

## Special Provision

Replace Section 740 with the following:

### SECTION 740 SIGNALS AND LIGHTING MATERIALS

**740-2.01 GENERAL.** Use electrical materials, devices, fittings, and hardware that conform to applicable NEMA and ANSI standards.

Use electrical products that are Third Party Labeled or Listed (by an approved independent electrical testing laboratory such as UL, Electrical Testing Laboratories (ETL), Canadian Standards Association (CSA), etc.), unless otherwise indicated on the Materials Certification List (MCL).

Ensure that all material and workmanship, as determined by the Department, conform to the standards of the NEC, the NESC, and local safety codes as adopted and amended by the authority having jurisdiction.

#### **740-2.02 SIGNAL AND LIGHTING STRUCTURES.**

1. Design. Design and fabricate structures to conform to:

- a. Highway Lighting Structures. 2013 Edition of AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals with 2013 Errata and 2015, 2019, and 2020 interim revisions and the highway lighting sheets in the Plans. Design must meet Fatigue Category II. Use a wind speed of 100 mph. Design each structure to support a sign with an area of 16 square feet with its centroid located 14 ft. above the pole base.
- b. Breakaway Traffic Signal Structures. 2001 Edition of AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals with interim revisions and Central Region Traffic Signal Details. Design must meet Fatigue Category II, a vibration mitigating device may be used in lieu of providing galloping computations, using a basic wind speed of 100 mph and Central Region standard loads.
- c. Mastarm Traffic Signal Structures. 2013 Edition of AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals with 2013 Errata and 2015, 2019, and 2020 Interim Revisions, and signal sheets in the Plans. Design must meet Fatigue Category I, a vibration mitigating device may be used in lieu of providing galloping computations, using a basic wind speed of 100 mph.

A vibration mitigation device is a non-aerodynamic damper system that is purpose-built to mitigate vertical movement of signal mast arms. Effectiveness shall be proven through analytical methods approved by the engineer. The system shall be self-adapting and must not require structure specific tuning. The device must provide an 85 percent or greater vibration reduction.

A registered professional engineer shall design the structures and provide stamped shop drawings and calculations. Submit the stamped drawings and calculations for each pole to the Engineer for approval. Design for the complete-in-place structure including the supported hardware.

- a. In the stamped calculations, indicate the edition of Standard Specifications to which the poles are being designed and provide the input data used to design each pole and mast arm, including: design wind speed, cross section shape, yield strengths of the component materials, dimensions of the pole components, and a summary of the loads used. For highway lighting structures, submit the actual total combined mass of luminaire supports and attached fixtures.
- b. On the stamped shop drawings, provide design wind speed and the details for building the poles and mast arms, including: materials specifications, slip fit joint dimensions, pole component dimensions, welds that will be made, and the welding inspection that will be done.

Submit the mill certifications for the steel items (piles, plates, bolts, and other related items) to the Engineer for approval.

2. Fabrication. Fabricate signal and lighting structures from tapered steel tubes with a round or 16 sided cross section. Orient handholes located near the base of poles to face downstream of traffic flow.

Furnish poles and mast arms up to 40 feet long in one piece. Poles and mast arms longer than 40 feet may be furnished in one piece or in two segments with a slip type field splice. For slip type joints, provide the minimum overlap specified in the Plans. In mast arms, locate these splices at least one foot away from the Plan location of signal heads and signs. In signal poles, locate the edge of the female section at least 6 inches above the top of the signal mast arm connection.

Fabricate tubes with walls up to 1/2 inch thick from the prequalified base metals listed in AWS D1.1. Fabricate elements greater than 1/2 inch thick from steel that conforms to AASHTO M270 and meets the Fracture Critical Impact Test requirements for Zone 3. The Department will not accept structures that use laminated steel elements.

Fabricate the cross section of each tube from no more than 2 pieces of steel. When using 2 pieces, place the longitudinal welded seams directly opposite one another. Place the welded seams on adjacent sections to form continuous straight seams from the base to the top of the pole.

When tenons are needed to install traffic signals and luminaires, make them from two inch nominal schedule 40 pipe that conform to ASTM A 53 Grade B.

Fabricate breakaway signal poles in accordance with the Pole Sheet in the Plans. Fabricate signal poles 10 to 16 feet long from 7 gauge (US Standard) sheet steel. Fabricate each post with a minimum inside diameter at the base plate as shown in the Plans. Use 4 inch diameter by 4 inch Schedule 40, ASTM A53, Grade B pipe as a post-top adapter.

The Department does not allow holes made for lifting purposes in the ends of tubular segments, except in the free ends of luminaire mast arms. To add lift points, weld them to the tube opposite the longitudinal seam weld on the outside of female segments and on the inside of male segments. Before shipment, remove lift points added to the outside of the tubes, grind the area smooth with the base metal, and hot stick repair the finish according to Subsection 660-3.01.8.a. Lift points added to the inside of tubes in place may be left in place.

Hot-dip galvanize lighting and signal structures to meet AASHTO M 111 and these specifications. Galvanizing kettles will be large enough to completely submerge each element, the mast arm, and the pole. Submerge the complete/whole element in the galvanizing process. An element galvanized in sections will not be accepted. Galvanize bolts and fasteners to meet AASHTO M 232.

After the poles and mast arms are galvanized, remove all excess zinc from all drip lines and points and surfaces of all tube ends that form slip type joints to provide a smooth finish.

The Department will reject poles and mast arms that are:

- Not fabricated according to these specifications or the approved shop drawings,
- Bowed with sweeps exceeding 1 inch throughout the length of the pole, mast arm, or segment, if furnishing a 2-piece pole or mast arm,
- Out of round. Sections are out of round when the diameters of round members or the dimension across the flats of multisided members exceed 2 percent of the dimension specified on the shop drawings.

Fabricate pile cap adapters from Grade X52 steel line pipe that conforms to API 5L and from steel plate that conforms to ASTM A 709 Grade 50. Attach the anchor plate to the pile section with a complete joint penetration (CJP) weld. Fabricate the anchor plate to match the base plate of the lighting standard.

3. Welding. Perform welding to conform to Subsection 504-3.01.7 and the 2013 Edition of AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals, the Central Region Traffic Signal Details, and the following:

- Make welds continuous. Grind exposed welds flush with the base metal at slip fit joints for the length of the slip fit joint plus one half the diameter of the female section.

- b. On steels 5/16 of an inch thick and thicker, inspect 100 Percent of CJP welds by either radiography (RT) or ultrasound (UT).
  - c. Inspect a random 25 percent of PJP and fillet welds by magnetic particle (MT). If a defect is found, inspect 100% of the PJP and fillet welds made to fill the order. In steels less than 1/8 inch thick, complete the tests according to AWS D1.1.
  - d. Only visually inspect welds made on luminaire mast arms.
4. Anchor Rods & Bolts. Furnish 2 inch diameter (nominal) anchor rods for signal poles that meet ASTM F1554 Grade 105, are 96 inch minimum length and conform to Supplemental Requirements; S2, Permanent Manufacturer's Identification, S3, Permanent Grade Identification and S-5 Charpy Impact Requirements. Hot dip galvanize according to AASHTO M232. Use nuts that conform to AASHTO Specification M292 of the grade, surface finish, and style for 2 inch diameter anchor rods. Washers shall conform to AASHTO M293.
5. Miscellaneous. Finish the edges of poles and mast arms to conform to the following requirements. Before hot dip galvanizing, neatly round the following features to the radius specified.
- a. On holes through which electrical conductors pass, provide a 1/16 inch radius on both the entrance and exit edges,
  - b. On pole base plates, provide a 1/8 inch radius on edges along which plate thickness is measured and a smooth finish on all other exposed edges,
  - c. On the ends of tubes that form slip type joints, complete the following tasks on the two surfaces that contact one another. First, provide 1/16 inch radii on the inside and outside edges of the female and male segments, respectively. Then for the length of the joint plus one half the diameter of the female section grind down welds until they feature a radius concentric with the mating surface and remove material protruding from the two surfaces.

Provide caps to cover the free ends of poles and mast arms.

Identify critical information for poles and arms with visible permanent aluminum tags that contain the information shown in Table 740-1. The measurements shown are for illustration purposes only. Use tags large enough to include required information using 1/4 inch high text, 3/8 inch of space between successive lines of text, and at least 3/8 inch of space between the edges of the tag and the text. Secure the tags with two 1/8 inch blind rivets at the base of poles and the underside of mast arms. If furnishing a two piece signal mast arm with slip type joint, mark both pieces with the same message. Provide the holes for the blind rivets before galvanizing.

**TABLE 740-1  
POLE MARKINGS**

*Note: Italic type indicates additional Tag Markings if poles have 2 luminaire or 2 signal mast arms.*

<b>POLES</b> (Including Mast Arms )	<b>MEASUREMENTS</b>	<b>TAG MARKINGS</b>
<b>Signal Poles</b>		
Signal mast arm length	45 ft./55 ft.	SMA 45/ <i>SMA 55</i>
Luminaire mast arm length	22 ft./18 ft.	LMA 22/ <i>LMA 18</i>
Pole height	36 ft.	PH 36
Intersection number (if more than one) -pole number		1 - P 4
Sum of signal mast arm moments about centerline of signal pole		SM 4000/ <i>SM 3200</i>
Design wind speed	100 mph	DWS 100
<b>Light Poles</b>		
Luminaire mast arm length	15 ft./15 ft.	LMA 15/ <i>LMA 15</i>
Pole height	37 ft.	PH 37
<b>Signal Mast Arm</b>		
Mast arm length	40 ft.	SMA 40
Intersection number (if more than one) -pole number		1 - P 4
Sum of signal mast arm moments about centerline of signal pole		SM 3740
Design wind speed	100 mph	DWS 100
<b>Luminaire Mast Arm</b>		
Mast arm length	18 ft.	LMA 18
Pole number (if unique arm design)		P 4

**740-2.03 WOOD POLES.** Use wood poles for service or temporary installations of the class shown on the Plans or as specified in the Special Provisions.

Use 45-foot poles, except for service poles use 25-foot poles.

Use mast arms and tie rods for wood pole installations that conform to Subsection 740-2.02, and to the details shown on the Plans. Provide each mast arm with an insulated wire inlet and wood pole-mounting bracket for mast arm and tie rod crossarm.

Use structural timber meeting Section 713. Do not use poles that have more than 180 degrees twist in grain over the full length. Ensure that the sweep is no more than 4 inches. Pressure-treat wood poles, that are not to be painted, after fabrication. Meet Section 714.

**740-2.04 RESERVED.**

**740-2.05 CONDUCTORS.** Use conductor sizes based on the American Wire Gauge (AWG). Use sizes that conform to the Plans or, when not shown, to this subsection.

Use insulated conductors made of uncoated, stranded copper that conforms to the specifications of ASTM B8. Use grounding conductors that are bare copper of the gauge required by the NEC. They may be stranded, solid, or braided.

Provide the following markings on the outer coverings of conductors and cables on intervals of 2 feet or less: manufacturer, the number of conductors or pairs in cables, conductor size, 600V, the conductor or cable type and environmental conditions for which the conductor or cables are listed, and the symbol of an approved independent testing laboratory.

Use conductors meeting the referenced specifications for the following purposes:

1. Power Conductors. For individual conductors, install general-purpose building wire manufactured according to UL Standard 44, and NEMA No. WC7. Furnish conductors insulated with cross-linked polyethylene listed as type XHHW-2 and rated for 600 volts AC operation.

**TABLE 740-2  
CONDUCTOR TERMINATION TABLE**

CONDUCTORS PER CABLE	CIRCUIT	WIRE COLOR	AWG. NO.	BAND LEGEND
7	Vehicle Red	Red	14	Head No.
	Vehicle Yellow	Orange		
	Vehicle Green	Green		
	Common Neutral	White		
	Spare	White/Black		
	Spare	Black		
	Spare	Blue		
7	Vehicle Red Arrow	Red	14	Head No.
	Vehicle Yellow Arrow	Orange		
	Vehicle Green Arrow	Green		
	Common Neutral	White		
	Spare	White/Black		
	Spare	Black		
	Spare	Blue		
7	Vehicle Red	Red	14	Head No.
	Vehicle Yellow	Orange		
	Vehicle Green	Green		
	Common Neutral	White		
	Spare	White/Black		
	Vehicle Yellow Arrow	Black		
	Vehicle Green Arrow	Blue		
5 MOA Ped Signals	Pedestrian Don't Walk	Red	14	Head No.
	Pedestrian Walk	Green		
	Common Neutral	White		
	Spare	Orange		
	Spare	Black		
4 SOA Ped Signals	Pedestrian Don't Walk	Red	14	Head No.
	Pedestrian Walk	Green		
	Common Neutral	White		
	Spare	Black		
4 SOA Ped Buttons	Pedestrian Pushbutton	Black	14	Head No.
	Neutral	White		
	Spare	Red		
	Spare	Green		
3 MOA Ped Buttons	Pedestrian Pushbutton	Black	14	Head No.
	Neutral	White		
	Spare	Red		

**TABLE 740-2**

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**CONDUCTOR TERMINATION TABLE**

(Continued)

CONDUCTORS PER CABLE	CIRCUIT	WIRE COLOR	AWG NO.	BAND LEGEND
3	Flashing Beacon	Black	14	Head No.
	Neutral	White		
	Spare	Red		
3	Per Manufacturer Installation Instructions	Orange	20	"PRE"
		Blue		
		Yellow		
3	Preemption Confirmation	Black	14	"PRECON"
	Neutral	White		
	Spare	Red		
3	Highway Luminaire	Black	8 or 6	Circuit No.
	Highway Luminaire	Red		Circuit No.
	Highway Luminaire Spare	White		
5	Photo Electric Control	Black	14	PEC
	Load to Contactor	Red		
	Neutral	White		
	Spare	Orange		
	Spare	Green		
3	Service to Controller	Black	6 or 4	"SIG"
	Neutral	White		No Band
	Spare	Red		No Band
3	Sign Luminaire	Black	8	SIGN
	Sign Luminaire	Red		SIGN
	Sign Spare	White		

Use size 10 AWG wire for illumination tap conductors. In an electrolier, the illumination tap conductors run from the fused disconnect kit to the ballast in the luminaire. Furnish conductors with black, red, or white colored insulation as required to identify the two phase and neutral conductors, respectively.

If conductors in controller cabinets carry the full signal load circuit, use size 10 AWG or larger conductors. Use orange-colored conductors from the flash transfer relay to program emergency flashing operation.

2. Illumination Cables. For cables that consist of three size 6 or 8 AWG conductors, furnish power cables that feature three conductors, each insulated with cross-linked polyethylene, and a black, low density, high molecular weight polyethylene jacket. Use insulated conductors listed as type XHHW-2.

Furnish these cables with one black, one white, and one red colored conductor and no grounding conductor. Use cables rated for 600 volts AC operation.

Use insulated conductors meeting UL Standard 44. The jacket must also meet NEMA No. WC70.

3. Power Cables. For cables that consist of three size 4 AWG and larger conductors, furnish tray cables that feature three conductors, each insulated with cross-linked polyethylene that meets the requirements of XHHW-2, and a polyvinyl chloride (PVC) jacket. Furnish these cables without an integral grounding conductor. Use cables manufactured according to UL Standard 1277, ICEA S-95-658, and NEMA No. WC70. Provide cables listed for direct burial and resistance to sunlight and rated for 600 volts AC operation.

Furnish these cables with black conductor insulation with one printed number (1, 2, or 3) identifying each conductor.

4. Control Cables. Wire with signal cable meeting IMSA 20-1 all vehicular signal heads, pedestrian signal heads, pedestrian push button detectors, flashing beacons, hardwired local coordination and preemption devices, and photoelectric controls.
5. Detector Loops. Use No. 14 AWG conductors for detector inductive loops that meet IMSA Specification 51-3, Type RHW/USE, or IMSA Specification 51-5, when called for on the Plans or specified in the Special Provisions.
6. Loop Lead-In Cables. Unless otherwise specified, use a tray cable that conforms to the following specifications to connect the loop detectors to the terminal blocks in the controller cabinet. Furnish this cable, also known as Snyder Cable; manufactured according to UL Standard 1277. Supply these cables third party certified as Type TC and certified for use in underground conduit or as an aerial cable supported by a messenger and rated for 600 volts AC operation.

Use size 18 AWG, 16 strand, tinned copper conductors per ASTM B33 insulated with wet-rated, cross-linked polyethylene similar to XHHW. Furnish conductors with insulation colors that match Table 660-1 twisted into pairs.

Provide each twisted pair with an overall aluminum foil coated mylar shield that provides 100% coverage and a 20 AWG tinned copper drain wire that is in constant contact with the foil side of the shield. Apply a tight-fitting polyvinyl chloride jacket over the conductor assembly.

Only use the following loop lead-in cable, also known as shielded data cable, to rewire existing traffic signals when specified. Use cables that consist of 7 twisted pairs that consist of stranded, size 18 AWG tinned copper wire and polyethylene or polypropylene insulation. Furnish each pair covered with an aluminum foil shield, stranded copper drain wire, and an overall PVC or PE jacket. Use cable rated for 300 volts and whose colored pairs match those specified in Table 660-1.

7. Telemetry Cable. Use interconnect cable that consists of solid copper conductors of the number of pairs called for in the Plans meeting the requirements of Rural Utilities Service (formerly the Rural Electrification Administration (REA) specification PE-39 for filled telephone cables. The shield may be either copper or aluminum.



