

**State of Alaska
Department of Transportation
&
Public Facilities

Northern Region**



Bid Forms, Contract, Bond, Standard Modifications, and Special Provisions for:

**Richardson Highway Dynamic
Messaging Sign (CMAQ)**

Project No. 0002479/NFHwy00554

Preliminary PS&E: June 22, 2021

To be used in conjunction with State of Alaska Standard Specifications for Highway Construction dated 2020, and the Plans for the above referenced project.

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6.	<u>State Wage Rates</u>		
	State wage rates can be obtained at http://www.labor.state.ak.us/lss/pamp600.htm . Use the State wage rates that are in effect 10 days before Bid Opening. The Department will include a paper copy of the State wage rates in the signed Contract.		



STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION AND PUBLIC FACILITIES

INVITATION TO BID

for Construction Contract

Date _____

Richardson Highway Dynamic Messaging Sign (CMAQ), 0002479/NFHWHY00554

Project Name and Number

The Department invites bidders to submit bids for furnishing all labor, equipment, and materials and performing all work for the project described below. The Department will only consider bids received **before 2:00 PM local time (per the Department's time source) on the _____ day of _____ 2021**. On that date, the Department will assemble, open, and then publicly announce the timely-received bids at **Engineering Services Building, Room 4, 2301 Peger Road, Fairbanks, Alaska at 2:00 PM**, or as soon thereafter as practicable.

Location of Project: Fairbanks North Star Borough, Alaska

Contracting Officer: Ryan F. Anderson, P.E., Regional Director

Issuing Office: Northern Region DOT&PF

State Funded Federal Aid

Description of Work:

Install and operate digital messaging signs and roadside hardware along the Richardson Highway between Fairbanks and North Pole.

Project DBE Utilization Goal: Race-Neutral, Goal is N/A Race-Conscious, Goal is XX.X%

The Engineer's Estimate is between \$500,000 and \$1,000,000

All work shall be completed in N/A Calendar Days, or by **June 30, 2022**.
The Department will identify interim completion dates, if any, in the Special Provisions.

The apparent successful bidder must furnish a payment bond in the amount of 100% of the contract and a performance bond in the amount of 100% of the contract as security conditioned for the full, complete and faithful performance of the contract. The apparent successful bidder must execute the said contract and bonds within fifteen calendar days, or such further time as may be allowed in writing by the Contracting Officer, after receiving notification of the acceptance of their bid.

Submission of Bidding Documents

Bidders may submit bidding documents electronically via the Department's approved online bidding service, through the mail or hand delivered. For mailed or hand delivered bids and for electronically submitted bids with a paper bid guaranty, documents shall be submitted in a sealed envelope marked as follows:

<p>Bidding Documents for Project: 0002479/NFHWHY00554 Richardson Highway Dynamic Messaging Sign (CMAQ)</p>	<p>ATTN: Chief of Contracts State of Alaska Department of Transportation & Public Facilities 2301 Peger Road Fairbanks, Alaska 99709</p>
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It is incumbent upon the bidder to ensure its bid, any amendments, and/or withdrawal arrive, in its entirety, at the location and before the deadline stated above. A bidder sending a bid amendment or withdrawal via email or fax must transmit its documentation to the Department at this email address: nrdotpfcontracts@alaska.gov or fax number: (907) 451-5390.

To be responsive, a bid must include a bid guaranty equal to 5% of the amount bid. *(When calculating the bid amount for purposes of determining the 5% value of the bid guaranty, a bidder shall include its base bid amount, plus the amount bid for alternate and supplemental bid items, if any.)*

The Department hereby notifies all bidders that it will affirmatively ensure that in any contract entered into pursuant to this Invitation, Disadvantaged Business Enterprises will be afforded full opportunity to submit bids and will not be discriminated against on the grounds of race, color, national origin, or sex in consideration for an award.

NOTICE TO BIDDERS

Bidders must have a Vendor ID or your bid may not be accepted. More information can be obtained at the following website:
<http://dot.alaska.gov/aashtoware/docs/AWP-Vendor-List-Guidance.pdf>

The following data may assist a bidder in preparing its bid:

- Quantity Calculations
- Cross Sections
- Geotechnical Report
- As Built
- Other applicable information

All supplemental information can be found under the letting for this project which may be selected using the following link:
<https://www.bidx.com/ak/lettings>

A bidder may obtain hard copy project plans and specifications for the price of \$50, from:

Engineering Services Building, Room 3

2301 Peger Road

Fairbanks, Alaska 99709

Phone: (907) 451-2247

TDD (for Hearing Impaired, requires special equipment): 711 or 1-800-770-8973

If a bidder has a question relating to design features, constructability, quantities, or other technical aspects of the project, it may direct its inquiry to the questions and answers area of the Bid Express proposal page: <https://www.bidx.com/ak/lettings>

A bidder requesting assistance in viewing the project site must make arrangements at least 48 hours in advance.

