds and other sources.

Each LED traffic signal lamp unit shall comprise a UV stabilized polymeric outer shell, multiple LED light sources, and a regulated power supply.

6. ELECTRICAL.

Each unit shall incorporate a regulated power supply engineered to electrically protect the LEDs and maintain a safe and reliable operation. The power supply shall provide capacitor filtered, DC regulated current to the LEDs per the LED manufacturer's specification. Design of the power supply shall be such that the failure of an individual component or any combination of components cannot cause the signal to be illuminated after AC power is removed. Any deviation without prior testing and approval from the Department, shall be grounds for removal from the Materials, Sources, and Devices with Special Acceptance Requirements Listing.

The LED traffic signal lamp unit shall operate on a 60 Hz AC line voltage ranging from 80 volts RMS to 135 volts RMS. The circuitry shall prevent flickering over this voltage range. Nominal rated voltage for all measurements shall be 117 volts RMS.

The LED traffic signal lamp unit shall be operationally compatible with NEMA TS1 & TS2 and Type 170 & 2070 controllers, conflict monitors with plus features, and malfunction management units currently used by the Alabama Department of Transportation and any other State government entities.

Two, captive, color coded, 600 V, 18 AWG minimum, jacketed wires, 3 feet ± 1 inch long, conforming to the National Electric Code, rated for service at 105 shall be provided for an electrical connection.

Individual LEDs shall be wired so that a catastrophic failure of one LED light source will result in the loss of only that one LED light source. Stringed losses shall not occur except where a center line is used as a "LED Replacement Indicator".

LEDs shall be arranged in no less than 5 equally loaded circuits.

The LED signal shall operate with a minimum 0.90 power factor.

Total harmonic distortion (current and voltage) induced into an AC power line by a signal module shall not exceed 20 percent.

LED signal modules and associated on-board circuitry shall conform to the requirements given in Federal Communications Commission (FCC) Title 47, Subpart B, Section 15 regulations concerning the emissions of electronic noise.

7. ENVIRONMENTAL REQUIREMENTS.

The LED traffic signal lamp unit shall be rated for use in the ambient operating temperature range of -40 °C to +74 °C.

The unit shall be dust and moisture tight to protect all internal LED and electrical components.

The unit shall consist of a housing that is a sealed, watertight enclosure that eliminates dirt contamination and allows for safe handling in all weather conditions. Moisture resistance testing shall be performed on LED signal modules in conformance with the requirements in NEMA Standard 250-1991 for Type 4 enclosures. Evidence of internal moisture after testing shall be cause for rejection.

8. WARRANTY REQUIREMENTS.

All LED traffic signal lamp units shall be warranted against failure due to workmanship and material defects during the first 60 months of field operation. The LED signal lamp units shall also be warranted to meet or exceed the minimum luminous intensity values during the first 60 months of operation. This warranty shall be included with each LED signal module, in writing, by the manufacturer. The warranty shall include a commitment by the manufacturer to replace all failed LEDs at no cost the Department.

(l) LENSES FOR LEDS.

The lens for an LED signal lamp unit shall be a UV stabilized polymeric lens that is sealed to the LED housing to prevent dust and moisture from entering into the unit.

(m) LEDS FOR REPLACING LAMPS IN EXISTING INCANDESCENT SIGNAL HEADS.

The LED traffic signal lamp unit shall be designed as a retrofit replacement for existing signal lamps, which will not require any special tools for installation. The 12" retrofit replacement LED traffic signal lamp unit shall fit into existing traffic signal housings without modifications to the housing.

Installation of a retrofit replacement LED traffic signal lamp unit into an existing signal housing shall only require removing the existing lens and incandescent lamp, fitting of the new unit securely in the housing door, and connecting the unit to existing electrical wiring or terminal block by means of simple connectors. The LED retrofit shall not require the removal of the reflector.

If proper orientation of the LED unit is required for optimal performance, prominent and permanent directional markings (an "UP arrow") for correct indexing and orientation shall exist on the unit.