**TABLE 740-3**  
**INTERCONNECT TERMINATION TABLE**

TELEMETRY CABLE: Type PE-39, No. 19 AWG, Solid Copper, as noted on the Plans or in the Special Provisions					
Pair No.	Tip	Ring	Pair No.	Tip	Ring
1	White	Blue	14	Black	Brown
2	White	Orange	15	Black	Slate
3	White	Green	16	Yellow	Blue
4	White	Brown	17	Yellow	Orange
5	White	Slate	18	Yellow	Green
6	Red	Blue	19	Yellow	Brown
7	Red	Orange	20	Yellow	Slate
8	Red	Green	21	Violet	Blue
9	Red	Brown	22	Violet	Orange
10	Red	Slate	23	Violet	Green
11	Black	Blue	24	Violet	Brown
12	Black	Orange	25	Violet	Slate
13	Black	Green			

HARDWIRE CABLES: IMSA Type 20-1, (2) 7 conductor No. 14 AWG			
Cable No. 1		Cable No. 2	
Circuit	Color	Circuit	Color
Cycle 2	Green	Offset 1	Green
Cycle 3	Orange	Offset 2	Orange
Cycle 4	Red	Offset 3	Red
Free	Blue	Split 2	Blue
Common	White	Common	White
Spare	Black	Spare	Black
Spare	White/Black	Spare	White/Black

**740-2.06 ELECTRICAL CONDUIT.** Unless specified otherwise, use rigid metal conduit and fittings for raceways. Furnish galvanized rigid type conduit and elbows conforming to UL Standard 6 and are manufactured of mild steel according to ANSI C80.1. Furnish third party certified fittings designed for rigid metal conduit.

For loop detectors, use Schedule 80 polyvinyl chloride (PVC) conduit that conforms to UL Standard 651. Use PVC fittings meeting NEMA TC 3.

When polyethylene conduits are specified in the Plans, use a smooth wall, schedule 40, high-density polyethylene (HDPE) pipe that conforms to UL Standard 651 B and NEMA TC-7-2000.

Furnish insulated throat grounding bushings made of malleable iron or steel with a mechanically galvanized or zinc plated finish. Grounding lugs shall either be an integral part of the bushing or consist

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of an attached tin-plated copper saddle. Grounding lugs shall feature a stainless-steel screw, the centerline of which falls within 20 degrees of conduit centerline. The bushings furnished shall also feature a stainless steel or brass mounting screw that locks the bushing onto the conduit end.

Furnish conduit outlet bodies and their covers with a hot dip galvanized finish and stainless-steel screws. For loop detectors, furnish Type X bodies and, for photoelectric control installation, furnish Types C and LB conduit bodies.

When Myers hubs are specified, furnish rain tight, grounding type hubs made of malleable iron with a hot dip or mechanically galvanized finish.

At expansion joints, provide watertight expansion fittings capable of the following movements without damaging the conduits attached to it or the conductors that pass through it. The movements include: axial expansion or contraction to 3/4 inch, angular misalignments in any direction to 30 degrees, and parallel misalignment of the conduits to 3/4 inch. The fittings shall also include a braided copper bonding jumper equal to an 8 AWG conductor, bushings to prevent scraping the conductors, and a smooth inner sleeve that maintains a constant diameter regardless of conduit alignment.

**740-2.07 FUSED SPLICE CONNECTORS.** Use fused, quick disconnect, splice connector that is weather tight and has two halves: a single-unit line side socket and a load-side plug. For LED fixtures, use fuses that are 5 amperes, midget (13/32" x 1-1/2") ferrule type with a time delay (slow blow) type design. For all other fixtures, use 10 amperes, midget (13/32" x 1-1/2") ferrule type with a fast acting current limiting design.

**740-2.08 SIGN SWITCHES.** Provide a NEMA 3R non-fused disconnect switch as shown on the Plans for each sign illumination installation.

Subsections 740-2.09, 2.10, 2.11, 2.12, and 2.13 vary whether a MOA or SOA maintained traffic signal. Use the first set of these sections for an SOA signal, use the second set of these subsection if an MOA signal. Delete the non-applicable set of subsections. If project contains both, specify what signals are to use which specification.

**740-2.09 CONTROLLER ASSEMBLIES.** Provide solid state, traffic controller assemblies having level 2 conformance to NEMA Standard Publication TS 2-2003 V02.06, Traffic Controller Assemblies with the National Transportation Communications for Intelligent Transportation Systems Protocol (NTCIP) Requirements as defined in NTCIP 1202. Traffic Controller Assemblies must meet or exceed the Environmental Requirements of Section 2 of the NEMA TS2-2003 V02.06 document. The Original Equipment Manufacturer (OEM) and its manufacturing and testing facilities shall be ISO 9001:2000 certified for processes involving the Traffic Controller Assemblies.

Use traffic control equipment that is compatible with the existing traffic signal monitoring system. Compatibility must be 100% at the cabinet level to include inputs, outputs, telemetry protocol, and block upload and download of RAM data.

In addition, features of the existing local controllers and controller modules must be functionally duplicated to meet or exceed the performance of the existing equipment.

The existing local controller cabinets at other intersections include the following equipment:

1. Econolite ASC/3-2100

Use LED indicators for all electronic devices covered under Subsections 740-2.09 through 740-2.13.

#### **740-2.10 CONTROLLER UNIT.**

1. Actuated Controller Unit (CU). Provide solid state, Type A2N CU meeting the requirements of Section 3 of the NEMA Standard Publication TS 2-2003 V02.06, Traffic Controller Assemblies with NTCIP Requirements.
  - a. The CU must meet the referenced National Transportation Communications for Intelligent Transportation Systems Protocol (NTCIP) and comply with publication TS 3.2 the Simple Transportation Management Framework, and shall meet the requirements for Conformance Level 2.
  - b. The software shall comply with NEMA TS 3.3, the Class B Profile, and shall include both an EIA/TIA 232-E and an FSK modem interface for NTCIP based communications.
  - c. The CU shall implement conformance groups and optional object groups as defined in NEMA TS 3.4 and TS 3.5 for A2N level 2.
  - d. Provide controllers with display heaters or enhancements to improve viewing in temperatures below 0°F.
  - e. Provide controllers having an interface compatible with SYNCRO-7 traffic modeling software.

Furnish Econolite Cobalt ATC Touch 2100 controller unit with the following optional features:

1. User interface Advanced Display with graphics and touch-screen
2. TS2 Type I connector
3. Data Key 3.3V, 8MB

**740-2.11 CONTROLLER CABINET.** Provide a controller cabinet that meets the requirements of NEMA Standard TS 2-2003 V02.06 Traffic Controller Assemblies with National Transportation Communications for Intelligent Transportation Systems Protocol (NTCIP) Requirements (NEMA TS-2), Section 5 Terminals and Facilities and Section 7 Cabinets.

1. Standard Features. Supply the following standard features:

- a. Materials

Unless otherwise designated in the Plans, provide cabinets constructed of sheet Aluminum.

- b. Cabinet Dimensions and Bracing

Unless otherwise designated in the Plans, provide a size 7 cabinet as defined in NEMA TS-2 Table 7-1.

The cabinet shall include 1.0" x 0.25" diagonal aluminum cross bracing welded to the back door frame of the cabinet.

- c. Doors

Provide a cabinet with full size lockable front and rear doors meeting the requirements of NEMA TS-2 Section 7.5. The locks must accept a Best CX series core that will be installed by the Department after the Contract is complete.

The front and rear doors shall be provided with top and bottom catches to hold the door open at both 90 and 180 ± 10 degrees. The catches shall be capable of holding the doors open at 90 degrees in a 60-mph wind acting at an angle perpendicular to the plane of the door.

- d. Shelves

Provide shelves meeting the requirements of NEMA TS-2 Section 7.6.

Shelves shall have a 3/8" lip on the front and back while not limiting access to equipment. Top shelf shall be braced to support additional weight of uninterruptable power supply (UPS) battery up to 150 lbs. Provide a restraint at the front and back.

Provide additional laptop computer shelf mounted approximately 30" above cabinet floor. The laptop shelf must accommodate a standard 17" computer and be retractable below one of the cabinets' shelves.

e. Finish and Preparation

Unless otherwise designated in the Plans, provide unpainted Aluminum Cabinets with a "natural" brushed appearance.

f. Cabinet Mounting

(1) Provide cabinet mounting features as defined NEMA TS-2 Section 7.8.

(2) The cabinet manufacturer is responsible for providing a cabinet that will mount without modification on the foundation detailed in Alaska Department of Transportation Central Region, Regional Detail, Controller Cabinet Foundation.

g. Cabinet Ventilation

Furnish a cabinet that fully meets the requirements of NEMA TS-2 Section 7.9 and the following:

(1) Furnish the fan and cabinet vent with internally mounted metal covers that are fabricated to close off the flow of air during winter operation.

(2) Equip the cabinet with a selectable, 750/1500 watt cabinet heating device. The heating device must have a remote air sensing thermostat. The contacts must be rated 20 amps, 120 volts, 60 hertz.

(a) Construct the thermostat so that contacts close on descending temperature and are adjustable between 0 and 30 °F  $\pm$  5 °F. The contacts must open on rising temperatures of 15 °F above the closing temperature. The adjustment must have an indicating pointer.

(b) Connect the thermostat in series with an electrical resistance heater and blower fan. The blower fan must be rated for continuous duty. The heater and fan must be connected in parallel and rated 120 volts, 60 Hertz. Mount the unit in the vertical position on the cabinet door. The thermostat shall be mounted immediately to the left of the heating device on the cabinet door.

(c) Do not block the air intake or outlet. Provide the unit with a SPST manual override switch that bypasses the thermostat to enable the fan and heater to operate at warmer temperatures.

h. Auxiliary Cabinet Equipment

(1) Mount a 4000K LED strip lighting fixture on the inside of the cabinet near the top front edge and under the controller shelf. The lighting fixture "ON-Off" switch must be a toggle switch mounted on an inside control panel. Include in the circuit a door actuated switch that turns the light ON when the door is open and OFF when the door is closed.

(2) Provide three (3) paper sets of complete and accurate cabinet drawings with delivery of each cabinet. Make cabinet drawings available electronically in DOT&PF's current version of AutoCAD and deliver with paper set, along with a ".pdf" copy.

(3) Provide one (1) paper set of manuals for the controller and Malfunction Management Unit with each cabinet. Make said manual available in electronic Adobe ".pdf" format and deliver with paper set.

i. Cabinet Wiring

Neatly arrange the wiring within controller cabinets to conform to the requirements of Subsections 660-3.05 and 740-2.05. Furnish controller cabinets wired to accommodate:

(1) Configuration #4 in Table 5-2 of the NEMA Standards Publications No. TS 2-2003 V02.06, Traffic Controller Assemblies with NTCIP requirements with two each Type 2 detector racks.

- (a) Equip the cabinet with required control and auxiliary equipment connecting cables to operate the phases and detection indicated on the Plans, including future use.
- (b) Size wiring, switches, surge protectors, flash relays, and flashers to handle the necessary amperage required under full cabinet use. Use orange-colored wires to run from the flash transfer relay used for emergency flash programming.
- (c) Wire the cabinet to accommodate 6 unique preempt sequences as defined by NEMA TS-2 Section 3.7 and 2 auxiliary preempt sequences. Configure each detector rack to accommodate 4 unique sequences.

j. Field Terminal Blocks

Provide Terminals and Facilities meeting the requirements of NEMA TS-2 Section 5, Configuration #4 (Table 5-2) and the following:

- (1) Provide 2 or more insulated terminal blocks to terminate field conductors. Provide each block with 12 poles with 10-32 screw type terminals. Use a terminal block that is a barrier type with removable shorting bars in each of the 12 positions and with integral type marking strips. Terminate conductors to a terminal block.
- (2) Terminate conductors from the controller unit in ring type terminal lugs or solder them to a through panel solder lug on the rear side of the terminal. Terminate other conductors in spade type terminal lugs.
- (3) Do not bring more than 3 conductors to any one terminal. Two flat metal jumpers, straight or U shaped, may also be placed under a terminal screw. Fully engage at least 2 full threads of terminal screws when the screw is tightened. Do not extend live parts beyond the barrier.
- (4) Terminals must be provided to terminate a future 25 pair interconnect cable with each conductor terminated on individual terminals. Terminate interconnect cable conductors on individual terminals.
- (5) On the right side of controller cabinets, install three (3) 16 position bus bars, for terminating the equipment grounding and neutral conductors used inside the cabinets. On the left side of the controller cabinets, install one (1) 32 position bus bar and one (1) 16 position bus bar for terminating the equipment grounding and neutral conductors from field wiring.

k. Cabinet Accessories

See NEMA Standard TS 2-2003 V02.06, Section 5 Terminals and Facilities, Figure 5-4 Cabinet Power Distribution Schematic for Items (1) through (6).

(1) Disconnecting Means

- (a) Main circuit breaker must be a single pole, 20 ampere, 10,000 amperes interrupting capacity for each cabinet.
- (b) Auxiliary circuit breaker(s) must be single pole, 20 ampere, 10,000 amperes interrupting capacity to protect fan, heater, light, and convenience outlet(s).

The rating of the main disconnect means with overcurrent protection must be not less than 125% of the maximum anticipated continuous load. When using disconnecting circuit breakers, use "trip indicating trip free," Type.

- (2) Signal Bus. Connect the signal bus to the incoming AC line through a signal bus mercury contactor and an overcurrent protection device. Energize the signal bus mercury contactor to provide power to the signal bus. The current rating of the signal bus mercury contactor must be at least the current rating of the main overcurrent protection device.
- (3) AC Service Transient Suppression. Connect the transient suppression device for the primary feed of the cabinet on the load side of the cabinet overcurrent protection device. The transient voltage suppression device connected to the controller power circuit must provide protection against voltage abnormalities of 1 cycle or less duration.

- (a) The suppressor must be solid state high energy circuit containing no spark gap, gas tube, or crow bar component. The current rating of the device must be 15 amps minimum. The device must provide transient protection between neutral and ground, line and ground, as well as line and neutral. If the protection circuits fail, they must fail to an open circuit condition. The device must meet requirements of UL Standard 1449.
  - (b) The suppressed voltage rating must be 600 volts or less when subject to an impulse of 6,000 volt, 3,000 amp source impedance, 8.0/20 microsecond waveform as described in UL Standard 1449. In addition, the device must withstand, without failure or permanent damage, one full cycle at 264 volts RMS.
  - (c) The device must contain circuitry to prevent self-induced regenerative ringing. There must be a failure warning indicator light that must illuminate when the device has failed and is no longer operable. The transient suppression device must withstand a 20,000 ampere surge current with an 8x20 microsecond (time to crest x time to second halfcrest) waveform 20 times at 3 minute intervals between surges without damage or degradation to the suppressor. Output voltage must not exceed 500 volts at any time during the test. Use a device that is a solid state, high energy circuit with no spark gap, gas tube, or bar component.
- (4) Radio Interference Suppression. Equip each traffic cabinet, flasher, and other current interrupting device with a suitable radio interference suppressor installed at the input power point. Install the radio interference suppressor after the AC service transient suppression unit described in Subsection 740-2.11.1.k (3). It must provide a minimum attenuation of 50 decibels over a frequency range from 200 kilohertz to 75 megahertz, when used with normal installations.
- (a) The interference suppressor must be hermetically sealed in a substantial metal case filled with suitable insulating compound. Terminals must be nickel plated, 10-24 brass studs of sufficient external length to provide space for connecting two No. 8 conductors and must be so mounted that the terminals cannot be turned in the case. Ungrounded terminals must be properly insulated from each other and must maintain a surface leakage distance of not less than 1/4 inch between any exposed current conductor and any other metallic part, with an insulation factor of 100 to 200 megohms dependent on external circuit conditions.
  - (b) The radio interference suppressor must have a minimum current rating equal to the rating of the main disconnect means as specified in Subsection 740-2.11.1.k (1) (a). It must be designed for operation on 120 volts, 60 hertz, single phase circuits and be UL and EIA compliant.
  - (c) Connect the ground connection of the radio interference suppressor only to AC neutral. Do not connect to Earth Ground directly.
- (5) Communications Transient Suppression. Provide a transient suppressor for the system interface communications lines when used. This suppressor must withstand a 100 ampere 10 x 700 microsecond waveform 20 times at 30 second intervals between surges without damage or degradation to the suppressor. Apply the transient surge both line to line and line to ground. Output voltage must not exceed 8 volts line to line and line to ground. Output voltage must not exceed 8 volts line to line or 250 volts line to ground at any time during the test.
- (6) Control Panel. Provide and label a control panel assembly that is readily accessible from the front of the cabinet. The control panel assembly must consist of:
- (a) "controller power" switch to energize the controller while the signal lights are off or are being operated by the flasher. Label and rate the switch for load current.
  - (b) An electrical outlet. It must be a duplex, 3 prong, NEMA Type 5-20R grounding type outlet with independent ground fault circuit protection.