The point of contact for inquiries for this project is **Maureen J. Carey, PA, Construction Manager**.

Email: maureen.carey@alaska.gov

Phone: (907) 451-5405

For questions relating to electronic bidding or for assistance with your Bid Express account, contact Bid Express customer support at customer.support@bidx.com or call toll free (888)352-BIDX(2439) Monday through Friday 7:00am to 8:00pm (Eastern).

A bidder may direct questions concerning bidding procedures and requirements to:

Construction Contracts Coordinator

Email: stacy.mcsorley@alaska.gov

Phone: (907) 451-2219

Other Information:

To report bid rigging activities call: 1-800-424-9071

The U.S. Department of Transportation (DOT) operates the above toll-free "hotline" Monday thru Friday. 8:00 a.m. to 5:00 p.m., Eastern Time. Anyone with knowledge of possible bid rigging, bidder collusion, or other fraudulent activities should use the "hotline" to report such activities.

The "hotline" is part of the DOT's continuing effort to identify and investigate highway construction contract fraud and abuse and is operated under the direction of the DOT Inspector General. All information will be treated confidentially and caller anonymity will be respected.

State of Alaska, Standard Specifications
for Highway Construction, Dated 2020 are
modified as follows:

STANDARD MODIFICATIONS

Preliminary

STANDARD MODIFICATIONS
Project No. 0002479/NFHwy00554
Richardson Highway Dynamic
Messaging Sign (CMAQ)

**SECTION 104
SCOPE OF WORK**

11/30/2020 (HSM20-2)

104-1.06 VALUE ENGINEERING CHANGE PROPOSALS BY CONTRACTOR. Delete item 3.e of this subsection and substitute the following: The Contractor may submit VECPs for an approved subcontractor. If the Contractor elects to submit a VECP for an approved subcontractor and it is subsequently accepted by the Department, the Department will reimburse the Contractor per 104-1.06.5.

**SECTION 108
PROSECUTION AND PROGRESS**

06/30/20 (HSM20-1)

108-1.07 FAILURE TO COMPLETE ON TIME. Delete Table 108-1 of this subsection in its entirety and substitute the following:

**TABLE 108-1
DAILY CHARGE FOR LIQUIDATED DAMAGES
FOR EACH CALENDAR DAY OF DELAY**

Original Contract Amount		Daily Charge
From More Than	To and Including	
\$ 0	500,000	\$1,000
500,000	1,000,000	1,500
1,000,000	5,000,000	1,800
5,000,000	10,000,000	2,500
10,000,000	25,000,000	3,800
25,000,000	-----	4,800

**SECTION 109
MEASUREMENT AND PAYMENT**

11/30/2020 (HSM20-3)

109-1.08 FINAL PAYMENT. Add the following after the fifth paragraph of this subsection: On federally funded projects, if DOLWD Wage and Hour Administration notifies the Department of a pending prevailing wage investigation, and that the investigation is preventing the closing out of the project, the Contractor may place the notified amount in escrow under Wage and Hour for the exclusive purpose of satisfying unpaid prevailing wages. Upon receipt of notice from Wage and Hour that the contractor has satisfactorily transferred the necessary funds into escrow, the Department will proceed to issue final payment.

**SECTION 203
EXCAVATION AND EMBANKMENT**

11/30/2020 (HSM20-5)

203-3.04 COMPACTION WITH MOISTURE AND DENSITY CONTROL. In the second paragraph of this subsection, delete the words "and ATM 214".

**SECTION 205
EXCAVATION AND FILL FOR MAJOR STRUCTURES**

11/30/2020 (HSM20-5)

205-3.05 COMPACTION. In the second paragraph of numbered paragraph 1. Compaction With Moisture and Density Control, delete the words “and ATM 214”.

**SECTION 301
AGGREGATE BASE AND SURFACE COURSE**

11/30/2020 (HSM20-5)

301-3.03 SHAPING AND COMPACTION. In the second paragraph of this subsection, delete the words “and ATM 214”.