The manufacturer's name, serial number, model number, manufactured date, and other necessary identification shall be permanently marked on the backside of the LED traffic signal lamp unit. A label shall be placed on the unit certifying compliance to ITE standards.

The LED traffic signal lamp unit shall be a single, self-contained device, not requiring on-site assembly for installation into an existing incandescent traffic signal housing.

(m) SUBMITTAL DATA REQUIRED FOR LEDS.

Each LED traffic signal lamp unit shall be provided with the following data:

- Complete and accurate installation wiring guide;
- Contact name, address, and telephone for the representative, manufacturer, or distributor for warranty repair;
- Schematics for all electronics.

The Contractor shall submit a copy of a test report certified by an independent laboratory (Intertek Testing Services ETL Semko) that the LED traffic signal lamp model submitted meets ITE Standard for light distribution, chromaticity, and power (consumption, power factor, and harmonic distortion). In addition, the independent lab report shall specify the drive current being supplied to individual LEDs within the unit. Designs which require LEDs to be operated at currents greater than the LED manufacturer's recommended drive current will not be allowed.

(n) DUAL INDICATION SIGNAL HEAD.

The dual indication signal shall provide a dynamic means of selectively displaying two separate colored indications from the same section during different intervals of the signal cycle.

The dual indication signal Heads shall conform to the applicable requirements for Programmed Vehicular Signal Heads including exterior finish and ITE Standards Publication "Adjustable Face Traffic Control Signal Heads".

No indication shall result from external illumination nor shall one light unit illuminate a second and only one indication shall be apparent to any viewer at one time.

**890.10 Pedestrian Signal Heads.**

(a) GENERAL.

All pedestrian signal heads shall conform to the requirements of the ITE Standards Publication "Adjustable Face Pedestrian Signal Heads" and the following, assembled in accordance with the latest edition of the MUTCD.

(b) INCANDESCENT PEDESTRIAN SIGNALS.

1. HOUSING, DOOR, and VISOR.

Housing: Housing shall be rectangular and constructed of lightweight die cast aluminum. The housing assembly shall form a dust tight and moisture resistant compartment.

The top and bottom of the signal shall be provided with two holes suitable for entrance of 1.5 inch {38 mm} conduit. Surrounding each hole shall be cast aluminum serration containing 72 teeth at 5° on center by 0.062 inches {1.57 mm} deep. The overall dimension of the pedestrian signal shall be 17.5 inches horizontal x 16.875 inches vertically x 9.875 inches front to back { 445 mm horizontal x 429 mm vertically x 251 mm front to back} including the visor. A door hinge is provided at the bottom of the case and two upset flanges at the top, to enable draw bolts to adequately draw down the door against the case. A neoprene gasket shall be fitted around the front edge of the case to provide a waterproof compartment when the door is closed.

Door: The door shall contain an offset upon which an endless neoprene gasket will seat, for the purpose of holding the lens, and causing a watertight fit of door to housing.

All components shall be readily and easily accessible from the door.

Two hinge lugs shall be cast at the bottom of the door, which shall mesh with two pairs of hinge lugs cast in the bottom of the housing. Stainless steel drive pins shall connect these hinges to permit the door to rotate downward. Two reinforced lugs, each with a vertical slot (open at the top) shall be cast integrally in the top of the door. The top of the front of these lugs shall be slightly offset to prevent the hinge bolts from sliding out of the slots. Two pairs of lugs shall be cast integrally with the top of the housing compartment. Two stainless steel hinge bolts with captive stainless steel wing nuts and plain washers shall be attached to the housing lugs with the use of a stainless steel 0.25 inch {6.5 mm} drive pin.