- (c) "auto/flash" switch that when placed in the "flash" position provides flashing operation without interrupting the controller unit power. When the switch is placed in the "auto" position the controller unit must provide normal operation.
  - (d) "stop time/off/on" switch that when placed in the "stop time" position causes the controller unit to stop time. In the "off" position, the controller unit must be active regardless of external commands. In the "on" position, the timing must be normal but subject to external command interruptions.
  - (e) momentary contact test switches to place calls on each vehicle and pedestrian phase. Switches must provide tactile feedback and be rated at 1 ampere, minimum, for a resistive load at 120 VAC and at 28 VDC. Contacts must be coin silver or gold plated and be enclosed and labeled as to their function.
  - (f) Tamper-proof toggle covers on door control switches.
- (7) Police Panel Assembly. Provide a Police Compartment meeting the requirements of NEMA TS-2 Section 7.5.7. The Police Compartment shall include a Universal Serial Bus (USB) port allowing connectivity with the controller when the door is closed and house the following switches with permanent labels:
- (a) "flash/automatic" switches that when placed in the "flash" position causes the intersection displays to go into the flashing mode. When placed in the "automatic" position, the signal system must resume normal operation.
  - (b) "signals on/off" switch that when placed in the "off" position removes power from the signal bus. Do not allow power on the bus when either "automatic" or "flash" operation is selected by any means.
- (8) Power panel cover. Provide a clear plastic cover over the power panel and Utility power terminal block. Cover shall be a minimum thickness of 0.1" and firmly attach at four points. Holes shall be slotted for easy removal and replacement.
- (9) Power Input Module. Provide an Econolite Zinc Blue Power Input Module (PIM).
- (a) Separate the power circuit for auxiliary equipment not intended to be powered by UPS or generator per plans and specifications.
  - (b) Wire signal equipment to be powered by UPS or generator through existing individual breaker, filters, sine wave trackers, surge protector, and PIM or size new breaker, if required.
- (10) Power outlet strips. Provide filtered aluminum power strip(s) as listed in the Plans. Power strips shall have 125 volt receptacles and 15 amp thermal-type circuit breakers with resets.
2. Special Features. Provide special features if called for in the Plans or as specified in the Special Provisions.

Coordination "Remote/Time of Day/Free" Switch. When the switch is in the "Remote" position, supervisory functions performed on the controller unit from a master coordinator or central computer must operate normally.

When the switch is in the "Time of Day" position, the local controller must use the local coordinators time of day plan. When the switch is in the "Free" position, it must be possible to remove any or all coordination devices and maintain normal, non-coordinated controller operation without wire jumpers, jumper plugs or other special devices. Provide this switch if a local coordination or system modem/interface unit is shown on the Plans.

## 740-2.12 STANDARD AUXILIARY EQUIPMENT.

Provide equipment meeting the requirements of Section 6 of the NEMA Standard Publication TS 2-2003 V02.06, Traffic Controller Assemblies with the National Transportation Communications for Intelligent Transportation Systems Protocol (NTCIP) Requirements (NEMA TS-2).

1. Three Circuit Solid State Load Switches. Use load switches conforming to NEMA TS-2, Section 6.2 Three Circuit Solid State Load Switches and as a minimum include Light Emitting Diode indicators on the DC input circuitry. The load switch must have three independent switching circuits, each being an individually replaceable solid state module.
2. Solid State Flasher. Use a NEMA Type III flasher unit that conforms to NEMA TS-2, Section 6.3 Solid State Flashers.
3. Malfunction Management Unit (MMU2). Provide Type 16 MMU2 to be fully compliant with the requirements of NEMA TS-2, Section 4. In addition, the MMU2 shall have a full intersection LCD back lighted signal on the front panel and shall be downward compatible with TS-1 CMUs.
4. Flash Transfer Relay. Use flash transfer relays that meet the requirements of NEMA TS-2, Section 6.4 Flash Transfer Relays.
5. Load Switch Test Socket. Provide 120V AC receptacle to allow for bump testing of indications.

**740-2.13 SPECIAL AUXILIARY EQUIPMENT.** Use the following special auxiliary equipment when called for on the Plans and/or Special Provisions:

Provide equipment meeting the requirements of the cited Sections of the NEMA Standard Publication TS 2-2003 V02.06, Traffic Controller Assemblies with National Transportation Communications for Intelligent Transportation Systems Protocol (NTCIP) Requirements (NEMA TS-2).

1. Local Coordination Units. Provide actuated coordination that conforms to the requirements of NEMA TS-2, Section 3.6 Actuated Coordination.
2. System Modem/Interface Unit. Supply a system modem/interface unit assembly that is compatible with the existing computerized traffic control system.
3. Preemption Units. Provide preemption that conforms to the requirements of NEMA TS-2, Section 3.7 Preemption and the following:

Install the following components of the GTT Company's Opticom Priority Control System according to GTT's written installation instructions at the signalized intersections listed on the Plans.

- a. The system must be capable of sending a signal to the controller when an Opticom signal from a vehicle mounted "GTT OPTICOM Emitter" has been received and maintained for a period of 1.7 seconds.
- b. Unless otherwise shown on the Plan, use Opticom Traffic Control Systems Opticom Detector Model 721 preemption detectors for infrared detector units and Opticom Model 3100 Global Positioning System (GPS)/Radio Unit containing a GPS receiver with Antenna and a 2.4 GHz spread transceiver with antenna for GPS detector units.
- c. Furnish the appropriate number of Opticom Traffic Control Systems 764 Phase Selectors to meet the number of channels of detection for each intersection. Use rack mounted phase selectors.
- d. The controller cabinet shall be wired with a Model 768 Auxiliary Interface Panel for the full utilization of all auxiliary detector and green sensing operations of the 764 Phase Selectors. Wire the cabinet with a Model 757 Auxiliary harness for interface between cabinet terminal blocks and Model 768 Auxiliary Interface panel.
- e. Install Model 138 detector lead in cable between the end of each signal mast arm and the controller cabinet for infrared detector units. Install Model 1070 GPS Installation cable when GPS units are specified. Furnish enough slack in these cables for them to extend 2 feet beyond the end of each signal mast arm and to leave 10 feet of slack in the controller cabinet. Seal both ends of each lead in cable with mastic lined, heat shrink tubing end caps.
- f. The controller, rather than the phase selector or auxiliary logic, must perform interval timing, signal sequences, and phase skips.



- g. Mount detectors according to manufacturer recommendations or as approved by the Engineer. Mount and aim detectors to provide maximum emergency vehicle recognition. Detector locations shown on the Plans are approximate and subject to change as directed by the Engineer.
- h. When emitters are required, provide GTT Opticom Priority Control System, Model 794HM Emitter with Model 2100 High Priority Radio/GPS Vehicle Control Unit and 210 Vehicle Interface Cable. The Emitter shall be factory programmed to the class and vehicle identification numbers assigned by jurisdiction as shown in the Plans and the following:
  - (1) Class 0 and Vehicle ID. Number 0 (Zero) shall be disabled for Emitters.
  - (2) Vehicle ID. Numbers shall be sequential, beginning with the lowest number in the EVP Emitter table for the appropriate class.
  - (3) Provide one copy of 790IS Emitter Software Kit including "Y" cable.
  - (4) One GTT Opticom Portable Emitter Kit with 794HM emitter on a magnetic base, 2100 Control Unit and cigarette lighter adapter power cord in a "Camera Bag" case.
- i. Manufacturer Assisted Start up. The Contractor shall retain the services of a representative from the GTT Opticom GPS equipment manufacturer and the controller equipment manufacturer Econolite (collectively Manufacturer's Representative), subject to the approval of the Engineer. The Manufacturer's Representative shall have previous experience with either the Central Region DOT&PF or Northern Region DOT&PF in assisting with traffic signal controller testing, field testing and turn on. Submit name(s) and professional credentials at least 30 days before beginning this work. When required, work on, and connections to, the Opticom GPS preemption system, vehicle equipment, and related equipment shall be performed by or directly supervised by a qualified person serving as the Manufacturer's Representative.

On-Site manufacturer assisted startup will be required for all intersections scheduled for GPS Opticom installations shown in the Plans. Red-lined cabinet prints shall be altered electronically and provided in hard copy, ".pdf", and AutoCAD format for each cabinet receiving GPS Opticom installation.

Telephonic manufacturer assisted start-up required for all intersections that do not require on-site manufacturer assisted start up as indicated above.

(1) Required Credentials of Manufacturer's Representative

- (a) 10 years experience working in the traffic controller industry, 5 years of that must have been as a signal technician.
  - (b) Must have IMSA Traffic Signal Technician, Level II certification
  - (c) Experience assisting with the Northern Region DOT&PF, or the Central Region DOT&PF
  - (d) Familiarity with both the NEMA TS1 and TS2 specifications
  - (e) Competent to read cabinet wiring diagrams and troubleshoot cabinet components
  - (f) Competent to troubleshoot Preemption issues
  - (g) Competent to test and Install GPS Preemption components
  - (h) Competent to conduct training on installed components
- (2) Training Except as otherwise noted, immediately preceding or following the Manufacturers Startup of the GPS Opticom System, the vendor shall provide training. All training is to be provided by a representative of the original equipment manufacturer. Training may be attended by any number of DOT&PF personnel from any of its three regions. Required training includes:
- (3) Provide 7.5 hours of instruction on the proper setup of the Radio/GPS Opticom Emergency Vehicle Preemption system. Training is to include all information necessary to properly set up and operate the Radio/GPS Opticom system as well as instruction on integration or use of the Opticom equipment/software with the Traffic Management system software Centracs.

The training audience is DOT&PF & MOA traffic Engineers. Deliver training time, day and location mutually agreeable to the contractor and the Traffic Design or Operations Engineer.

- (4) When emitters are included in the project provide two (2) 4.0 hour sessions of instruction on the proper use of the Radio/GPS based Opticom emitter. Training must be provided by a representative authorized by the original equipment manufacturer. Training is to include all information necessary to properly operate the Radio/GPS Opticom emitter. Deliver training at a time, day and location mutually agreeable to the contractor and the Traffic Design or Operations Engineer. One of the two training sessions will be delivered in the evening between 6:00pm and 12:00 am. Note; training will not be accepted until contract required equipment is delivered.
  - (5) Upon completion of training the manufacturer representative shall provide two (2) copies on thumb drives and two (2) copies on CD of any software required for setup, operation of, or maintenance of the GPS Opticom system components. This includes but is not limited to On-Site Interface Software and Central Managements Software.
4. Bus Interface Unit (BIU). Provide BIU's that fully meet the requirements of NEMA TS-2 Section 8. Unless otherwise called for in the Plans provide BIU's that meet the NEMA designation BIU2.
  5. Traffic Logging System. If called for in the Plans, furnish, and install in the controller cabinet, a stand-alone unit that collects, time stamps, and stores data in an unattended manner.
  6. Radar Detection System. For vehicle detection, provide a complete and functional Wavetronix digital wave radar vision system including the following:
    - a. Stop Bar Detector (SBD). For all intersection approaches indicated in the Plans, provide a Wavetronix SmartSensor Matrix™.
    - b. Continuous Tracking Advance Detector (CTAD). For all intersection approaches indicated in the Plans, provide a Wavetronix SmartSensor Advance Extended Range™.
    - c. Sensor Mount. For each detector indicated in the Plans, provide a Wavetronix SmartSensor™ Mount with Add-on Knuckle.
    - d. Cabinet Interface Device. For each signal controller cabinet, provide the quantity of Wavetronix Click 650 or Click 656 devices indicated in the Plans.
    - e. Configuration Software. Provide SmartSensor Manager Matrix (SSMM) software to configure and monitor the radar detectors.
    - f. Cable. Provide each of the following:
      - (1) SmartSensor™ 6-conductor Cable. For each radar detector, provide a sufficient length of Wavetronix SmartSensor™ 6-conductor Cable needed to connect radar detectors to mini junction boxes.
      - (2) Home Run Cable. Provide SmartSensor™ system compatible UL listed 2PR or 2 triad 22AWG + PR 18AWG shielded cable consisting of stranded, tinned, copper conductors with PVC insulations in a PVC jacket. Conductors shall be identified as white or gray/orange & orange (22AWG), white or gray/blue & blue (22AWG), black & red (18AWG). Drain wire shall be minimum 22AWG.

For each radar detector, provide sufficient cable to run from the sensor cable junction box mini to the cabinet interface device inside the signal controller cabinet. Provide 15 feet of neatly coiled slack cable in the base of the signal controller cabinet foundation. Provide sufficient slack at the pole so the in-line terminal enclosure can be pulled out of the handhole for maintenance work.
    - g. Sensor Cable Junction Box Mini. For each radar detector, provide a sensor cable junction box mini to provide a connection between the sensor's pigtail cable and home run cable.

- h. Support. The SBD and CTAD manufacturer shall provide both training and technical support services.
- (1) Training. The manufacturer-provided training shall be sufficient to fully train installers and operators in the installation, configuration, and use of the SBD to ensure accurate SBD performance.
  - (2) Technical Assistance. A manufacturer-provided technical representative shall be available to assist with the physical installation, alignment, and configuration of each supplied SBD and CTAD. Technical support shall be provided thereafter to assist with troubleshooting, maintenance, or replacement of SBDs or CTADs should such services be required.
  - (3) Documentation. SBD and CTAD documentation shall include an instructional training guide, a comprehensive user guide, as well as an installer quick-reference guide and a user quick-reference guide. The SBD and CTAD manufacturer shall supply the following documentation and specification test results at the time of the bid submittal:
    - i. FCC CFR 47 certification
    - ii. IEC 61000-4-5 class 4 test report
7. Pan-Tilt-Zoom (PTZ) Camera. Furnish an Axis Q6010-E Camera with the following specifications:
- a. Furnish an Axis Q6010-E 60 Hz Camera with the following specifications:
    - (1) Micro SDXC card with a capacity of 1TB and speed class U3 or V30
  - b. Furnish an Axis Q6075-E PTZ Dome network camera 60Hz camera with the following specifications:
    - (1) Power with Axis High PoE midspan 1-port 100-240 V AC, max 60 W.
    - (2) Micro SDXC card with a capacity of 1TB and speed class U3 or V30.
  - c. Include T91 mounting accessories.

Begin MOA subsection 2.09, 2.10, 2.11, 2.12 & 2.13. Use or delete as previously instructed.

**740-2.09 CONTROLLER ASSEMBLIES.** Provide solid state, traffic controller assemblies having level 2 conformance to NEMA Standard Publication TS 2-2003 V02.06, Traffic Controller Assemblies with NTCIP Requirements as defined in NTCIP1202. Traffic Controller Assemblies must meet or exceed the Environmental Requirements of Section 2 of the NEMA TS2-2003 V02.06 document. The Original Equipment Manufacturer (OEM) and its manufacturing and testing facilities shall be ISO 9001:2000 certified for processes involving the Traffic Controller Assemblies.

Use traffic control equipment that is compatible with the existing traffic signal monitoring system. Compatibility must be 100% at the cabinet level to include inputs, outputs, telemetry protocol, and block upload and download of RAM data.

The existing traffic signal monitoring system is Centrac's Advanced Transportation Management Solutions by Econolite.

In addition, features of the existing local controllers and controller modules must be functionally duplicated to meet or exceed the performance of the existing equipment.

The existing local controller cabinets at other intersections include the following equipment:

1. Econolite Cobalt Advanced Traffic Control Touch 2100

Use LED indicators for all electronic devices covered under Subsections 740-2.09 through 740-2.13.

**740-2.10 CONTROLLER UNIT.**

1. Actuated Controller Unit (CU). Provide solid state, Type A2N CU meeting the requirements of Section 3 of the NEMA Standard Publication TS 2-2003 V02.06, Traffic Controller Assemblies with NTCIP Requirements.
  - a. The CU must meet the referenced National Transportation Communications for ITS Protocol (NTCIP) and comply with publication TS 3.2 the Simple Transportation Management Framework, and shall meet the requirements for Conformance Level 2
  - b. The software shall comply with NEMA TS 3.3, the Class B Profile, and shall include both an EIA/TIA 232-E and an FSK modem interface for NTCIP based communications.
  - c. The CU shall implement conformance groups and optional object groups as defined in NEMA TS 3.4 and TS 3.5 for A2N level 2.
  - d. Provide controllers with display heaters or enhancements to improve viewing in temperatures below 0 °F.
  - e. Provide controllers having an interface compatible with SYNCRO-7 traffic modeling software.
2. Front Panel
  - a. The front of the controller shall consist of a panel for the display, keyboard and connectors for all necessary user connections.
  - b. The display shall be a seven-inch (7"), color, Thin Film Transistor (TFT) Liquid Crystal Display (LCD) with high brightness. It shall be readable in direct sunlight. The display shall perform over the NEMA temperature range and shall have a resolution of 800 X 480 with an 18 bit color depth. The luminous intensity shall be a minimum of 800 nits. The display shall include an industrial, resistive touch screen that can be operated with gloved hands. The touch screen and display shall not be affected by condensation or water drops.
  - c. Front-panel operator inputs shall be via touch screen or by clearly labeled elastomeric keypad. These shall include a 10-digit numeric keypad, Main and Sub keys, toggle keys, special function and enter keys, six function keys, status and help keys and a large four direction cursor control key.
  - d. The front panel shall include a built-in speaker for enhanced controller audio feedback.
  - e. The front panel shall include a tri-color status LED.
3. Required Optional Features.
  - a. User interface Advanced Display with graphics and touchscreen.
  - b. TS2 Type 2 connectors.
  - c. Data key 3.3V, 32MB

**740-2.11 CONTROLLER CABINET.** Provide a controller cabinet that meets the requirements of NEMA Standard TS 2-2003 V02.06 Traffic Controller Assemblies with National Transportation Communications for Intelligent Transportation Systems Protocol (NTCIP) Requirements (NEMA TS-2), Section 5 Terminals and Facilities and Section 7 Cabinets. Cabinet enclosure shall be UL listed. The cabinet assembly shall be completely manufactured in the United States of America.

1. Standard Features. Supply the following standard features:
  - a. Materials

Unless otherwise designated in the Plans, provide cabinets constructed of sheet Aluminum.

Back and sides of cabinet shell, shall be of one continuous piece of Aluminum.

b. Cabinet Dimensions

Unless otherwise designated in the Plans, provide a size 6 cabinet as defined in NEMA TS-2 Table 7-1.

c. Doors

- (1) The cabinet shall be equipped with a universal lock bracket capable of accepting a Best CX series lock. The cabinet shall come equipped with a Best blue construction core lock. Provide two keys for lock.