**SECTION 641
EROSION, SEDIMENT, AND POLLUTION CONTROL**

11/30/2020 (HSM20-14)

641-2.05 MATERIALS. Delete the fifth paragraph of this subsection and substitute the following: Use straw and straw products certified weed free of prohibited and restricted noxious weed seed and quarantined pests, according to Alaska Administrative Code, Title 11, Chapter 34 (11 AAC 34). When straw or straw products certified according to 11 AAC 34 are not available, use non-certified products manufactured within Alaska before certified products manufactured in another state, country, or territory. Non-certified straw or straw products manufactured in another state, country, or territory shall not be used. Grass, legumes, or any other herbaceous plants produced as hay, shall not be substituted for straw or straw products.

**SECTION 660
SIGNALS AND LIGHTING**

11/30/2020 (HSM20-16)

660-3.04 JUNCTION BOXES. Delete item 1. of the seventh paragraph of this subsection and substitute the following:

1. 300 feet maximum for any conduit run containing either:
 - a. One single cable, plus one bare or insulated equipment grounding conductor (EGC); or
 - b. 2 or fewer single pair No. 12 AWG (or smaller) loop lead-in cables, plus one bare or insulated EGC.

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**SECTION 106
CONTROL OF MATERIAL**

106-1.01 SOURCE OF SUPPLY AND QUALITY REQUIREMENTS. *Add the following:*

PROHIBITION ON CERTAIN TELECOMMUNICATION AND VIDEO SURVEILLANCE SERVICES OR EQUIPMENT. On projects using federal funds, the Contractor shall comply with the requirements of 2 CFR 200.216, as amended effective August 13, 2020, Federal Register, Vol. 85, No. 157, 49506 – 49582, **Prohibition on certain telecommunication and video surveillance services or equipment.**

Contractor shall submit documentation acceptable to the Department certifying it has not entered into a contract nor extended or renewed a contract to procure or obtain equipment, services, or systems that uses covered telecommunications equipment or services as a substantial or essential component of any system, or as critical technology as part of any system produced by:

- Huawei Technologies Company or ZTE Corporation (or any subsidiary or affiliate of such entities).
- Hytera Communications Corporation, Hangzhou Hikvision Digital Technology Company, or Dahua Technology Company (or any subsidiary or affiliate of such entities).
- Any entity that the Secretary of Defense, in consultation with the Director of the National Intelligence or the Director of the Federal Bureau of Investigation, reasonably believes to be an entity owned or controlled by, or otherwise connected to, the government of a covered foreign country.

The Contractor shall further certify that it has complied with the requirements of 2 CFR 200.216, as amended effective August 13, 2020, Federal Register, Vol. 85, No. 157, 49506 – 49582 and that it will continue to do so throughout the term of the Contract.

**SECTION 203
EXCAVATION AND EMBANKMENT**

01/20/15 (N8)

203-3.01 GENERAL. *Add the following to the eighth paragraph:* Disposal in wetlands is prohibited, except as described in Subsection 107-1.11.

Add the following after the eighth paragraph: The Contractor shall certify in writing to the Engineer that all permits and clearances relating to all waste disposal sites selected by the Contractor have been obtained prior to any clearing or ground disturbance in the disposal site.

01/20/15 (N12)

203-4.01 METHOD OF MEASUREMENT. *Add the following:* Borrow will not be weighed or used while free moisture is observed draining from the haul vehicle at the scale location.

**SECTION 401
HOT MIX ASPHALT PAVEMENT**

04/08/21 (N76)

401-2.01 ASPHALT BINDER. *Add the following:* Provide the grade of Asphalt Binder shown in the Bid Schedule, except PG 52-28 may be used for Items 401.0011.____ and 401.0012.____, HMA Driveway.

401-2.08 RECYCLED ASPHALT PAVEMENT. *Add the following:* The maximum amount of RAP in the HMA is limited to 10%.

401-2.09 JOB MIX DESIGN. Delete the last two rows of Table 401-1 HMA MARSHALL DESIGN REQUIREMENTS.

(04/08/21) N85

Add the following: For HMA placed under Item 401.2010.0000 HMA, Sidewalks and Paths:

1. JMD shall be Type II or Type III, Class B.
2. Asphalt Binder shall be PG 52-28 or PG 52E-40.
3. The maximum amount of RAP in the HMA is limited to 10%.

401-3.18 SURFACE REQUIREMENTS AND TOLERANCES. Add the following: When Item 401.0010.____ appears in the Bid Schedule, profiler measurements will be taken on through lanes and passing lanes.