Visor: A single unit sun shield eggcrate type visor shall be attached to the cast door without the use of any screws and be capable of being removed only when the door is opened. The visor shall sit directly on the door. The visor shall consist of 15 vertical 0.30 inch {7.6 mm} thick polycarbonate strips and 26 horizontal 0.030 inch {0.76 mm} polycarbonate strips. The strips shall be slotted such that they fit together in cross hatch fashion. The polycarbonate strips when assembled shall be bordered by an extruded 0.040 inch {1.0 mm} aluminum channel that shall be pop riveted together to provide a solid support for the polycarbonate strips. The visor shall have two horizontal mounted 1/8 inch {3.2 mm} diameter aluminum reinforcement rods. The visor assembly shall be 1.5 inches {38.1 mm} deep and the grid pattern shall measure approximately 0.5 inches X 0.5 inch {12.7 mm X 12.7 mm}.

2. OPTICAL UNIT.

The reflector shall be a one-piece reflector made of die cast aluminum with an Alzak finish. The inside surface of the reflector shall be metalized silver and overcoat for endurance. The reflectors shall consist of two parabolic curves, one situated behind the UPRaised HAND symbol one behind the WALKING PERSON symbol. Two lamp sockets shall mount directly to the back of the reflector. The reflector shall be designed to accept 69 watt bulbs through 150 watt bulbs depending

upon the light intensity required. Higher wattage lamp shall not cause any degradation to the die cast aluminum reflector or lens.

Internal illumination shall be used.

3. HARDWARE.

All screws, bolts, nuts, washers, hinge pins, and other necessary fasteners shall be made of 18-8 stainless Type 304.

4. EXTERIOR FINISH.

Before painting, housing shall be cleaned and treated in accordance with Military Specification 5541.

The housing, door, and visor channel shall be cleaned and etched prior to paint and then painted with one coat of primer and two coats of baking enamel.

When a visor is required, the inside of the visor must be Flat Black. The balance of the signal shall be Federal Yellow.

5. LENSES.

The symbols shall transmit light through a prismatic surface. The prismatic surface shall be on the inside. The molded lenses shall have the proper colors, Portland Orange for the UPRaised HAND and Lunar White for the WALKING PERSON, molded in the glass. The background shall be opaque black. Lunar White and Portland Orange shall conform to ITE requirements.

The UPRaised HAND indication shall be mounted directly above or integral with the WALKING PERSON indication.

The lens size shall be 14 inches X 14 inches {350 mm X 350 mm}. The lens material shall be two pieces, 1/4 inch {6.4 mm} molded glass.

The letter height shall be 4.5 inches {115 mm}.

6. WIRING.

Each pedestrian signal shall be wired completely internally and ready for connection of field wiring. There shall be a four point terminal block inside the housing to which a wiring harness consisting of 18 AWG wiring shall be attached. The other end shall be sufficient to allow the reflector to be fully removed from the signal.

(c) LED PEDESTRIAN SIGNALS.

Light Emitting Diode (LED) pedestrian signal head shall conform to ITE's interim specifications for LED pedestrian traffic signals.

**890.11 Pedestrian Detectors.**

(a) GENERAL.

Pedestrian detectors shall conform to the American with Disabilities Act Accessibility Guidelines, Section 14.2.5(1) "Crossing Controls", dated 1994.

(b) MATERIALS.

Pedestrian detector shall be capable of actuation by a force equal to or less than 5 pound force {22.2N}.

A control button shall be raised or flush and shall be a minimum of 2 inches {50.8 mm}.

The microswitch shall be dustproof, water resistant type.

The splice between the cable and the detector leads shall be waterproof.

The pipe or other protective cable covering to the detector housing shall be secure.

The detector shall be provided with a housing to prevent the entrance of water.

Where a 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 push button is to be mounted on top of a post, the housing shall be provided with a slip-fitter fitting and screws for securing rigidly to the post.

(c) HARDWARE.

Hardware and fittings shall be constructed of galvanized steel or non-corrosive metal.

**890.12 Signal Cable.**

(a) DESCRIPTION.

Signal cable shall be used to supply electrical power to vehicle and pedestrian signal heads, lane control signals, electrically powered signs, and pedestrian detectors.

(b) MATERIALS.