The door shall be mounted with a single continuous stainless steel piano hinge that runs the length of the door. Attaching tamper resistant bolts shall also be stainless steel.

- (2) Provide a Police Compartment meeting the requirements of NEMA TS-2 Section 7.5.7. Provide two keys for lock. The Police Compartment shall house the following switches:

(a) "flash/automatic" switch that when placed in the "flash" position causes the intersection displays to go into the flashing mode. When placed in the "automatic" position, the signal system must resume normal operation.

(b) "signals on/off" switch that when placed in the "off" position removes power from the signal bus. Do not allow power on the bus when either "automatic" or "flash" operation is selected by any means.

- (3) Permanently label switches in the Police Compartment.

- (4) Provide Generator Bypass Compartment

(a) The cabinet front door shall have a locking generator bypass compartment that shall be used to connect a generator to operate the cabinet during extended loss of service line power. The generator compartment shall be capable of being closed and locked while a generator is connected. The mechanism for allowing generator cable access, while the compartment is closed, shall be an integral part of the generator bypass door, via a sliding panel that will normally be in the closed position. Inside the compartment there shall be a silkscreened panel housing a Hubbell HBL2615

30A / 125V flanged inlet receptacle capable of accepting a standard generator plug, a BACO HC52DQG cam switch with split AC+ feeds, and (2) LED lamps with sockets. One LED shall be illuminated when the cabinet has service line power and the other when the cabinet is under generator control. All LED's shall be field replaceable without putting the intersection in flash.

(b) All wiring to the generator bypass compartment shall be contained in a single cable bundle. The cable shall connect to the backside of the electrical components and shall only be accessible from the inside of the cabinet front door. All electrical components on the inside of the front door that carry AC voltage shall be covered by a see-through plexiglass cover. The generator bypass cable shall terminate at the same power panel location as service line voltage.

(c) The generator bypass receptacle compartment shall come with a tapered lock using a Best CX series blue core.

(d) The welds for the generator receptacle compartment shall be done on the inside of the front door. All welds shall be free from burrs, cracks, blow holes or other irregularities.

(e) Mount compartment on inside of the controller cabinet door. Mount the access door flush with the cabinet door.

d. Shelves

Provide shelves meeting the requirements of NEMA TS-2 Section 7.6.

Shall come with (2) double beveled shelves 10" deep that are reinforced welded with V channel, fabricated from 5052-H32 0.125-inch thick aluminum with double flanged edges rolled front to back. Slotted hole shall be inserted every 7" for the purpose of tying off wire bundles.

Provide additional laptop computer shelf mounted approximately 30" above cabinet floor. The laptop shelf must accommodate a standard 17" computer, be retractable below one of the cabinets' shelves and contain a storage drawer.

e. Finish and Preparation

The cabinet shall be powder-coated grey on the outside and white on the inside. All exterior seams shall be manufactured with a neatly formed continuously weld construction. The weld for the police box door shall be done on the inside of the cabinet door. All welds shall be free from burrs, cracks, blowholes or other irregularities.

f. Cabinet Mounting

- (1) Provide cabinet mounting features as defined NEMA TS-2 Section 7.8.
- (2) The cabinet manufacturer is responsible for providing a cabinet that will mount without modification on the foundation detailed in Alaska Department of Transportation Central Region, Regional Detail, Controller Cabinet Foundation.
- (3) The cabinet shall come with lifting ears affixed to the upper exterior of the cabinet. These ears shall utilize only one bolt for easy reorientation.

g. Cabinet Ventilation

Furnish a cabinet that fully meets the requirements of NEMA TS-2 Section 7.9 and the following:

- (1) Furnish the fan and cabinet vent with internally mounted metal covers that are fabricated to close off the flow of air during winter operation.
- (2) Equip the cabinet with a selectable, 600/900/1500 watt cabinet heating device with a 2 speed fan. The heating device must have a remote air sensing thermostat. The contacts must be rated 20 amps, 120 volts, 60 hertz. Heating device shall be mounted on inside of the cabinet door, below the control panel. Heating device shall be a Caframo model 9206CA-BBX or approved equivalent.
  - (a) Construct the thermostat so that contacts close on descending temperature and are adjustable between -30 and 110 °F  $\pm$ 5 °F. The contacts must open on rising temperatures of 15 °F above the closing temperature. The adjustment must have an indicating pointer. Remote bulb type thermostat shall not be used. Thermostat shall be a Johnson Controls model A19BBC-2C or approved equivalent.
  - (b) Connect the thermostat in series with an electrical resistance heater and blower fan. The blower fan must be rated for continuous duty. The heater and fan must be connected in parallel and rated 120 volts, 60 Hertz. Mount the unit on the cabinet door below the auxiliary panel.
  - (c) Do not block the air intake or outlet. Provide the unit with a SPST manual override switch that bypasses the thermostat to enable the fan and heater to operate at warmer temperatures.

h. Auxiliary Cabinet Equipment

- (1) Light fixtures. The cabinet shall have two (2) LED lighting fixtures with 15 high power LEDs using a cool white color emitting 300 lumens min @ 12VDC/750mA. The LED fixtures shall be a Rodeo Electronics TS-LED-05M02. It shall be powered by a Mean Well class 2 power supply LPV-20-12 that shall be mounted on the inside top of the cabinet near the front edge. The cabinet light circuit shall be designed so a second LED fixture will be installed in the cabinet below the rollout drawer without the need a of a second power supply. It shall be attached so that it remains stationary when drawer is extended. Provide a resealable print



pouch. The pouch shall be mounted to the door of the cabinet. The pouch shall be of sufficient size to accommodate one complete set of cabinet prints.

The lighting fixture "ON-OFF" switch must be a toggle switch mounted on the on the inside control panel. Include in the circuit a door actuated switch that turns the light ON when the door is open and OFF when the door is closed.

- (2) Provide three (3) paper sets of complete and accurate cabinet drawings with delivery of each cabinet. Make cabinet drawings available electronically in AK DOT's current version of AutoCAD and deliver with paper set, along with a ".pdf" copy.
- (3) Provide one paper set of manuals for the controller, Malfunction Management Unit, and vehicle detector amplifiers with each cabinet. Make said manuals available in electronic Adobe ".pdf" format and deliver with paper set.

i. Cabinet Wiring

Neatly arrange the wiring within controller cabinets to conform to the requirements of Subsections 660-3.05 and 740-2.05. Furnish controller cabinets wired to accommodate:

- (1) Configuration #4 in Table 5-2 of the NEMA Standards Publications No. TS 2-2003 V02.06, Traffic Controller Assemblies with NTCIP requirements with the quantity of Type 2 detector racks indicated in the plans.
  - (a) Equip the cabinet with required control and auxiliary equipment connecting cables to operate the phases and detection indicated on the Plans, including future use with a minimum of 16 load switch positions, 8 flash transfer relay position and 1 flasher socket.
  - (b) Size wiring, switches, surge protectors, flash relays, and flashers to handle the necessary amperage required under full cabinet use. Use orange colored wires to run from the flash transfer relay used for emergency flash programming.
  - (c) Wire the cabinet to accommodate 6 unique preempt sequences as defined by NEMA TS-2 Section 3.7 and 2 auxiliary preempt sequences. Wire in a single wiring harness for the Opticom Model 764 operation and terminate the wiring harness on Detector Rack #1. Leave sufficient slack in the wiring harness for termination elsewhere in the cabinet.
  - (d) Wire the cabinet with an auxiliary interface panel and wiring to accommodate the full quantity of emergency preemption inputs and green sense operations available with GTT Company's Opticom Priority Control System 764 series phase selector.  
  
Install a GTT Company's Opticom Priority Control Model 768 Auxiliary Interface Panel and Model 757 Auxiliary harness. Install Opticom panels in close proximity to one another.
  - (e) Wire the cabinet so that each inductive loop detector channel input termination has three adjacent screw terminal positions provide, so that two loops can be series terminated for each individual detector channel.
  - (f) Wire the cabinet so that there is a single field terminal wired to each of the cabinet's flasher outputs circuits #1 and #2.
  - (g) Wire the cabinet so that channel 1-16 green field outputs are jumpered to a terminal block. Also route the GTT Opticom phase selector's green sense wires to adjacent positions on the same terminal block. Intended for wiring programming assignment of the green sense conductors to any of the channel 1-16 green field outputs.
  - (h) Wire cabinet so that there are terminal block locations (test points) for all T&F BIU's #1 & #2 wiring circuits
  - (i) Provide a load resistor panel with 8 resistors for usage to "load" future circuits for Flashing Yellow Arrow (FYA) operation.

- (j) Wire all preemption outputs from the rack to a terminal block. Wire BIU wires for preemption inputs to adjacent positions on same terminal block. Intended for wiring programming of alternative assignment (Preempt 2-5 or Preempt 3-6). For emergency vehicle preemption.
- (k) Wire the cabinet so that confirmation lights are activated via controllers Preempt Active Outputs, not phase selector confirmation light outputs.
- (l) Wire the cabinet so that preemption confirmation light circuits utilize the yellow outputs of LS9 – LS12.
- (m) Wire all BIU preemption outputs wires to a terminal block. Wire conductors for LS9 – LS12 yellow inputs to a terminal block.
- (n) Terminate the Malfunction Management Unit (MMU) wires associated with channel # 9–12 yellow outputs on a terminal block, for future use. Install conductors from channel # 9–12 yellow field terminals to position adjacent to relocated MMU wires.
- (o) All wires terminated behind the main panel or on the back side of other panels shall be soldered. No pressure or solder-less connectors shall be used.
- (p) All cabinets shall be wired to flash for all channels. Flashing operation shall alternate between channels 1,3,5,7,13,14,15,16 and 2,4,6,8,9,10,11,12. Flash programming shall be either red or yellow simply by changing wires on the front of the load-bay.
- (q) Wire the cabinet so that the control panel's momentary contact test switches for vehicle calls Phase 1-8 are wired to Detector rack Channels 1-8 respectively.

j. Field Terminal Blocks

Provide Terminals and Facilities meeting the requirements of NEMA TS-2 Section 5, Configuration #4 (Table 5-2) and the following:

- (1) Provide 2 or more insulated terminal blocks to terminate field conductors. Provide each block with 12 poles with 10-32 screw type terminals. Use a terminal block that is a barrier type with removable shorting bars in each of the 12 positions and with integral type marking strips. Terminate conductors to a terminal block. The load-bay shall have two rows of field terminals tied together in series. Solder connected on the back sides of the terminal blocks. Each channel shall have 6 terminals, two complete rows each consisting of 3 terminations from left to right beginning with phase 1 corresponding to the appropriate vehicle phase Green, Yellow and Red and following the order of the load switches. Field terminals shall be #10 screw terminal and be rated for 600V.
- (2) Terminate conductors from the controller unit and MMU unit in ring type terminal lugs or solder them to a through panel solder lug on the rear side of the terminal. Terminate other conductors in spade type terminal lugs.
- (3) Do not bring more than 3 conductors to any one terminal. Two flat metal jumpers, straight or U shaped, may also be placed under a terminal screw. Fully engage at least 2 full threads of terminal screws when the screw is tightened. Do not extend live parts beyond the barrier.
- (4) A TII Porta Systems Model No. 1512 building entrance protector 12-pair unit, 3M 2810-HC0/87-DPM cross connect terminal block with pigtails and a 3M 80-6113-3163-0 frame shall be installed for telemetry cable pair terminations.
- (5) Building entrance protector unit and the cross connect terminal block with frame shall be mounted on a common panel on the right side of the controller cabinet.
- (6) On the right side of controller cabinets, install two 16 position bus bars, for terminating the equipment grounding and neutral conductors used inside the cabinets. On the left side of the controller cabinets, install two 32 position bus bars, for terminating the equipment grounding and neutral conductors from field wiring. Offset upper 16 position bus bar past the lower 16 position bus bar where 32 positions are required.



k. Cabinet Accessories

See NEMA Standard TS 2-2003 V02.06, Section 5 Terminals and Facilities, Figure 5-4 Cabinet Power Distribution Schematic for Items (1) through (6).

(1) Disconnecting Means

- (a) Main circuit breaker must be a single pole, 40 ampere, 10,000 amperes interrupting capacity for each cabinet.
- (b) Provide a minimum of 2 Auxiliary circuit breakers, each must be single pole, 20 ampere, 10,000 amperes interrupting capacity to protect fan, heater, light, and convenience outlet(s). One auxiliary circuit breaker shall only service a single outlet receptacle for exclusive use for the cabinet heater.

The rating of the main disconnect means with overcurrent protection must be not less than 125% of the maximum anticipated continuous load. When using disconnecting circuit breakers, use "trip indicating trip free," Type.

- (2) Signal Bus. Connect the signal bus to the incoming AC line through a signal bus solid state relay and an over current protection device. Energize the signal bus solid state relay to provide power to the signal bus. The current rating of the signal bus solid state relay must be at least the current rating of the main over current protection device. Solid state relay shall have an LED input status indicator.

- (3) AC Service Transient Suppression. Connect the transient suppression device for the primary feed of the cabinet on the load side of the cabinet overcurrent protection device. The transient voltage suppression device connected to the controller power circuit must provide protection against voltage abnormalities of 1 cycle or less duration.

- (a) The suppressor must be solid state high energy circuit containing no spark gap, gas tube, or crow bar component. The current rating of the device must be 15 amps minimum. The device must provide transient protection between neutral and ground, line and ground, as well as line and neutral. If the protection circuits fail, they must fail to an open circuit condition. The device must meet requirements of UL Standard 1449.
- (b) The suppressed voltage rating must be 600 volts or less when subject to an impulse of 6,000 volt, 3,000 amp source impedance, 8.0/20 microsecond waveform as described in UL Standard 1449. In addition, the device must withstand, without failure or permanent damage, one full cycle at 264 volts RMS.
- (c) The device must contain circuitry to prevent self-induced regenerative ringing. There must be a failure warning indicator light that must illuminate when the device has failed and is no longer operable. The transient suppression device must withstand a 20,000 ampere surge current with an 8x20 microsecond (time to crest x time to second halfcrest) waveform 20 times at 3 minute intervals between surges without damage or degradation to the suppressor. Output voltage must not exceed 500 volts at any time during the test. Use a device that is a solid state, high energy circuit with no spark gap, gas tube, or bar component.

- (4) Radio Interference Suppression. Equip each traffic cabinet, flasher, and other current interrupting device with a suitable radio interference suppressor installed at the input power point. Install the radio interference suppressor after the AC service transient suppression unit described in Subsection 740-2.11.1.k (3). It must provide a minimum attenuation of 50 decibels over a frequency range from 200 kilohertz to 75 megahertz, when used with normal installations.

- (a) The interference suppressor must be hermetically sealed in a substantial metal case filled with suitable insulating compound. Terminals must be nickel plated, 10-24 brass studs of sufficient external length to provide space for connecting two No. 8 conductors and must be so mounted that the terminals cannot be turned in the case. Ungrounded terminals must be properly insulated from each other and must maintain a surface leakage

distance of not less than 1/4 inch between any exposed current conductor and any other metallic part, with an insulation factor of 100 to 200 megohms dependent on external circuit conditions.

- (b) The radio interference suppressor must have a minimum current rating equal to the rating of the main disconnect means as specified in Subsection 740-2.11.1.k (1) (a). It must be designed for operation on 120 volts, 60 hertz, single phase circuits and be UL and EIA compliant.
- (c) Connect the ground connection of the radio interference suppressor only to AC neutral. Do not connect to Earth Ground directly.
- (5) Communications Transient Suppression. Provide eight (8) hybrid (solid state/gas tube) 5-pin protector modules. Modules shall have gold pins and a black case. The module shall be a Bourns part No. 2410-3-1-G-MSP-ST or approved equal.
- (6) Control Panel. Provide and label a control panel assembly that is readily accessible from the front of the cabinet. The control panel assembly must consist of:
  - (a) "Controller power" switch to energize the controller while the signal lights are off or are being operated by the flasher. Label and rate the switch for load current.
  - (b) "Cabinet light" "ON-OFF" switch.
  - (c) "Auto/flash" switch that when placed in the "flash" position provides flashing operation without interrupting the controller unit power. When the switch is placed in the "auto" position the controller unit must provide normal operation.
  - (d) "Stop time/off/on" switch that when placed in the "ON" position causes the controller unit to stop time. In the "off" position, the controller unit must be active regardless of external commands. In the "AUTO" position, the timing must be normal but subject to external command interruptions.
  - (e) "Heater by-pass" switch to bypass the remote heater thermostat.
  - (f) Momentary contact test switches to place calls on each vehicle and pedestrian phase. Switches must provide tactile feedback and be rated at 1 ampere, minimum, for a resistive load at 120 VAC and at 28 VDC. Contacts must be coin silver or gold plated and be enclosed and labeled as to their function.
  - (g) Provide a hinged clear plastic cover over the control panel switches. Plastic cover shall be of a minimum thickness of 0.1"
  - (h) Control Panel shall be attached to door with a hinge located along bottom edge, to allow panel to be lowered for testing or replacement of switches.
- (7) Receptacle Outlets. The cabinet shall be wired with one quad outlet with a ground fault interrupter, one convenience duplex outlet without ground fault interrupters and one single outlet, exclusively for the heating device without ground fault interrupter. The ground fault outlet shall be mounted on the right side of the cabinet on or near the power panel. The one convenience outlet shall be near the top shelf. The heater outlet shall be mounted on the right side of the cabinet on or near the power panel. No outlets shall be mounted on the door. The GFI power shall be fed through the auxiliary breaker. The convenience outlet shall power shall be fed through an EDCO SHP300-10 transient voltage suppressor located on the cabinet power panel.
- (8) Power Panel cover. Clear plastic cover material shall be a minimum thickness of 0.1". Cover shall be firmly attached at four points. Holes shall be slotted for easy removal and replacement.
- (9) Silkscreen labeling. Both sides of the Control Panel and the Load-Bay shall be silkscreened. Aluminum panel for the Power Panel shall be silk screened also.