401-4.02 ACCEPTANCE SAMPLING AND TESTING. Add the following: The bid quantity for Item 401.2010.0000 HMA, Sidewalks and Path will be considered 1 lot. The lot will be divided into sublots of 500 tons. HMA for Sidewalks and Paths will be accepted for payment based on:

1. The Engineer's approval of the JMD.
2. Placement and compaction of the HMA to the specified depth, finished surface requirements, and tolerances.
3. Conformance to the Upper Specification Limit (USL) and Lower Specification Limit (LSL) shown in Table 401-2. The TV is the specification value shown in the approved Job Mix Design.
4. Mat Density will be sampled and tested according to Subsection 401-4.02.3. Density test results will be based on the MSG from the approved JMD.
5. At the discretion of the Engineer, Asphalt Binder Content may be tested according to Subsection 401-4.02.1, Aggregate Gradation may be tested according to Subsection 401-4.02.2, and Asphalt Binder Grade may be tested according to Subsection 401-4.02.5.

The Engineer reserves the right to perform any testing required in order to determine acceptance.

401-5.01 BASIS OF PAYMENT. Add the following: HMA placed on driveways, turnouts, and pullouts will be paid under Item 401.0012.____ HMA, Driveway, Type ____; Class ____.

Asphalt binder, liquid anti-strip additives and tack coat are subsidiary to Item 401.2010.0000 HMA, Sidewalks and Paths.

Item 401.0008.____ HMA Price Adjustment does not apply to Item 401.2010.0000 HMA, Sidewalks and Paths.

Add the following pay item:

PAY ITEM		
Item Number	Item Description	Unit
401.2010.0000	HMA, Sidewalks and Paths	TON

**SECTION 603
CULVERTS AND STORMDRAINS**

01/20/15 (N21)

603-3.03 JOINING PIPE. Delete numbered subparagraphs 2.a.2) & 3) and substitute the following:

(2) Bands shall have a minimum width of 22 inches.

Delete numbered subparagraphs 2.b.2), 3) and 4) and substitute the following:

(2) Bands shall have a minimum width of 22 inches and shall have two circumferential rows of projections for each pipe end being joined.

(3) Furnish and install these bands with a gasket that resists infiltration and leakage.

**SECTION 606
GUARDRAIL**

11/01/16 (N67)

606-5.01 BASIS OF PAYMENT. Add the following: All traffic control devices necessary for removal, installation, reconstruction, or maintenance of 606 Pay Items shall be subsidiary to the respective 606 Pay Items.

Delete Section 618 in its entirety and substitute the following:

02/01/20 (N30)

**SECTION 618
SEEDING**

618-1.01 DESCRIPTION. It is the intent of this work that a uniform living vegetative cover be established according to the Plans and Specifications. This work consists of soil preparation, seeding, fertilizing, mulching, and establishing, and maintaining vegetated areas.

618-2.01 MATERIALS. Use materials that conform to the following:

Seed	Section 724
Fertilizer	Section 725
Mulch	Subsection 727-2.01
Water	Subsection 712-2.01

CONSTRUCTION REQUIREMENTS

618-3.01 SOIL PREPARATION. Clear all areas to be seeded of stones 4" and larger in diameter and of all weeds, plant growth, sticks, stumps and other debris or irregularities which may interfere with the seeding, establishment, and maintenance of the vegetated areas.

Prior to the application of seed, prepare slopes using one or more of the following methods, or as approved by the Engineer:

1. Manual Raking – Requires manual labor with landscaping rakes to produce a uniform pattern of grooves perpendicular to the fall of the slope.
2. Mechanical Raking - Requires the use of a scarifying slope board to produce grooves with an approximate width and depth of 1", and no more than 6" apart. The resultant indentations shall leave a uniform pattern of grooves perpendicular to the fall of the slope.

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3. Mechanical Track Walking - Requires operating tracked equipment in such a manner as to leave a uniform pattern of grooves perpendicular to the fall of the slope.

618-3.02 SEEDING SEASON. Perform seeding after the ground is free of snow and no sooner than [REDACTED] and no later than [REDACTED]. Perform seeding when wind conditions, climatic conditions, and soil conditions will not hinder seeding and establishment.

618-3.03 APPLICATION METHOD. Use the Hydraulic Method. You must obtain the Engineer's permission to use the Mechanical Method.