Signal cable shall conform to the requirements of IMSA Specification No. 20-1, polyethylene insulated, polyethylene jacketed communication cable.

Unless otherwise noted on the plans, signal cable conductors shall be solid copper, No. 14 AWG. The number of conductors shall be provided as follows:

Pedestrian Push Button Assembly	2 Conductors
Pedestrian Signal Head	3 Conductors
Flashing Beacon	3 Conductors
3 - Section Signal Head	4 Conductors
5 - Section Signal Head	7 Conductors

**890.13 Loop Detector Wire.**

(a) DESCRIPTION.

Loop detector wire shall be used to provide a zone of detection (sensor loop) where the passage or presence of a vehicle in the zone causes a decrease in the inductance of the loop.

(b) MATERIALS.

1. WIRE.

Wire shall be Type USE-2, Type RHH, or Type RHW-2 XLP, 600 V cross-link polyethylene insulated cable. All loop wire shall have an insulation thickness of 0.045" (45 mils).

Wire shall be No. 12AWG.

Wire shall have a single conductor that is soft annealed stranded wire of not less than 98 percent conductivity; **seven strands shall make up this single conductor.**

The outer jacket shall be surface printed indicating the manufacturer, national research testing laboratory listing, maximum rated voltage, AWG size, the proper type letter or letters for the type of wire or the IMSA specification number every two feet {0.6 m} or less.

2. LOOP SEALANT.

Proposed loop sealant shall be included in the proposed material submittal as required in Section 730.

**890.14 Loop Detector Lead-In Cable.**

(a) DESCRIPTION.

Loop detector lead-in cable shall be used to connect the sensor loop to the input of the loop detector unit.

(b) MATERIALS.

Loop detector lead-in cable shall conform to the requirements of IMSA Specification No. 50-2, polyethylene insulated, polyethylene jacketed shielded, loop detector lead-in cable.

The cable shall have stranded tinned copper conductors, No. 12 AWG.

The cable shall have two conductors individually insulated in a twisted pair configuration.

**890.15 Junction Box.**

(a) DESCRIPTION.

Junction box shall be provided to splice loop wires to shielded lead-in-cable, to allow access to ground rods located beneath sidewalks, and to decrease friction drag of pulling underground cable through conduit.

(b) MATERIALS.

1. JUNCTION BOX.

The junction box shall be constructed of non-concrete plastic mortar reinforced with heavy-weave fiberglass. It shall be capable of withstanding a vertical load test of 20,000 pounds {9.07 metric tons} over a 10 inch { 254 mm} by 10 inch {254 mm} area.

Junction box shall conform to the dimensions shown on the details in the Special and Standard Highway Drawings.

2. JUNCTION BOX COVER.

All junction boxes shall be supplied with a heavy duty cover tested to 20,000 pounds {9.07 metric tons} over a 10 inch {254 mm} by 10 inch {254 mm} area. All covers shall conform to the American Association of State Highway and Transportation Officials' (AASHTO) Specification H10 10 Ton GVW HA Cover Rating. All covers shall comply with the requirements given in ASTM Standard Publication No. ASTM C857, "Practice for Minimum Structural Concrete Utility Structures" and conform to load test, 20,000 pounds {9.07 metric tons} performed as stated in AASHTO T280-87, "Standard Method of Testing For Concrete Pipe, Section, or Tile". The junction box shall have a locking cover. The junction box cover shall be embossed with "TRAFFIC SIGNALS" in standard block type not less than 1.5 inches {38.1 mm} in height.

**890.16 Conduit.**

(a) DESCRIPTION.

Conduit furnished shall be metallic or non-metallic, of the size specified on the plans.

(b) RIGID METAL CONDUIT (RMC).

Rigid metal conduit, couplings, and fittings shall be galvanized steel, meeting the requirements given in UL 6. Couplings and fittings shall be threaded.

(c) RIGID NONMETALLIC CONDUIT (RNC).