(10) Load bay. The entire load bay shall roll down and provide access to all of the back of panel wiring. All solder terminals shall be accessible when the load-bay is rolled down. The assembly shall be able to roll down without requiring other components, cables or load switches to be removed. The load-bay shall be balanced such that it will not roll down when fully loaded with load switches, flashers and flash transfer relays, when retaining attachments are removed.

(11) SDLC Hardware. Provide 8 SDLC cables neatly wired into the cabinet. Cables shall be equipped with spring latch type connectors on the equipment end and screw down type connectors on the SDLC hub end. All SDLC connectors shall be fully populated with 15 pins each. The SDLC cable's drain wire shall only be connected to Pin 12 on the equipment end connection of each cable.

Provide a SDLC hub with a minimum of 9 connections. One connection shall be a spring latch type and all others shall be screw down type.

2. Special Features. Provide the following.

- a. Coordination Switch. When the switch is in the "Auto" position, the controller must use the controller's internal coordinator time of day plan.

When the switch is in the "Free" position, all coordinator control of the controller operation shall be disabled.

- b. "Force-Off" Switch. There shall be 2 momentary test switches tied to ring 1 and ring 2 on the controller. These switches shall have two positions labeled "On" which shall force the controller into the next ring in the phase sequence, "Off" which shall be normal operation. These switches shall be labeled Ring 1 and 2.

- c. Detector rack cover. Provide a clear plastic cover mounted on top of the detector racks. Cover to extend over harness connectors and wiring on card slots. Clear plastic cover material shall be a minimum thickness of 0.1".

**740-2.12 STANDARD AUXILIARY EQUIPMENT.**

Provide equipment meeting the requirements of Section 6 of the NEMA Standard Publication TS 2-2003 V02.06, Traffic Controller Assemblies with NTCIP Requirements (NEMA TS-2).

1. Three Circuit Solid State Load Switches. The cabinet shall come with (16) load switches. All load switches shall be cube type and have LED indications for both the input and output side of the load. The load switches shall be PDC model SSS-87-I/O or approved equivalent.
2. Solid State Flasher. The cabinet shall come with (1) flasher. The flasher shall be cube type and have LED indications. The flasher shall be PDC model SSF87 or approved equivalent.
3. Malfunction Management Unit (MMU2). The cabinet shall come with a (MMU2) that meets all the requirements of NEMA TS2-2003 and NEMA Standard TS-2 Amendment 4-2012 while remaining compatible with NEMA TS1. It shall have (2) high contrast LCD displays and an internal diagnostic wizard. It shall come with a 10/100 ethernet port. It shall come with software to run flashing yellow arrow operation. The MMU2 shall be Eberle Design, Inc. model MMU2-16LEip or approved equivalent.
4. Flash Transfer Relay. The cabinet shall come with (8) heavy duty flash transfer relays. The flash transfer relays shall be Detrol Controls model 295 or approved equivalent.

**740-2.13 SPECIAL AUXILIARY EQUIPMENT.** Provide equipment listed under Items No.1-6 with all controller cabinets. Provide equipment listed under Items No. 1, No.7, and No.8 only when called for in Plans or Special Provisions.

Provide equipment meeting the requirements of the cited Sections of the NEMA Standard Publication TS 2-2003 V02.06, Traffic Controller Assemblies with NTCIP Requirements (NEMA TS-2).

1. Inductive Loop Detector Units. Provide (16) inductive loop detectors that conform to the requirements of NEMA TS-2, Section 6.5 Inductive Loop Detector Units. Unless otherwise called for in the Plans provide 4 Channel Inductive Loop Detectors. The loop amplifiers shall be Eberle Design, Inc. model ORACLE4e or approved equivalent.
2. Local Coordination Units. Provide actuated coordination that conforms to the requirements of NEMA TS-2, Section 3.6 Actuated Coordination.

### 3 System Modem/Interface Unit. Confirm with MOA.

3. System Modem/Interface Unit. The cabinet shall come with an 8 pair copper ethernet switch. Four ports of 10/100TX and an optional 1000base SFP port. The ethernet switch shall support all of the following minimum requirements; EFMplus technology, virtual local area networks (VLAN) tagging (IEEE 802.1q) and dynamic bridging (IEEE 802.1). The copper ethernet device shall provide for communication over copper pairs split into two directions and the high speed link shall be over bonded copper pairs (IEEE 802.3ah 2Base-TL). The copper ethernet switch shall be an Actelis Networks model ML688 or approved equivalent. The following items shall be supplied with the copper ethernet switch:
  - a. Two quad DSL cables 504R20110
  - b. One AC power adapter 506R00006
  - c. Four Cat6 patch cables 3 feet
  - d. One SFP Optics 100base FX SM 1310nm 15km LC 506R00032
  - e. Carrier-class element management system
  - f. Wall mounting kit 510R21080
4. Preemption Units. Provide preemption that conforms to the requirements of NEMA TS-2, Section 3.7 Preemption and the following:
  - a. EVP Infrared Opticom  
 Install the following components of the GTT Company's Opticom Priority Control System according to GTT's written installation instructions at the signalized intersections listed on the Plans.
    - (1) The system must be capable of sending a signal to the controller when an Opticom signal from a vehicle-mounted "GTT OPTICOM Emitter" has been received and maintained for a period of 1.7 seconds.
    - (2) Unless otherwise shown on the Plan use Opticom Traffic Control Systems Opticom Detector Model 721 preemption detectors.
    - (3) Furnish the appropriate number of Opticom Traffic Control Systems 764 Phase Selectors to meet the number of channels of detection for each intersection. Use rack mounted phase selectors.
    - (4) The controller cabinet shall be wired with a Model 768 Auxiliary Interface Panel for the full utilization of all auxiliary detector and green sensing operations of the 764 Phase Selectors. Wire the cabinet with a Model 757 Auxiliary harness for interface between cabinet terminal blocks and Model 768 Auxiliary Interface panel.
    - (5) Install Model 138 detector lead in cable between the end of each signal mast arm and the controller cabinet. Furnish enough slack in these cables for them to extend 2 feet beyond the end of each signal mast arm and to leave 10 feet of slack in the controller cabinet. Seal both ends of each lead in cable with mastic lined, heat shrink tubing end caps.
    - (6) The controller, rather than the phase selector or auxiliary logic, must perform interval timing, signal sequences, and phase skips.

- (7) Mount detectors according to manufacturer recommendations or as approved by the Engineer. Mount and aim detectors to provide maximum emergency vehicle recognition. Detector locations shown on the Plans are approximate and subject to change as directed by the Engineer.
- (8) When emitters are required, provide GTT Opticom Priority Control System, Model 794H Emitter with 793 in vehicle switch. The Emitter shall be factory programmed to the class and vehicle identification numbers assigned by jurisdiction as shown in the Plans and the following:
  - (a) Class 0 and Vehicle ID. Number 0 (Zero) shall be disabled for Emitters.
  - (b) Vehicle ID. Numbers shall be sequential, beginning with the lowest number in the EVP Emitter table for the appropriate class.
  - (c) Provide one copy of 790IS Emitter Software Kit including "Y" cable.
  - (d) One GTT Opticom Portable Emitter Kit with 792R emitter on a magnetic base, 793R switch and cigarette lighter adapter power cord in a "Camera Bag" case.

b. GPS Opticom Unit

- (1) Install the following components of the GTT Company's Opticom Priority Control System according to GTT's written installation instructions at the signalized intersections listed on the Plans.
- (2) The system must be capable of sending a signal to the controller when an Opticom signal from a vehicle-mounted "GTT OPTICOM Emitter" has been received and maintained for a period of 1.7 seconds.
- (3) Unless otherwise shown on the Plan use Opticom Model 3100 GPS/Radio Unit containing a GPS receiver with Antenna and a 2.4 GHz spread transceiver with antenna.
- (4) Furnish a 11 conductor radio/GPS cable to connect the Traffic Control Systems 764 Phase Selectors to the Model 3100 GPS Radio Unit.
- (5) Install Model 1070 GPS Installation cable when GPS units are specified. Furnish enough slack in these cables for them to extend 2 feet beyond the end of each signal mast arm and to leave 10 feet of slack in the controller cabinet. Seal both ends of each lead in cable with mastic lined, heat shrink tubing end caps.
- (6) Mount GPS Unit according to manufacturer recommendations or as approved by the Engineer. Mount and aim detectors to provide maximum emergency vehicle recognition. Detector locations shown on the Plans are approximate and subject to change as directed by the Engineer.
- (7) When GPS emitters are included, provide GTT Opticom Priority Control System, Model 792H Emitter with 793 in vehicle switch. The Emitter shall be factory programmed to the class and vehicle identification numbers assigned by jurisdiction as shown in the Plans and the following:
  - (a) Class 0 and Vehicle ID. Number 0 (Zero) shall be disabled for Emitters.
  - (b) Vehicle ID. Numbers shall be sequential, beginning with the lowest number in the EVP Emitter table for the appropriate class.
  - (c) Provide one copy of the Emitter Software Kit including required connection cables.
  - (d) One GTT Opticom Portable Emitter Kit with 794R emitter on a magnetic base, 2100 Control Unit and cigarette lighter adapter power cord in a "Camera Bag" case.
- (1) Manufacturer Assisted Startup. The Contractor shall retain the services of a representative from the GTT Opticom GPS equipment manufacturer and the controller equipment manufacturer Econolite (collectively Manufacturer's Representative), subject to the approval of the Engineer. The Manufacturer's Representative shall have previous experience with

either the MOA or Central DOT in assisting with traffic signal controller testing, field testing and turn on. Submit name(s) and professional credentials at least 30 days before beginning this work. When required, work on, and connections to, the Opticom GPS preemption system, vehicle equipment, and related equipment shall be performed by or directly supervised by a qualified person serving as the Manufacturer's Representative.

On-Site manufacturer assisted startup will be required for all intersections scheduled for GPS Opticom installations shown in the Plans. Red-lined cabinet prints shall be altered electronically and provided in hard copy, pdf, and AutoCAD format for each cabinet receiving GPS Opticom installation.

Telephonic manufacturer assisted start-up required for all intersections that do not require on-site manufacturer assisted start up as indicated above.

(a) Required Credentials of Manufacturer's Representative

- i. 10 years experience working in the traffic controller industry, 5 years of that must have been as a signal technician.
  - ii. Must have IMSA Traffic Signal Technician, Level II certification
  - iii. Experience assisting with the MOA and the Central Region DOT&PF
  - iv. Familiarity with both the NEMA TS1 and TS2 specifications
  - v. Competent to read cabinet wiring diagrams and troubleshoot cabinet components
  - vi. Competent to troubleshoot Preemption issues
  - vii. Competent to test and Install GPS Preemption components
  - viii. Competent to conduct training on installed components
5. Bus Interface Unit (BIU). Provide BIU's that fully meet the requirements of NEMA TS-2 Section 8. Unless otherwise called for in the Plans provide six BIU's that meet the NEMA designation BIU2. In addition, all BIUs shall provide separate front panel indicator LED's for DC power status and SDLC Port 1 transmit and receive status. The (BIU)'s shall be Eberle Design, Inc. model BIU700 or approved equivalent.
  6. Power supply. Provide a shelf mounted power supply that conforms to the requirements of NEMA TS-2 Section 5.3. The (PS) shall be Eberle Design, Inc. model PS250 or approved equivalent.
  7. Radar Detection System. For vehicle detection, provide a complete and functional Wavetronix digital wave radar vision system including the following:
    - a. Stop Bar Detector (SBD). For all intersection approaches indicated in the Plans, provide a Wavetronix SmartSensor Matrix™.
    - b. Continuous Tracking Advance Detector (CTAD). For all intersection approaches indicated in the Plans, provide a Wavetronix SmartSensor Advance Extended Range™.
    - c. Sensor Mount. For each detector indicated in the Plans, provide a Wavetronix SmartSensor™ Mount with Add-on Knuckle.
    - d. Cabinet Interface Device. For each signal controller cabinet, provide the quantity of Wavetronix Click 650 or Click 656 devices indicated in the Plans.
    - e. Configuration Software. Provide SmartSensor Manager Matrix (SSMM) software to configure and monitor the radar detectors.
    - f. Cable. Provide each of the following:



- (1) Smartsensor 6-conductor Cable. For each radar detector, provide a sufficient length of Wavetronix SmartSensor™ 6-conductor Cable needed to connect radar detectors to mini junction boxes.
- (2) Home Run cable. Provide SmartSensor™ system compatible UL listed 2PR or 2 triad 22AWG + PR 18AWG shielded cable consisting of stranded, tinned, copper conductors with PVC insulations in a PVC jacket. Conductors shall be identified as white or gray/orange & orange (22AWG), white or gray/blue & blue (22AWG), black & red (18AWG). Drain wire shall be minimum 22AWG.

For each radar detector, provide sufficient cable to run from the sensor cable junction box mini to the cabinet interface device inside the signal controller cabinet. Provide 15 feet of neatly coiled slack cable in the base of the signal controller cabinet foundation. Provide sufficient slack at the pole so the in-line terminal enclosure can be pulled out of the handhole for maintenance work.

- g. Sensor Cable Junction Box Mini. For each radar detector, provide a sensor cable junction box mini to provide a connection between the sensor's pigtail cable and home run cable.
- h. Support. The SBD and CTAD manufacturer shall provide both training and technical support services.
  - (1) Training. The manufacturer-provided training shall be sufficient to fully train installers and operators in the installation, configuration, and use of the SBD to ensure accurate SBD performance.
  - (2) Technical Assistance. A manufacturer-provided technical representative shall be available to assist with the physical installation, alignment, and configuration of each supplied SBD and CTAD. Technical support shall be provided thereafter to assist with troubleshooting, maintenance, or replacement of SBDs or CTADs should such services be required.
  - (3) Documentation. SBD and CTAD documentation shall include an instructional training guide, a comprehensive user guide, as well as an installer quick-reference guide and a user quick-reference guide. The SBD and CTAD manufacturer shall supply the following documentation and specification test results at the time of the bid submittal:
    - iii. FCC CFR 47 certification
    - iv. IEC 61000-4-5 class 4 test report

8. Pan-Tilt-Zoom (PTZ) Camera. Furnish an Axis Q6010-E Camera with the following specifications:
  - a. Furnish an Axis Q6010-E 60 Hz Camera with the following specifications:

- (1) Micro SDXC card with a capacity of 1TB and speed class U3 or V30

- b. Furnish an Axis Q6075-E PTZ Dome network camera 60Hz camera with the following specifications:

- (1) Power with Axis High PoE midspan 1-port 100-240 V AC, max 60 W.
- (2) Micro SDXC card with a capacity of 1TB and speed class U3 or V30.

- c. Include T91 mounting accessories.

**740-2.14 VEHICULAR SIGNAL HEADS.** Provide Light Emitting Diode, (LED) Signal Heads that conform to the following publications:

- Circular Indications: *Vehicle Traffic Control Signal Heads: Light Emitting Diode (LED) Circular Signal Supplement*, 6/27/05 (ITE Publication ST-052). This is hereafter referred to as "VTC SH-Circular-05".

- Arrow Indications: *Vehicle Traffic Control Signal Heads – Light Emitting Diode (LED) Vehicle Arrow Traffic Signal Supplement*, 7/1/07 (ITE Publication ST-054). This is hereafter referred to as “VTCSH-Arrow-07”.

“The applicable ITE Specification”, as used in this specification, means VTCSH-Circular-05 for circular LED indications and VTCSH-Arrow-07 for arrow LED indications.

# 1. Signal Heads.

Use signal heads that: are the adjustable, vertical type with the number and type of lights specified; provide a light indication in one direction only; are adjustable through 360 degrees about a vertical axis; and are mounted at the location and in the manner shown on the Plans. Ensure that all vehicular signal heads at any one intersection, except for programmed visibility signal heads, are of the same make and type.

## Programmed Visibility Signal Heads.

- Indications provide a nominal 12 inch diameter circular or arrow indication. Meet the VTCSH requirements for color and arrow configuration.
  - Provide each section with a 1 inch cutaway visor.
  - Provide each signal section with an adjustable connection that permits incremental tilting from 0 to 10 degrees above or below the horizontal while maintaining a common vertical axis through couplers and mounting axis in 5 degree increments.
  - The signal must be mountable with ordinary tools and capable of being serviced without tools. Preset the adjustment at 4 degrees below the horizontal.
  - The visibility of each signal face must be capable of adjustment or programming within the face. When programmed, each signal face's indication must be visible only in those areas or lanes to be controlled. During dusk and darkness, a faint glow to each side will be permissible.
  - Program the head as recommended by the manufacturer and as directed by the Engineer.
- Provide a removable aluminum tunnel visor with an open slot at the bottom for each optical unit.

Furnish housing, backplates and visors factory finished with a single coat of environmentally safe, ultraviolet-resistant, polyester powder coating that is applied electrostatically at 90kV and baked for 20 minutes at 400 degrees Fahrenheit per ASTM D3359, ASTM D3363 and ASTM D522. Coating to be a Dull Black finish meeting AMS-STD-595 color number 37038.