Rigid nonmetallic conduit shall be Schedule 40 or Schedule 80 PVC and shall meet the requirements given in UL 651.

(d) LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC).

Liquidtight flexible metal conduit shall meet the requirements given in UL 360. The thermoplastic covering shall be oil resistant. Connectors shall be either angle or straight and be UL listed for the intended use. LFMC shall be installed where conduits cross an expansion or open joint on bridges, barrier rails and other structures and shall be installed at other expansion locations as directed by the Engineer. The LFMC shall be a maximum of 36 inches {1800 mm} long and shall not sag more than 3 inches {150 mm} between the fixed ends of the rigid conduit.

(e) LIQUIDTITE FLEXIBLE NON-METALLIC CONDUIT (LFNC).

Liquidtight flexible non-metallic conduit shall meet the requirements given in UL 1660.

**890.17 Supporting Structures.**

(a) GENERAL.

Supporting structures (metal traffic signal pole, prestressed concrete traffic signal pole, mast arm pole, and pedestal pole) used for mounting signal equipment shall conform to the requirements of Section 718 and Section 891.

(b) METAL AND CONCRETE SUPPORTING STRUCTURE FEATURES.

Handholes with covers shall be provided to facilitate installation and wiring.

Adapter with provisions for overhead wiring and wire entrance shall be provided for the top of the pole.

A grounding connection shall be provided adjoining the base.

When painting of the supporting structure is specified by the plans or proposal, the supporting structure shall have two primer coats applied at the factory or point of fabrication and two additional coats of high-grade exterior grade enamel applied in the field.

Paints shall conform to the applicable portions of Section 855.

(c) **TIMBER POLES.**

Timber poles shall be southern yellow pine treated in accordance with the latest American Wood-Preserver's Association (AWPA) standards and conform to the requirements of Section 833.

Unless otherwise noted on the plans, timber poles used for supporting traffic signals shall be Class 5 and shall conform to the requirements of ANSI Standards Publication No. 05.1-1992. The poles shall not have more than 180 degrees of twist in grain over the full length and the sweep shall be no more than 4 inches {100 mm}.

When required, guy wires shall be provided of adequate strength and shall meet the requirements of ASTM A 475-89. Guy wire anchors shall be expanding or screw type with a minimum guy tension of 8000 pounds {35 kN}.

**890.18 Luminaire Extension Assembly.**

(a) **DESCRIPTION.**

Luminaire extension assembly shall consist of an extension arm, housing, reflector, a refractor or lens, a lamp socket, an integral ballast, a terminal strip, and a lamp shall conform to the requirements of this specification unless otherwise specified on the plans, in the proposal, and on the details in the Special and Standard Highway Drawings.

(b) **GENERAL.**

The luminaire shall be of the horizontal type for IES Type III medium cutoff distributing an asymmetrical light pattern.

(c) **MATERIALS.**

1. **LUMINAIRE EXTENSION ARM.**

Unless otherwise shown on the plans, the extension arm shall be 12 feet {3.7 m} in length. Stud mounting bolts and brackets shall be provided.

2. **PHOTOELECTRIC CONTROL UNIT.**

A photoelectric control unit shall be provided and conform to the requirements of the Institute of Electrical and Electronic Engineers (IEEE) and NEMA.

3. **HOUSING.**

The housing shall be fabricated from die-cast aluminum.

If the housing is provided with a hole for the receptacle, the hole shall be closed, covered, and sealed with weatherproof material, in a permanent manner. The housing shall be weather-tight and shall be gasketed.

All hinges, bolts, nuts, washers, screws and miscellaneous hardware shall be stainless steel.

4. **LENS.**

The lens shall be a pressed borosilicate glass refractor to provide the IES lighting pattern indicated.

5. **BALLAST.**

The ballast shall be a CWA Type.

6. **LAMP.**

Each luminaire shall have clear high-pressure sodium (HPS) lamp of the required wattage. Average lamp life shall be 24,000 hours. Initial lumen output shall be 27,500 lumens for 250 W and 50,000 lumens for 400 W.

7. **FIELD WIRES.**

Field wires connected to the luminaire shall terminate on a barrier type terminal block secured to the housing.

An ultra violet resistant No. 10 AWG cable shall be provided. Phase or current carrying conductors shall be of the Type RHH, RHW, USE, or XHHW and shall be identified by a continuous black color or colors other than white, gray, or green. If colors are used, they shall be consistent for circuit and phase.

#### 8. SURGE ARRESTOR.

The surge arrestor shall be enclosed in a watertight case with mounting ears so that no additional hardware will be required except attachment screws. There will be no limitation as to proper orientation for mounting to insure that the unit is 100 percent functional.

The surge protection elements shall be metal-oxide varistors with a total peak surge current rating (8x20 microseconds) of 45 kA for the 120 V mode. Certified response time shall be 5 nanoseconds max at 700 A and 440 V. Certified test reports from an independent laboratory shall be submitted when requested by the Engineer.

The arrestor shall provide protection from line to ground and neutral to ground. It shall have a calculated surge life of greater than 40,000 occurrences at 700 A or 1000 occurrences at 1000 A. There shall be no follow current and current drain shall be less than 100  $\mu$ A.

#### 890.19 Concrete Foundations.

All concrete foundations or footings shall conform to the requirements of Section 718.

A ground rod of a non-ferrous coating material, 5/8 inch {16 mm} in diameter by 8 feet {2.4 m} in length, shall be provided. The ground rod shall be provided with a bonding copper wire or strip equivalent to the cross sectional area of a No. 6 AWG {4.25 mm} wire.

#### 890.20 Signs.

The R10-10 sign, R10-12 sign, R10-4B sign, and any sign as indicated on the plans, as a part of the signal installation shall conform to the requirements of Section 880.

#### 890.21 Video Detection System.

##### (a) CAMERA.

The camera enclosure shall have the following features and functionality:

- provide real time detection;
- operate from 0% to 100% humidity;
- include a lens with an automatic iris;
- be easily field replaceable;
- shall be clearly identified with the focal length and aperture;
- shall be resistant to vibration and resistant to shock when installed for operation.

##### (b) CAMERA ENCLOSURE.

The camera enclosure shall have the following features and functionality:

- shall be a NEMA Type 4 enclosure;
- shall be fabricated from corrosion resistant aluminum;
- shall be finished in a light colored UV and weather resistant paint;
- shall be provided with a sunshield;
- sunshield shall be designed to divert water flow to the sides of the sunshield.

##### (c) CAMERA AND ENCLOSURE ASSEMBLY.

The camera in the enclosure shall have the following features and functionality:

- shall have a heater mounted toward the front of the enclosure;
- weight of all components shall not exceed 10 pounds {4,54 kg}.

All devices required for maintaining the internal temperature and faceplate temperature shall be integral to the environmental enclosure. The heater shall not interfere with the operation of camera electronics, and shall not cause interference with the video signal.

The weight shall include the environmental enclosure, complete with camera, fittings, heater, and transformers.

##### (d) CAMERA MOUNTING ASSEMBLY.

The camera mounting assembly shall have the following features:

- shall have all stainless steel or aluminum construction;
- shall meet the support requirements of the camera manufacturer;
- shall be equipped with lightning protection;
- connections shall be mounted on the rear of the enclosure;
- all connections shall have liquid tight fittings.

(e) PROCESSOR.

The processor shall be rack or shelf mounted in a controller cabinet and shall have a RS232 serial port.

The processor shall provide video output (BNC) for connecting a television monitor for testing purposes and for connection to video transmitter provided by others. The video output (BNC) shall be located at the front of the processor.

The processor shall be plugged into a NEMA-5-15R receptacle located in the controller cabinet.

The processor shall be capable of detecting vehicle presence in 8 user-defined detection zones. When the vehicle is in the detection zone, the detection zone shall change color or intensify on the screen to verify proper operation of the detectable system.