- LED Optical Units. Use LED optical units and lenses meeting the requirement of the applicable ITE specification for all indications. Also meet the following requirements:
  - Gaskets. Use one-piece EPDM (ethylene propylene rubber) gaskets to seal LED modules.
  - Markings. Provide LED Signal module with manufacturer applied markings listed in Section 3.6, Module Identification, of the applicable ITE Specification. For circular indications marking shall include: “Manufactured in conformance with the ITE Vehicle Traffic Control Signal Heads: LED Vehicle Circular Traffic Signal Supplement (June 27, 2005).” For arrow indication markings shall include: “Manufactured in conformance with the ITE Vehicle Traffic Control Signal Heads: LED Vehicle Arrow Traffic Signal Supplement (July 1, 2007).”
  - Compatibility. Use LED signal modules that are operationally compatible with currently used controller assemblies (solid state load switches, flashers, and conflict monitors).
  - Testing Requirements.
    - All LEDs Functional. LED modules with any non-functioning individual LEDs at the final inspection will be rejected.
    - Burn-in. Manufacturer shall energize each new LED module for a minimum of 24 hours at operating voltage before shipment to ensure electronic component reliability.



- (c) Production Testing and Inspection. Submit manufacturer's certification that all tests in Section 6.3 of the applicable ITE Specification have been successfully completed on each LED module to be used on the project.

Show results of each individual test on the certification.

- (d) Design Qualification and Quality Assurance Testing by an Independent Lab. Have ETL/Intertek or other approved OSHA "Nationally Recognized Testing Laboratory" do the following:

- i. Perform an initial assessment of the manufacturer's factory, engineering and manufacturing systems, and procedures to confirm compliance with ISO 9000.
- ii. Perform initial Design Qualification Testing as specified in Section 6.4 of the applicable ITE specification.
- iii. Every 6 months, conduct a factory inspection and perform Quality Assurance Tests on two samples of each certified LED module in accordance with the following sections of the applicable ITE specification:

*6.4.2 Conditioning*

*6.4.4.1 - 6.4.4.4 Luminous Intensity*

*6.4.4.6 Chromaticity*

*6.4.6.1 Current Consumption*

*6.4.6.6 Power Factor*

*6.4.6.7 Total Harmonic Distortion*

- iv. Provide a certification label on each certified LED traffic signal module verifying the manufacturer's factory and modules passed the tests listed in a. through c. above.

- (5) Warranty. Provide written warranty by the signal module manufacturer that covers defects in materials, workmanship, and compliance with the applicable ITE specification for a period of 60 months after the manufacture date. No new LED module will be accepted if its manufacture date is more than 12 months before the date of installation. Begin warranty period for modules that replace failed modules on the date of installation.

The warranty shall require the manufacturer to replace LED modules that fail within the warranty period with new LED modules at no cost to the Department, and to cover the cost of shipping failed modules. The warranty does not include the cost of removing failed modules or reinstalling new modules. Warranty shall require the manufacturer to send the Department prepaid authorization to return the failed module and provide a toll free telephone number for notifying them when it becomes necessary to return failed LED modules.

The warranty shall require the manufacturer to deliver replacement LED modules within 5 working days of receiving failed modules to the location specified by the Department.

- b. Lens. Use only clear lenses for all green signal modules. Use lenses that meet the requirements of the applicable ITE Specification.

- c. Housing.

- (1) Use die cast aluminum, meeting ASTM B85, for all parts of the housing, including the doors and end plates. Ensure all parts are clean, smooth, and free from flaws, cracks, blow holes, or other imperfections.
- (2) Use a one-piece housing with integral top, bottom, sides, and with square doors, for each signal section.

- (3) Use stainless steel for all exposed bolts, screws, hinges, pins, and door-locking devices. Use stainless steel or approved non-ferrous, corrosion-resistant material for all interior screws and fittings.
  - (4) Provide an opening in the top and bottom of each housing to accommodate standard 1-1/2 inch pipe fittings and brackets.
  - (5) Provide the top and bottom openings of each housing with integral serrated bosses that will provide positive positioning of the signal head in 5-degree increments to eliminate undesirable rotation or misalignment of the signal head as well as between sections. Provide a total of 72 teeth in the serrated boss. Ensure teeth are clean and sharp to provide positive position with the grooves of the mating section or framework.
  - (6) Fasten individual signal sections together with a cadmium-plated tri-stud connector, lock washers, and nuts with access holes for the passage of electrical conductors from one section to another.
  - (7) Provide 2 integral hinge lugs on the left side of each signal housing for mounting the door.
  - (8) Provide 2 latches with stainless steel wing nut assemblies on the right side of each signal housing to engage the door latches.
  - (9) Provide each signal housing door opening with a one-piece EPDM gasket around the periphery to provide a weather tight seal in a NEMA Type 3R enclosure.
  - (10) Provide a round opening designed to accommodate any standard traffic signal lens in each signal housing door.
- d. Backplates. Backplates shall not be louvered. Install backplates around vehicular signal faces except post mounted flashers. Furnish backplates constructed of 0.100 inch minimum thickness aluminum alloy sheet meeting ASTM B209, alloy 3003-H14. For those backplates fabricated from 2 or more pieces of sheeting, furnish them fastened together with 3/16" aluminum rivets or bolts peened after assembly.

Furnish 3 inch wide backplates regardless of where the signals are installed, on mast arms, on top of posts, or on the sides of poles.

Use "d." above for signals outside MOA, use "d." below for signal within the MOA. Delete the other.

- d. Backplates. Backplates shall not be louvered. Install backplates around vehicular signal faces except post mounted flashers. Furnish backplates constructed of 0.063 inch minimum thickness aluminum alloy sheet meeting ASTM B209, alloy 3003-H14. For those backplates fabricated from 2 or more pieces of sheeting, furnish them fastened together with 3/16" aluminum rivets or bolts peened after assembly.
- Furnish 5 inch wide backplates regardless of where the signals are installed, on mast arms, on top of posts, or on the sides of poles.
- e. Signal Mounting Hardware: Furnish elevator plumbizers, elbow pipe fittings, and post top adapters (without a terminal compartment) with integral serrated contacts that feature 72 teeth. Provide signal heads that will be mounted on mast arms or pipe tenons with ferrous or bronze elevator plumbizers.

For signal faces installed on the sides of poles, furnish signal frames that consist of watertight assemblies of 1 1/2 inch nominal diameter standard steel pipe, malleable iron or brass pipe fittings, and bronze terminal compartments. The side of the terminal compartment opposite the door shall feature a saddle shape for wobble free mounting on round poles and include a cable guide and two holes for mounting the compartment.

Furnish vehicular signal frames with a horizontal dimension between the center of the terminal compartment and the axis of the adjacent signal face of 22 inches in side mounted frames and 11 inches on double headed post top installations.

Post top adapters shall slip fit over 4 inch nominal standard pipe and feature two rows of three cadmium plated steel setscrews. Furnish post top adapters with terminal compartments, except one way signal heads may be installed on adapters without a terminal compartment provided the adapters include offset openings. Post top adapters without a terminal compartment or compartments - provide manufactured of bronze metal.

Furnish terminal compartments with a terminal block containing 12 poles, each with two screw type terminals. Each terminal must accommodate at least three 14 AWG conductors. Provide terminal compartments with a rain tight door that provide ready access to the terminal block.

For mounting each terminal compartment, furnish (2) 1/2" x 13 hot dip galvanized bolts that conform to ASTM A325 and (2) 1/2" hot dip galvanized washers that conform to ASTM F 436.

When replacing signal heads include all mounting hardware, backplates and visors.

- f. Finish. Factory finish housing, brackets, fittings, backplates, and visors, each face, with a single coat of environmentally safe, ultraviolet-resistant, polyester powder coating that is applied electrostatically at 90kV and baked for 20 minutes at 400 degrees Fahrenheit per ASTM D-3359, ASTM D-3363, and ASTM D-522. Coating to be a Dull Black finish meeting AMS-STD-595 color number 37038.

**740-2.15 PEDESTRIAN SIGNALS.** Use LED Pedestrian Countdown modules that use the international "HAND/WALKING PERSON" symbols. Except for the countdown indication and as otherwise noted in this specification, use modules that conform to "Pedestrian Traffic Control Signal Indications - Part 2: Light Emitting Diode (LED) Pedestrian Traffic Signal Modules" Institute of Transportation Engineers, 3/19/2004, (hereafter referred to in this document as "PTCSI-04") and to the applicable Sections of the current Alaska Traffic Manual.

Provide pedestrian signal heads according to the following:

1. Pedestrian Signal Modules: Provide Portland Orange "HAND" and "COUNTDOWN DIGITS" and lunar white "WALKING PERSON." Locate COUNTDOWN DIGITS adjacent to the associated UPRAISED HAND. Make "HAND" and "WALKING PERSON" symbols a minimum of 11 inches high and 7 inches wide and COUNTDOWN DIGITS a minimum of 9 inches high and 7 inches wide. Provide incandescent looking WALKING PERSON, HAND and COUNTDOWN DIGITS. Ensure the WALKING PERSON, UPRAISED HAND and COUNTDOWN DIGITS are not readily visible when not illuminated. Provide "AlInGaP" Portland Orange LEDs or equivalent, rated for 100,000 hours or more at 77°F and 20 mA. Provide "InGaN" White LEDs.

Make all exposed components of modules suitable for prolonged exposure to the environment, without appreciable degradation that would interfere with function or appearance.

Provide modules with an installed gasket to seal the junction with the signal housing.

- a. Lens. Use modules with internal masks to prevent the icons and digits from being visible when not in operation. No external silk-screen is permitted. Provide a smooth or textured lens of transparent polycarbonate material, frosted to prevent sun phantom. Use lenses that will not crack, craze or yellow due to solar UV exposure typical for a south-facing Arizona desert installation, after a minimum of 60 months in service.
- b. Retrofit. When a module will replace an existing module in an existing signal housing, furnish signal modules designed as retrofit replacements for existing neon type pedestrian signals (ICC 4090 and/or 4094). Provide modules that do not require special tools for installation. Provide modules that fit securely into existing pedestrian signal housings without any modification to the housing, connect directly to existing electrical wiring, and form a weather-tight seal. Provide modules and components constructed so each retrofit of existing pedestrian signals only requires the removal of the existing neon message module, gasket, and power supply and installation of

the new LED pedestrian countdown module. Provide all necessary components to complete conversion including a one piece gasket.

c. Photometric Requirements. Meet the following requirements:

- (1) Minimum Luminance. Maintain the following minimum luminance values for at least 60 months, under the operating conditions defined in Sections 3.3.1 and 5.2.1 of PTCSI-04 (when measured normal to the plane of the icon surface):
  - (a) WALKING PERSON 2,200 cd/m<sup>2</sup>,
  - (b) UPRAISED HAND 1,400 cd/m<sup>2</sup>,
  - (c) DIGITS 1,400 cd/m<sup>2</sup> (when "88" is displayed).
- (2) Maximum Luminance. Provide modules for which the actual luminance of a module does not exceed three times the minimum maintained luminance, as defined in Section 4.1.1 of PTCSI-04, when operated within the temperature range -40°F to +165°F
- (3) Uniformity: Provide modules for which the uniformity of the signal output across the emitting section of the module lens (i.e. icons or digits) does not exceed a ratio of 5 to 1 between the maximum and minimum luminance values as measured in 0.5 in. diameter spots.
- (4) Markings. Permanently mark the back of each LED signal module with:
  - (a) Manufacturer's name, trademark, and other necessary identification
  - (b) Warranty information
  - (c) Rated voltage and power consumption in volt-amperes
  - (d) An up arrow or the word "UP" or "TOP" for orientation within a signal housing.

d. Electrical. Provide LED pedestrian countdown signal modules that:

- (1) Are operationally compatible with currently used controller assemblies (solid state load switches, flashers, and conflict monitors).
- (2) Have a maximum of 4 each secured, color coded, 36 inches long, 600V, 18 AWG minimum, jacketed wires, conforming to the National Electrical Code, rated for service at +221°F for electrical connection.
- (3) Operate from a 60 ±3 Hz AC line over a voltage range of 80 VAC to 135 VAC. Test voltage for all photometric performance measurements shall be 120 ±3 volts rms.
- (4) Use LED circuitry that prevents perceptible flicker over the voltage range specified above.
- (5) Include voltage surge protection against high-repetition noise transients and low-repetition noise transients as stated in Section 2.1.8, NEMA Standard TS-2, 2003. Module must meet the following test requirements: Section 8.2 IEC 1000-4-5 & Section 6.1.2 ANSI/IEEE C62.41.2, 3kV, 2 ohm and Section 8.0 IEC 1000-4-12 & Section 6.1.1 ANSI/IEEE C62.41.2, 6kV, 30 ohm.
- (6) Have a current draw sufficient to ensure compatibility and proper triggering and operation of load current switches and conflict monitors in signal controller units. When the module is switched from the On state to the Off state the terminal voltage shall decay to a value less than 10VAC RMS in less than 100 milliseconds when driven by a maximum allowed load switch leakage current of 10 milliamps peak (7.1 milliamps AC).

- (7) Have a maximum power consumption at 77°F of: Hand 11.0 watts, Walking Person 10.0 watts, Digits 8.0 watts (when display shows "88")
- (8) Have waterproof strain relief and anti-capillary wires or have electrical wires that do not penetrate the LED module housing. This is intended to prevent water seepage between the back cover and the electrical wires, or between the copper and insulation of the wires (Connection may be made by use of an over molded connector).
- (9) Will default to the hand symbol for abnormal conditions when nominal voltage is applied to the unit across the two phase wires (rather than being applied to the phase wire and the neutral wire).
- (10) Have three separate power supplies: one each for the Walking Person, the Upraised Hand and the countdown digits. Use separate circuitry to power the LED Walking Person icon and the LED Upraised Hand icon, in order to virtually eliminate the risk of displaying the wrong icon.

e. Testing Requirements.

- (1) All LEDs Functional. LED modules with any non-functioning individual LEDs at the final inspection will be rejected.
- (2) Burn-in. Manufacturer shall energize each new LED module for a minimum of 24 hours at operating voltage before shipment to ensure electronic component reliability.
- (3) Production Testing and Inspection by Manufacturer. Submit manufacturer's certification that all tests in Section 6.3 of PTCSI-04 have been successfully completed on each LED module to be used on the project. Show result of each individual test on the certification.
- (4) Design Qualification and Quality Assurance Testing by an Independent Lab. Have ETL/Intertek or other approved OSHA "Nationally Recognized Testing Laboratory" do the following:
  - (a) Perform an initial assessment of the manufacturer's factory, engineering and manufacturing systems, and procedures to confirm compliance with ISO 9000.
  - (b) Perform initial Design Qualification Testing as specified in Section 6.4 of the PTCSI-04.
  - (c) Every 6 months, conduct a factory inspection and perform Quality Assurance Tests on two samples of each certified LED module in accordance with the following sections of PTCSI-04:
    - 6.4.2 Conditioning
    - 6.4.4.1 - 6.4.4.4 Luminous Intensity
    - 6.4.4.6 Chromaticity
    - 6.4.6.1 Current Consumption
    - 6.4.6.6 Power Factor
    - 6.4.6.7 Total Harmonic Distortion
  - (d) Provide a certification label on each certified LED traffic signal module verifying the manufacturer's factory and modules passed the tests listed in a. through c. above.
- f. Warranty. Provide a manufacturer's written warranty that covers defects in materials, workmanship, and compliance with PTCSI-04 for a period of 60 months after the manufacture date. No new LED module will be accepted on a project if its manufacture date is more than 12 months before the date of installation. Begin warranty period for modules that replace failed modules on the date of installation.

The warranty shall require the manufacturer to replace LED modules that fail within the warranty period with new LED modules at no cost to the Department, and to cover the cost of shipping failed modules. The warranty does not include the cost of removing failed modules or reinstalling new modules. Warranty shall require the manufacturer to send the Department prepaid authorization to return the failed module and provide a toll free telephone number for notifying them when it becomes necessary to return failed LED modules.

The warranty shall require the manufacturer to deliver replacement LED modules within 5 working days of receiving failed modules to the location specified by the Department.

g. Countdown Module Functions.

- (1) General. Begin the countdown at the beginning of the FLASHING HAND indication. End the countdown at "0" at the end of the FLASHING HAND indication. Make the countdown display dark from the end of one FLASHING HAND indication until the beginning of the next. Display steady, not flashing, countdown digits. Do not provide user accessible switches, controls, or options that would allow modification of cycle time, icons, digits or that would allow the countdown to operate while the WALKING PERSON or STEADY HAND is displayed.
- (2) Learning Cycle. At power on, make the countdown display dark for one learning cycle in which it will determine the duration of the FLASHING HAND indication.
- (3) Normal Operation. Display the countdown/FLASHING HAND for the duration measured in the learning cycle for every cycle until the module measures a different FLASHING HAND duration.
- (4) Countdown Duration Modification. When a different duration is measured, make the countdown dark for the next cycle, and enter a Learning Cycle as previously described. Resume Normal Operation with the new FLASHING HAND duration if the measured FLASHING HAND duration for the next cycle is the same as for the first cycle when a change was detected. Continue Learning Cycles, if the duration is different, until the measured FLASHING HAND duration is the same for two cycles. Resume Normal Operation with the new duration when that happens.
- (5) Countdown Truncation. Make the digits dark if the controller output displays a STEADY HAND or if both the HAND and WALKING PERSON go dark, regardless of whether the countdown to zero has been completed.
- (6) Preemption. Handle preemption events as described under Countdown Duration Modification and, if necessary, Countdown Truncation.
- (7) Recycling. Allow for consecutive cycles without display of the STEADY HAND.
- (8) Power Outage. Maintain an uninterrupted countdown during short power failures (<1.5 seconds). Make the digits dark after a loss of power of more than 1.5 seconds and enter a Learning Cycle when the power is restored.

2. Housing

- a. Provide signal housings that have a maximum overall dimensions of 18-1/2 inches wide, 18-3/4 inches high, and 9 inches deep.
- b. Provide a dustproof and weatherproof housing that allows easy access to and replacement of all components.
- c. Provide a one-piece, corrosion-resistant, aluminum-alloy die-cast case complete with integrally cast top, bottom, sides and back. Provide 4 integrally cast hinge lug pairs, 2 at the top and 2 at the bottom of each case, for operation of a swing-down door.



d. Provide 1 of the following 3 versions of the case, according to project specifications:

- (1) Clamshell mount, with hardware, for "pole left of message" installation. These need not include upper and lower openings, but when provided the openings must be plugged to be weather-tight. No other openings are allowed. Clamshell mounting bracket shall be capable of swinging open more than 90 degrees when mounted on a pole.
- (2) Clamshell mount, with hardware, for "pole right of message" installation. These need not include upper and lower openings, but when provided the openings must be plugged to be weather-tight. No other openings are allowed. Clamshell mounting bracket shall be capable of swinging open more than 90 degrees when mounted on a pole.
- (3) Make suitable for either post top or bracket mounting with upper and lower openings to accommodate standard 1-1/2 inch pipe brackets. Plug unused openings to be weathertight. This case is only allowed when called for in the plans. Integrally cast a shurlock boss into the bottom opening of the signal case. Make the dimensions of the shurlock boss as follows: outside diameter, 2-5/8 inch; inside diameter, 1-31/32 inch; number of radial teeth, 72; and depth of teeth, 5/64 inch. Use clean and sharp teeth that provide full engagement to eliminate rotation or misalignment of the signal.

e. Make the door frame a one-piece, corrosion-resistant, aluminum-alloy die-casting, complete with 2 hinge lugs cast at the bottom and 2 latch slots cast at the top of each door. Attach the door to the case by means of two Type 304 stainless steel spring pins. Attach 2 stainless steel hinged bolts with captive stainless steel wing nuts and washers to the case with the use of stainless steel spring pins. Provide a door that will latch and unlatch without the use of tools.

3. Conductors: Meet IMSA specifications 20-1 with No. 14 AWG or larger.
4. Load Switches: Place all load switches for operation of pedestrian signals in the controller cabinet.
5. Fasteners. Use machine screws, studs, and washers that are stainless steel.
6. Gaskets: Use gaskets that conform to ASTM D1056, Grade 2C2.
7. Terminal Blocks: Provide a rain tight terminal compartment with a 12 position terminal block.

Use "7." above for signals outside MOA, use "7." below for signal within the MOA. Delete the other.

7. Terminal Blocks: Provide a rain tight terminal compartment with a 3 position terminal block.
8. Finish. Factory finish the outside of pedestrian signal head housings and visors and signal visor interiors with a single coat of environmentally safe, ultraviolet-resistant, polyester powder coating that is applied electrostatically at 90kV and baked for 20 minutes at 400 degrees Fahrenheit per ASTM D3359, ASTM D3363 and ASTM D522. Coating to be a Dull Black finish meeting AMS-STD-595 color number 37038.

**740-2.16 PEDESTRIAN PUSH BUTTONS.** Push buttons shall be Tamper proof with a 2 inch minimum diameter convex 316 stainless steel actuator button.

Construct a weatherproof assembly designed to prevent an electrical shock under any weather condition and grounded per the NEC.

Push Button Switch. Furnish Polara model RBDL3-B-4H or approved equal with the following features. Provide a solid state electronic piezo type, switching unit, with screw type terminals, rated 15 amperes at 125 VAC. Must have the following characteristics:

1. Switching unit that is solid state electronic piezo rated for 100 million cycles.
2. Sealed to prevent ice from impeding function.

3. Must hold the call for a minimum of 5 seconds.
4. Switch operating force of 3 pounds or less with no moving plunger or moving electrical contacts.
5. Provide an LED indication and an audible tone or beep within the button when pushed, at a minimum 68 db. at 1 meter.
6. Must have a raised rim or ridges to protect the button from side impacts.
7. Powder coated cast switch housing.

Where a pedestrian push button is to be mounted on top of a 2-1/2 inch diameter post, provide the housing with a slip-fitter with screws for securing to the post.

Factory finish pedestrian push button housings, mountings, brackets, and fittings with 2 coats of dull black enamel or powder coat. Painting/powder coating is not required where the color is an integral part of the component material.

**740-2.17 FLASHING BEACONS.** Furnish beacons that consist of one or more traffic signal sections meeting the requirements of Subsection 740-2.14 Vehicular Signal Heads. See the Plans for the number, size and color of the signal sections required for each beacon.

Use the flasher in signal controller cabinets to energize beacons that flash continuously and are installed near traffic signals. Otherwise, each flashing beacon controller assembly consists of the following 120 VAC equipment housed in a NEMA 3R enclosure: a circuit breaker, a radio interference suppressor, a transient voltage suppressor, a NEMA Type 3 flasher, neutral and ground busses, and terminal blocks. The cabinet assembly shall contain a thermostatically controlled incandescent cabinet light with a door activated bypass switch. The cabinet light fixture shall be an incandescent type porcelain lamp holder rated for 660W-250V AC/CA. the lamp shall be 75W.

Controller assemblies for school zone speed limit sign beacons shall also include a time switch.

The NEMA 3R enclosure shall feature a hinged door. Hinge shall run the full length of the enclosure and shall be attached to the left side of cabinet. The door locking mechanism shall contain a Best CX series lock with a Best blue construction core lock. Provide two keys for lock.

The AC transient voltage and radio interference suppressors shall meet the requirements of Subsections 740-2.11.1.k. (3) and (4), respectively.

Use a solid state NEMA Type 3 flasher meeting the requirements of NEMA Standard TS 1-1989, Traffic Control Systems.

Use 20 ampere, 600 volt barrier type phenolic terminal blocks with plated brass screw type terminals. Field wiring termination blocks shall be sized to accept No. 8 AWG conductors. Power feed termination block shall be a single three (3) position box lug type terminal block capable of accepting up to No. 6 AWG conductors for terminating power feed cable.

Furnish an RTC Manufacturing model AP22 time switch complete with wiring harness, or an approved, calendar programmable, solid state time switch with liquid crystal display, keyboard, input/output port, and wiring harness. The approved time switch shall:

1. Operate on line voltages from 95 to 135 VAC, operate in temperatures from -22° F to 165° F, and include a capacitor that provides 48 hours of backup power to retain programming and time when the unit is disconnected from AC voltage.
2. Include a backlit display and provide 2 lines of alphanumeric legend with 16 characters per line. The display shall automatically prompt the operator while programming the device through the keyboard for ease of use.
3. Include an input/output port and keyboard activated special functions that transfer the program to other units and download the program to a printer for a hard copy record of the program.
4. Automatically compensate for changes in Daylight Savings Time and leap years and include a keyboard activated special function to quickly change the dates for the begin and end of Daylight Savings Time.



5. Provide at least 10 basic plans for daily and/or weekly use and at least 200 program steps that are equally divided amongst the actual number of basic plans. Each program step shall be assignable to a single day, weekend, weekday, or every day. The time switch shall also include 20 plans that activate the basic plans to provide one year of time based control.
6. Include 2 single pole double throw, relay controlled outputs rated for 15 amperes of resistive load at 115 VAC. Each pole shall be independently activated for steady on or momentary on and be manually switched on through the keyboard.
7. Provide a 9 pin RS232 serial I/O port connector on the unit for programming via laptop, Ethernet, or cellular.

When a signal controller cabinet flasher is used to energize a beacon, furnish a two pole, fused block with built in fuse pullers to protect the flasher. Furnish third party certified blocks that hold 13/32" x 1-1/2" midget ferrule fuses, are rated for 30 amperes, and feature tubular screw terminals that accommodate conductors to 8 AWG. Furnish blocks with two fast acting, 3 ampere (BAF-3) fuses, and flat bases that can be directly mounted on a dead panel.

**740-2.18 LUMINAIRES.** Furnish roadway and intersection luminaires that conform to the following specifications and provide the light distributions specified. When luminaire performance criteria are specified, luminaires shall also:

1. Meet or exceed the minimum initial light levels indicated.
2. Provide light distribution uniformity ratios and veiling luminance ratios equal to or less than the maximums indicated.

When luminaire performance criteria are specified, submit the following information for each luminaire type and light distribution type specified: luminaire specifications, the lumen output of the lamps that will be furnished, and current electronic photometric data to the Engineer for approval. Furnish the photometric data in Illuminating Engineering Society (I.E.S.) format. The Engineer will use software that calculates light levels and uniformity ratios according to the American National Standard Practice for Roadway Lighting, A.N.S.I./I.E.S. RP-8 to verify each luminaire provides the light levels, uniformities, and veiling luminance ratios specified.

When cut off distributions are specified, furnish luminaires with flat glass lenses (when used) and a full cutoff light distribution as defined in the American National Standard Practice for Roadway Lighting, A.N.S.I./I.E.S. RP-8, dated 2014.

Furnish each luminaire with a high pressure sodium lamp or LED of the wattage specified and matching ballast with an input voltage equal to circuit voltage. [Provide at least 2 but preferably 3 proven fixture options from different lighting manufacturers for each type of luminaire.](#)

The following luminaires are proven to meet A.N.S.I./I.E.S. RP-8-14 light levels, uniformities, and veiling luminance ratios as specified in the plans, but are still subject to verification:

1. Roadway luminaire
  - a.
2. Intersection luminaire
  - a.

#### Luminaires General

Install luminaires that feature:

- a. Corrosion resistant enclosures with gray painted finish, cooling elements not required to be painted, and space for the ballast.
  - (1) Painted or finished luminaire surfaces exposed to the environment shall exceed a rating of six (6), after 1,000 hours or four (4) of 5,000 hours salt spray test according to ASTM D1654 and ASTM B117 testing. The coating shall exhibit no greater than 30% reduction of gloss.

according to ASTM D523, after 500 hours of ASTM G154 Cycle 6 QUV® accelerated weathering testing.

- b. All luminaires shall have ANSI C136.15 external labels and ANSI C136.22 internal labels. The luminaire shall be listed for wet locations by a nationally recognized testing laboratory (NRTL) as defined by OSHA and shall be in compliance with UL 8750 and UL 1598. It shall be identified as such by a tag/sticker on the inside of the luminaire.
- c. All hardware shall be stainless steel or suitably corrosion resistant to match the 20-year expected life of the fixture. Captive screws are required on any component that requires maintenance after installation.
- d. Glass lenses, unless polycarbonate resin refractors are specified.
- e. Terminal blocks for attaching the illumination tap conductors.
- f. Aluminum reflectors with an ALZAK or ALGLAS finish when using HPS fixtures.
- g. Optical components free of substances that affect photometric performance, paint.
- h. Housings cast with no provision for a photoelectric control receptacle.
- i. For HPS fixtures; airtight reflector and lens units that breathe through activated charcoal filters and include elastomer gaskets to seal the gap between the two components, gasket material must withstand the temperatures involved and be securely held in place.
- j. For HPS fixtures include plug in starting aids with lamps through 400 watts.

1. Luminaires – High Pressure Sodium; Cobrahead and Offset/Turnpike.

Furnish HPS fixtures that feature a rated life of 40,000 hours based on 10 hours per start and ballasts that conform to Subsection 740-2.21. Each cobrahead or offset luminaire shall also include:

- a. An easily removed hinged door used exclusively for mounting the ballast.
- b. A second door that frames the lens (for HPS), hinges on the house side, and fastens on the street side with an automatic type latch.
- c. A two (2) or four (4) bolt mounting brackets that is designed to fit a 2-inch nominal diameter standard pipe and feature a center pivot for leveling the luminaire.

Offset luminaires shall also include knuckle style pole top adapters that are sized to fit 2 inch nominal diameter standard pipe and feature a wire way meeting NEC requirements for installing three size 10 AWG conductors between the pole and the terminal block located in the luminaire.

2. Luminaires – LED.

- a. General. The luminaire shall be assembled in the United States and shall be assembled by and manufactured by the same Manufacturer. For easy removal, quick-connect/disconnect plugs shall be supplied between the discrete electrical components within the luminaire such as the driver, surge protection device, and optical assembly. The quick-connect/disconnect plugs shall be operable without the use of tools and while insulated gloves are worn. The luminaire shall be in compliance with ANSI C136.37 LED light source(s), and driver(s) shall be compliant with the Restriction of Hazardous Substances (RoHS) Directive 2011/65/EU.

- (1) Manufacturer Experience. The luminaire shall be designed to be incorporated into a lighting system with an expected 20-year lifetime. The luminaire Manufacturer shall have a minimum of 20 years' experience manufacturing high-intensity discharge (HID) roadway luminaires and shall have a minimum of 5 years' experience manufacturing LED roadway luminaires. The Manufacturer shall have a minimum of 5,000 total LED roadway luminaires installed on a minimum of 30 separate installations, all within the United States.

- b. Housing. The housing shall be designed to ensure maximum heat dissipation and to prevent the accumulation of water, ice, dirt, and debris. A passive cooling method with no moving or rotating

parts shall be employed for heat management. The effective projected area of the luminaire shall not exceed 1.2 sq. ft. The total weight of the luminaire(s) and accessories shall not exceed 55 lb.

- c. Optical Assembly. The LED optical assembly, consisting of LED packages, shall have a minimum ingress protection rating of 66 (IP66) as defined in ANSI/IEC 60529. Circuiting shall be designed to minimize the impact of individual LED failures on the operation of the other LEDs.

The optical assembly shall utilize high-brightness, long-life LEDs with a minimum color rendering index (CRI) of 70, 3000 K (+/- 200 K) color temperature, and binned according to ANSI C78.377. Lenses shall be UV-stabilized acrylic or glass. Provisions for house-side shielding shall be specified along with means of attachment.

Lumen depreciation at 50,000 hours of operation shall not exceed 15% of initial lumen output at the specified LED drive current and an ambient temperature of 77°F (25°C).

The assembly shall have individual serial numbers or other means for Manufacturer tracking.

- (1) Photometric Performance Testing. Luminaires shall be tested according to IES LM-79. The laboratory performing this test shall hold accreditation from the National Voluntary Laboratory Accreditation Program (NVLAP) under NIST. Submitted reports shall have a backlight, uplight, and glare (BUG) rating according to IESNA TM-15, including a luminaire classification system graph with both the recorded lumen value and percent lumens by zone.

Lumen maintenance shall be measured for the LEDs according to LM-80, or when available for the luminaires according to LM-84. The LM-80 report shall be based on a minimum of 6000 hours; however, 10,000-hour reports shall be provided for luminaires in cases in which tests have been completed.

Thermal testing shall be provided according to UL 1598. The luminaire shall start and operate in the ambient temperature range specified. The maximum rated case temperature of the driver, LEDs, and other internal components shall not be exceeded when the luminaire is operated in the ambient temperature range specified.

Mechanical design of protruding external surfaces such as heat sink fins shall facilitate hose-down cleaning and discourage debris accumulation. Testing shall be submitted when available to show that the maximum rated case temperature of the driver, LEDs, and other internal components are not exceeded when the luminaire is operated with the heat sink filled with debris.

- (2) Calculations. Complete point-by-point luminance and veiling luminance calculations as well as listings of all indicated averages and ratios as applicable shall be provided according to IES RP-8 recommendations. Lighting calculations shall be performed using AGI32 software with calculations performed to two decimal places (i.e., x.xx cd/m<sup>2</sup>). Calculation results shall demonstrate that the submitted luminaire meets the lighting metrics specified in the plans. Scotopic or mesopic factors will not be allowed.

- (3) Lumen Maintenance Projection. The LEDs shall have long-term lumen maintenance documented according to IESNA TM-21, or when available for the luminaires according to IESNA TM-28. The submitted calculations shall incorporate an in situ temperature measurement test (ISTMT) and LM-80 data with TM-21 inputs and reports according to the TM-21 calculator, or when available an ISTMT and LM-84 data with TM-28 inputs and reports according to the TM-28 calculator. Ambient temperature shall be 77°F (25°C).

- d. Driver. The driver for the luminaire shall be integral to the unit. It shall be mounted in the rear of the luminaire on the inside of a removable door or on a removable mounting pad. The removable door or pad shall be secure when fastened in place, and all individual components shall be secured upon the removable element. Each component shall be readily removable from the removable door or pad for replacement.

The driver shall be installed in a manner to keep it mechanically separated from the LED array heat sink.

- (1) Circuit Protection. The driver shall tolerate indefinitely open and short-circuit output conditions without damage.
  - (2) Ingress Protection. The driver itself shall have an IP65 or IP66 rating, not the housing. Do not gasket the driver door or seal in order to prevent condensation and allow for draining.
  - (3) Input Voltage. The driver shall be suitable for operation over a range of 120 to 277 V or 347 to 480 V as required by the system operating voltage.
  - (4) Operating Temperature. The driver shall have an operating ambient temperature range of -40°F to 131°F (-40°C to 55°C).
  - (5) Driver Life. The driver shall provide a lifetime of 100,000 hours at an ambient temperature of 77°F (25°C).
  - (6) Safety/UL. The driver shall be listed under UL 1012 or UL 1310.
  - (7) Power Factor. The driver shall maintain a power factor of 0.9 or higher and total harmonic distortion of less than 20%.
  - (8) Driver Efficiency. The driver shall have a minimum efficiency of 90% at maximum load and a minimum efficiency of 85% for the driver operating at 50% power, with driver efficiency defined as output power divided by input power.
  - (9) Electrical Interference. The driver shall meet the electromagnetic compatibility (EMC) requirements for Class A digital devices included in the FCC Rules and Regulations, Title 47, Part 15.
  - (10) Thermal Fold Back. The driver shall reduce the current to the LED module if the driver is overheating as a result of abnormal conditions.
  - (11) Dimming. The driver shall have 0 to 10 V dimming capability.
  - (12) Leakage Current. The driver shall comply with safety standards according to IEC 61347-1.
- e. Surge Protection Device (SPD). SPD shall be labeled as Type 4 in accordance with UL 1449 and be an integral part of the luminaire. It shall provide a minimum system protection level of 10 kV, 10 kA. To protect for a 10 kV, 10 kA surge the required clamping voltage of the external metal oxide varistor (MOV) or other SPD shall be lower than 1 kV at 8 kA  $\{(10 \text{ kV} - 2 \text{ kV})/1 \text{ ohm} = 8 \text{ kA}\}$ .