(f) VIDEO INTERFACE PANEL AND CABLES.

The video interface panel shall provide facilities to protect against damage from lightning and to isolate the ground of the cables from that of the video detection system.

Coaxial cable and power cable shall meet the requirements of vehicle detection manufacturer.

(g) TWO CHANNEL AND FOUR CHANNEL DETECTOR UNIT.

All detector units shall be card rack units, suitable for mounting in a detector unit as specified in NEMA Standard Publication TS-2-1992.

## 890.22 Priority Control System, Traffic Signal Preemption.

(a) PRIORITY CONTROL SYSTEMS.

The priority control system shall be either acoustically (sound) activated, optically activated, or GPS (Global Positioning System) activated. All equipment and components shall meet or exceed all National Electrical Manufacturers Association (NEMA) TS1 and TS2, as well as, Type 170 and Type 2070 weather exposure durability requirements.

(b) OPERATIONAL REQUIREMENTS.

The priority control system shall be capable of providing preemption information to the standard NEMA TS1, NEMA TS2, Type 170, and Type 2070 traffic controllers used by the ALDOT. The priority control system shall be capable of setting time limits for how long a call can be held, when the call is dropped after a vehicle passes, or if the call is lost.

Acoustically activated systems shall be able to detect and respond to a preemption call from an emergency or priority vehicle at a minimum of 1000 feet {300 meters} from a roadway intersection. All other systems shall be able to detect and respond to a preemption call from an emergency or priority vehicle at a minimum of 2500 feet {760 meters} from a roadway intersection.

Setup and programming of the priority control system shall be accomplished through the use of the current ALDOT computer operating software.

(c) LOG FILE.

The priority control system shall maintain a log file of at least 2000 of the most recent priority calls. This log file shall be downloadable in a standard ASCII, delimited format. Each call record for all systems shall contain the following four items:

- Time & Date: shall indicate the time and date the call was made;
- Direction: indicates the direction from which the call was made;
- ID: identifies what vehicle or device made the request;
- Duration: indicates the total amount of time the call was active.

The following are additional requirements for optical and GPS activated systems:

- User: what department or agency that used the system;
- Level: shows what priority level was used.

(d) SOFTWARE.

The manufacturer's software shall be provided for the operation of the system. One software package shall be provided for each detection system. Software updates and revisions shall be provided to the ALDOT as updated by the manufacturer at no additional cost. The software shall not require a licensing fee.

All setup, controller program, and diagnostic software shall be provided and shall run on Microsoft Windows based operating systems. Software updates shall be provided free of charge. On-line help screens shall be provided as an integral part of the system software. Interface software shall be capable of real-time viewing of the system activity.

(e) DOCUMENTATION REQUIREMENTS.

A minimum of 2 sets of operational and maintenance manuals shall be provided with the system. These manuals shall cover all aspects of the system from the installation to maintenance.

The following data shall also be provided by the manufacturer:

- Model & Serial numbers shall be visible on all electrical components;
- Power and current requirements;
- Acceptable operational temperature ranges;
- Weight and dimensions;
- Required mounting equipment;
- Operating frequency where needed;
- Detection range;
- Response time and sensitivity;
- Required software;
- Manufacturer's advertised product capabilities;
- Any limitations, requirements, or potential hazards associated with the operation or maintenance of the device.

(f) WARRANTY.

Final payment will not be made until a written warranty is provided by the Contractor and accepted by the Engineer in writing. The warranty shall be a written guarantee from the distributor or manufacturer that the priority control system will be fully functional and will remain free of defects in material and workmanship for a period of one year from date of acceptance. During the warranty period, the distributor or manufacturer shall repair with new materials, or replace at no charge, any device, product or other material containing a warranty defect. All materials returned from warranty repairs shall be made through the distributor or manufacturer at no additional charge. Warranty repairs and replacements shall not exceed two weeks from date of return to the distributor or manufacturer.

The warranty will not begin until the traffic signal installation "30 operation check period" is complete