The SPD shall comply with the following standards:

- (1) IEEE C62.41.1, IEEE Guide on the Surge Environment in Low-Voltage (1000 V and Less) AC Power Circuits,
- (2) IEEE C62.41.2, IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits,
- (3) IEEE C62.45, IEEE Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000 V and Less) AC Power Circuits, and
- (4) ANSI C136.2, American National Standard for Roadway and Area Lighting Equipment — Luminaire Voltage Classification.

The SPD and performance parameters shall be posted at [www.UL.com](http://www.UL.com) under category code

- f. Photoelectric Control. Furnish fixtures with a built in ANSI C136.41 7-pin twist type photo cell receptacle. Receptacles shall be provided with shorting caps.
- g. Failed Equipment and Workmanship. The luminaire and all of its components, for the term of the Contract, from initial installation through final acceptance 105-1.16, when directed, promptly replace failed equipment and repair failed workmanship.
  - (1) Negligible light output from more than 10% of the LED packages,
  - (2) Moisture inside the optical assembly,
  - (3) Driver that continues to operate at a reduced output, and/or
  - (4) Other failed conditions that do not meet specifications.
- h. Submittal Requirements. The Contractor shall submit, for approval, an electronic version of all associated luminaire IES files, AGI32 files, and the TM-21 or TM-28 calculator spreadsheet with inputs and reports associated with the project luminaires. The Contractor shall also provide an electronic version of each of the following Manufacturers' product data sheets for each type of luminaire.
  - (1) Descriptive literature and catalog cuts for luminaire, LED package, driver, and surge protection device;
  - (2) LED drive current, total luminaire input wattage, and total luminaire current at the system operating voltage or voltage range and ambient temperature of 77°F (25°C);
  - (3) Luminaire efficacy expressed in lumens per watt (lpw) per luminaire;
  - (4) Initial delivered lumens at the specified color temperature, drive current, and ambient temperature;
  - (5) Computer photometric calculation reports;
  - (6) TM-15 BUG rating report;
  - (7) Certification of Manufacturers' experience and certification that luminaires were assembled in the United States;
  - (8) Supporting documentation of compliance with ANSI standards, as well as listing requirements;
  - (9) Supporting documentation of laboratory accreditations and certifications for specified testing;
  - (10) Thermal testing documents;
  - (11) IES LM-79, LM-80 (or LM-84), and TM-21 (or TM-28) reports;
  - (12) Salt spray (fog) test reports and certification;
  - (13) Vibration characteristics test reports and certification;
  - (14) IP test reports;
  - (15) Manufacturer written warranty; and
  - (16) Luminaire installation, maintenance, and washing instructions.

### 3. Lenses.

When polycarbonate resin lenses are specified, the fabricator shall furnish certified lenses conforming to the following criteria:

- a. The lenses are molded in a single piece from virgin polycarbonate resin.
- b. The lenses are free from cracks, blisters, burns, and flow lines, and furnished with the natural molded surface.
- c. The lenses are of uniform density throughout and free from air, gas, or moisture pockets, and uncured areas.
- d. The lenses are transparent with a clear bluish tint, produced from ultraviolet stabilized resin to reduce the effects of ultraviolet radiation on their color properties.
- e. The resins used meet the requirements for the self-extinguishing classification of ASTM D 635 and feature a minimum impact strength, Izod notched of 12 foot pounds per inch when tested according to ASTM D 256, Method A, using a 1/8 inch by 1/2 inch bar molded according to ASTM recommended practice.

#### 740-2.19 SIGN LIGHTING FIXTURES.

1. Incandescent Down Light. Provide the type of sign lighting fixture, with incandescent lamp, shown on the Plans or as specified in the Special Provisions.
  - a. Hood. Cadmium plated, finished with aluminum paint, and side outlet tapped for conduit.
  - b. Reflector. Symmetrical 8-inch steel. Porcelain enameled green finish on the outside and white on the inside.
  - c. Lamp. Provide 2,900 lumen.
2. Mercury Vapor. Fully enclosed, rain-tight, dust-tight, and corrosion-resistant. Design each fixture for mounting at the bottom of the sign on an overhead sign structure as shown on the Plans. Painting of fixture is not required.
  - a. Housing. Cast aluminum alloy or other non-corrosive material conforming to the Plans. Finish all housings in a workmanlike manner with no exposed burrs or sharp edges.
  - b. Refractor. Glass having inner prisms with a smooth exposed face. Mount the refractor in a door frame assembly which is hinged to the body of the fixture and fastened with an automatic type latch.
  - c. Gaskets. Made of a material capable of withstanding the temperatures involved, and securely held in place.
  - d. Light Distribution. Light distribution over the sign face must conform to the isolux distribution patterns shown in the Plans. Accomplish light distribution entirely by refraction through the lens with no additional refractors or reflectors.
  - e. Miscellaneous. All ballasts, lampholders, lamps, terminal blocks, and necessary fuses must conform to applicable requirements of Subsection 740-2.21 or to the Plans.
  - f. Lamps. Color-improved to provide good color rendition of signs.

#### 740-2.20 ILLUMINATION CONTROL.

For each luminaire, provide a GE LightGrid™ ELWC-Cellular node. Prior to installing the nodes, the Contractor shall deliver them to Anchorage DOT&PF M&O for programming. After the nodes have been programmed, the Contractor shall retrieve and install them. For each node, attach the barcode sticker from the manufacturer to the inside of the handhole cover of the corresponding electrolier.

Include above paragraph for lighting within the MOA. Delete for all other locations.



When indicated in the plans, provide a GE LightGrid™ ELWC-Cellular node for each load center. Prior to installing the nodes, the Contractor shall deliver them to DOT&PF M&O for programming. After the nodes have been programmed, the Contractor shall retrieve and install them. For each node, attach the barcode sticker from the manufacturer to the inside of the load center door.

Otherwise, provide each load center with photoelectric controls capable of directly switching multiple lighting systems. Furnish photoelectric units designed for pole top mounting which include a slip-fitter, terminal block, and cable supports or clamps to support pole wires.

1. Photoelectric Unit. A light sensitive element connected directly to a normally closed, single-pole throw control relay without intermediate amplifications. Plug the unit into a phenolic resin twist lock receptacle set in a cast aluminum mounting bracket with a threaded base. Screen photoelectric units to prevent artificial light from causing cycling.

Use either horizontal sensing or zenith sensing type units meeting the following:

- a. A supply voltage rating of 60 Hz, 105-277 volts
- b. A maximum rated load at a minimum of 1,800 volt-amperes
- c. An operating temperature range from -40 °F to +150 °F
- d. A power consumption of less than 10 watts
- e. A unit base with a 7-pin, EEI-NEMA standard, twist-lock plug mounting

Furnish units for highway lighting that have a "turn-on" between 10.8 and 54 lux and a "turn-off" at between 1.5 and 5 times "turn-on."

Furnish units for illuminated signs that have a "turn-on" level of between 215 and 270 lux. ("Turn-on" level specified above corresponds to a switching level of approximately 430 to 540 lux measured in the horizontal plane.) "Turn-off" level must not exceed 3 times "turn-on" level.

Measurements must meet the procedures in *EEI-NEMA Standards for Physical and Electrical Interchangeability of Light-Sensitive Control Devices Used in the Control of Roadway Lighting*.

2. Temperature Switch. When mercury vapor sign lighting fixtures are used, provide a temperature switch in each photoelectric control circuit for lighting systems which will:
  - a. bypass the photoelectric unit when the ambient temperature drops to -13 °F, and energize the mercury vapor light circuits;
  - b. return switching functions to the photoelectric unit upon a temperature rise of 5 to 10 °F above the turn-on temperature; and
  - c. have a minimum range of (-40 °F to +40 °F), and be setable in increments no greater than 5 °F.

**740-2.21 BALLASTS.** Include ballasts for high intensity discharge lamps as an integral part of each luminaire and design for the voltages and lamp types specified in the Plans or Special Provisions. Ensure that the current needed to start the lamps is less than the operating current.

Furnish regulator-type ballasts with copper windings electrically isolated from each other, which will start and operate the lamps in temperatures down to -40 °F. The allowable line voltage variation is plus and minus 10%.

Equip high-pressure sodium luminaires, except those with 1000 watt lamps, with magnetic regulator ballasts with the following additional operating characteristics:

1. The lamp wattage regulation spread at any time over the life of the lamp must not exceed 18% of nominal lamp watts at plus and minus 10% line voltage variations.
2. With nominal line and lamp voltages, the ballast must regulate the lamp output to within 5% of the ballast design center, and sustain lamp operation with a minimum 60% voltage drop lasting 4 seconds or less.

Equip luminaires with 1000 watt high pressure sodium lamps with auto-regulator ballasts that provide a maximum 30% lamp regulation spread, a minimum 35% voltage dip tolerance, and with nominal line and lamp voltages regulate lamp output to within 5% of the ballast design center.

Furnish ballasts, for soffit luminaires, with mounting brackets attached and equip with terminal blocks for primary connections and lamp socket preconnected to the secondary for flush mounted luminaires and with terminal blocks for both primary and secondary connections for use with suspended luminaires.

Submit the ballast manufacturer's specification sheets for review and approval.

#### **740-2.22 RESERVED.**

**740-2.23 UNDERPASS LIGHTING SYSTEM.** Use underpass luminaires that have vandal-resistant surface-mounted fixtures installed in a galvanized welded steel enclosure as detailed on the Plans. The lamp must be a mogul based 150-watt, clear, ANSI/NEMA C78.42, horizontal mount, high pressure sodium type. The lamp must provide a minimum of 15,000 initial lumens with a rated life of 24,000+ hours based on a minimum burn period of 3 hours.

Mount the ballast within the body of the fixture with a constant wattage autoregulator CWA type meeting ANSI/NEMA C78.1355 operating characteristics. See Plans for input voltage.

Provide a square lens that is semi-recessed, extra thick, injection molded polycarbonate prismatic type, with internal specular aluminum reflector. The lens must provide the uniformity specified in the Plans or Specifications with a minimum spacing to mounting height ratio (S/MH) of 3.5:1, in the plane defined by the axis of the lamp, and a minimum S/MH ratio of 1:1 in the plane passing vertically through the length of the lamp axis.

Provide a lens frame and side housing made of ASTM B209, alloy 6061-T6 tempered aluminum a minimum of 0.177 inch thick, or equivalent stainless steel, secured with tamper proof screws requiring a special manufacturer's tool to remove.

Provide fixtures that are Third Party listed for wet, damp, and dry locations. Fasten the fixture into the mounting enclosure with stainless steel screws accessible only from within the fixture housing.

Fabricate the mounting enclosure from 0.138 inch thick mild steel with continuous welded seams and hot-dipped galvanized, as detailed on the Plans. Use wiring within the enclosure that might come in contact with the ballast rated at 390 °F [type SR-2]. Provide a grounding screw or lug within the enclosure for a maximum No. 8 AWG ground conductor.

Submit the manufacture's fixture specifications, photometric data, and a computer-generated lighting layout for approval prior to ordering. Calculate, by the point-to-point method, the light level on the walkway surface through the underpass with no wall, ceiling, or walkway reflectances. The calculated light level on the walking surface and the calculated average-to-minimum uniformity ratio may not be worse than the light level and uniformity ratio noted on the drawings. Center the calculation area on the light fixtures and base it on the width of the walkway less 12 inches, and the length of the walkway equal to the distance between the first and last fixtures plus a distance equal to 50% of the spacing between the fixtures added to each end of the walkway. You may substitute fixtures having similar construction, electrical, and light distribution characteristics, if approved. In the case of a substitution, construct the enclosure shown on the drawing to match the mounting requirements of the submitted fixture. Submit shop drawings for the enclosure for approval along with the fixture shop drawings.

Use 740-2.24 section for SOA projects only, unless requested by MOA. Delete interconnect option not applicable to project.

**740-2.24 TRAFFIC SIGNAL COMMUNICATIONS SYSTEM.** Furnish only fully functioning new equipment of the brand and type listed or approved equal. To be considered an approved equal equipment must meet or exceed the listed specifications. The products listed in this subsection are subject to review and approval if they are included on the Materials Certification List (MCL).

1. Broadband Ethernet Radio Interconnect System. The contractor shall provide a 5GHz Broadband Wireless Ethernet Radio Interconnect System. The system shall be the Intuicom Nitro58™ Wireless Solutions or an approved equal meeting the following minimum specifications:
  - a. Comply with FCC part 15 and IC RSS-210 rules/regulations.
  - b. Support and provide the following wireless protocols:
    - (1) IEEE 802.11a (OFDM)
    - (2) IEEE 802.11n (MIMO 2x2:2, OFDM)
    - (3) Proprietary Wireless Protocol
  - c. Shall be available in the following wireless hardware configurations:
    - (1) 108Mbps – Integrated Panel Antenna or Stand Alone Radio
    - (2) 216Mbps – Stand Alone (Dual) Radio
    - (3) 432Mbps - Access Point Cluster (Quad) Radio
    - (4) 300Mbps – 802.11n Integrated Panel Antenna
  - d. All Radios shall contain embedded GPS for automatic Geo-location of fixed or mobile wireless locations.
  - e. Integrated Panel Antennas must contain an external status panel which combines Received Signal Strength Indicators (RSSI), Power Indicator, and a Reset Button.
  - f. Radios include Adaptive Modulation, Dynamic Frequency Selection, Automatic Transmit Power Control – RF link is monitored to automatically adjust the data rate to optimize the maximum link performance.
  - g. Any Radio shall be configurable as an Access Point, Remote, Repeater and Mesh Node.
  - h. The manufacturer and/or supplier of the Radio will be located in North America with performance testing over the Radio's operating temperatures of -40° to +85 C. Shall be IP67 and NEMA exceeding environmental specifications.
  - i. Detailed Requirements:
    - (1) Operating Frequency: 5.150 – 5.825 GHz
    - (2) Ethernet: Auto-sensing 10/100/1000BASE-T Ethernet
    - (3) Electrical: Gigabit PoE Compliant (IEEE 802.3af/at)
    - (4) Receiver Sensitivity: -74 to -94dBm
    - (5) Peak Transmit Power: 802.11a (Up to 28dBm), 802.11n (Up to 27dBm, +/- 2dBm)
    - (6) Channel Width: 5, 10, 20, 40 MHz

(8) Supported Network Topologies: Point to Point, Point to Multipoint, Mesh

(9) Wireless Security Options:

- (a) 802.11i WPA/WPA2 (PSK, EAP), AES-CCM, TKIP, 802.1X, RSN.
- (b) Radius Authentication
- (c) MAC Access Control List
- (d) User Login Controls

(10) Support the minimum IEEE Networking Features:

- (a) 802.11e (WMM & QoS)
- (b) 802.11h (DFS & TPC)
- (c) 802.1d (Ethernet Bridging)
- (d) 802.1p (Traffic Prioritization)
- (e) 802.1q (VLAN)
- (f) 802.1w (Rapid Spanning Tree)
- (g) 802.3ac (802.1q & 802p support)
- (h) 802.3ad (Link Aggregation)
- (i) 802.3x (Full Duplex and Flow Control)

(11) Minimum Wireless Software Features:

- (a) Automatic Geolocation of embedded GPS radios
- (b) Icon roll over feature displays latitude and longitude coordinates of radios
- (c) Customizable Menu Interface
- (d) Automatically discover, organize, configure radios in network tree
- (e) Provide a "Drag and Drop" radio configuration tool
- (f) A color coded display of network-wide wireless diagnostics illustrated on map
  - i. Data Rate, RSSI, Client Connection Quality
- (g) Provide Wireless Alert Reporting
  - i. A unique slider control allowing users to adjust upper and lower alert limits
- (h) Network Management Capabilities
  - i. Firewall, ARP/Bridge Tables, Spanning Tree, Data Throughput
  - ii. IP Discovery, IP/Subnet Configuration, IP Conflict Tool
  - iii. Ping Watchdog
- (i) Real-time wireless diagnostic tools
  - i. Bandwidth Test Tool, RSSI and CCQ
  - ii. Spectrum Analysis with AP Scan Tool
  - iii. Audio Antenna Aiming Tool
- (j) Advanced User Control
  - (1) Terminal Window, Telnet, SSH2

- (2) Dynamic Routing (BGP+, OSPFv3 and RIP protocols)
  - (3) Sniffer and Fetch tools
  - (4) IPV6 support
  - (5) DNS
2. Copper and Fiber Ethernet Switch Furnish the below model of Siemens RuggedCom Ethernet Switch in the quantity indicated in the plans
- a. RSG920P: 6GK6092-OPS23-0BA0-ZA04+B04+C04+D04 (LC Fiber SFPS)
  - b. RS900G: 6G6090-0GS23-0BA0-ZA05 (SC Connectors)
  - c. RSL910: 6GK6491-OLB00-1CA0 (LC Fiber SFPs)
  - d. RX1511:
    - (1) 6GK6015-1BM26-0EC0-ZA01+B01+C36 (blank slot 2 SFPs)
    - (2) 2x 6GK6000-8FG52-0AA0 (2x1000LX SM, 1310, LC, 10km for slot 2)