Hydraulic Method:

1. Seeding by the hydraulic method consists of furnishing and placing a slurry of dye, seed, fertilizer, trace mulch, water, and a second application of mulch.
2. Do not place seed in the slurry prior to 30 minutes before application.
3. Add the proportionate amount of seed to the water slurry in the hydraulic seeder after the proportionate amounts of trace mulch and fertilizer have been added.
4. Apply the slurry mixture in a manner that results in an even distribution of all materials. Apply seed, fertilizer, and trace mulch together in one application.
5. Hydraulic seeding equipment must maintain continuous slurry agitation so that a homogeneous, uniform mixture is applied through a spray nozzle, for the complete tank load. The pump must be capable of producing sufficient pressure to maintain a continuous, nonfluctuating spray capable of reaching the extremities of the seeding area with the pump & nozzle unit located on the roadbed. Provide sufficient hose to reach areas not practical to seed from the pump & nozzle unit situated on the road bed.
6. A second application of mulch shall be applied within 24-hours after seeding. Mulch shall be furnished and evenly applied at the rates required for temporary stabilization per the manufacturer's recommendations and according to Subsection 727-2.01. Mulch sprayed on signs or sign structures shall be removed the same day.

Mechanical Method:

1. Use mechanical spreaders, seed drills or other approved mechanical seeding equipment when seed and fertilizer are to be applied in dry form.
2. Water seeding area both prior to and after the application of fertilizer.
3. Spread fertilizer separately from seed.
4. An application of mulch shall be applied within 24-hours after seeding. Mulch shall be furnished and evenly applied at the rates required for temporary stabilization per the manufacturer's recommendations and according to Subsection 727-2.01. Mulch sprayed on signs or sign structures shall be removed the same day.

618-3.04 APPLICATION RATE. Apply seed, fertilizer, and trace mulch at the rates specified in the table below:

MATERIALS	TYPE	APPLICATION RATE PER 1,000 SQUARE FEET
Seed*	Annual Ryegrass	lb lb 0.1 lb
	Total	lb
Fertilizer	20-20-10	10 lb
Trace mulch**	See Subsection 727-2.01	20 lb

* Do not remove the required tags from the seed containers.

** Trace mulch application rate may be adjusted according to the manufacturer's recommendations when approved by the Engineer. Trace mulch is not required for mechanical seeding.

618-3.05 MAINTENANCE. Protect seeded areas against erosion and sedimentation. Protect seeded areas against traffic by approved warning signs or barricades. Water seeded areas, in a non-erosive manner, as required to establish a uniform living perennial vegetative cover. Be responsible for identifying, retracking, reseeding, refertilizing and remulching gullied or otherwise damaged areas. The second application of mulch shall be maintained so it properly performs its temporary stabilization function until final stabilization is achieved. Rescarify, reseed, refertilize and remulch unproductive areas as directed by the Engineer.

618-3.06 PERIOD OF ESTABLISHMENT. The establishment period extends until a uniform (e.g. evenly distributed, without large bare areas) perennial living vegetative cover with a density of 70 percent of the native background vegetative cover is established.

618-3.07 ACCEPTANCE. The Engineer will accept seeding when a uniform (e.g. evenly distributed, without large bare areas) perennial living vegetative cover with a density of 70 percent of the native background vegetative cover is established.

618-4.01 METHOD OF MEASUREMENT. Section 109 and as follows:

Watering seeded areas per Subsection 618-3.05 will not be measured directly for payment and is subsidiary, except when Pay Item 618.0003.____ is listed on the Bid Schedule.

Identifying, retracking, reseeding, refertilizing and remulching gullied or otherwise damaged areas will not be measured directly for payment and is subsidiary.

Seeding by the Acre. By the area of ground surface acceptably seeded and maintained. Soil preparation, seed, fertilizer, all mulch, dye, and water required for seed and fertilizer application will not be measured directly for payment and is subsidiary.

Seeding by the Pound. By the dry weight of seed acceptably seeded and maintained. Soil preparation, fertilizer, all mulch, dye, and water required for seed and fertilizer application will not be measured directly for payment and is subsidiary.

Water for Seeding. By the M Gal. (1,000 gallons) acceptably placed. Use a conversion factor of 8.34 pounds per gallon, if measured by weight.

618-5.01 BASIS OF PAYMENT. The accepted quantity will be paid for at the contract price, per unit of measurement, for the pay items listed below that appear on the bid schedule.

Payment will be made under:

PAY ITEM		
Item Number	Item Description	Unit
618.0001.____	Seeding	ACRE
618.0002.____	Seeding	LB
618.0003.____	Water for Seeding	MGAL

Delete Section 641 in its entirety and substitute the following:
02/01/20 (N33)

**SECTION 641
POLLUTION CONTROL**

641-1.01 DESCRIPTION. Plan, provide, inspect and maintain control of hazardous materials contamination.

641-1.02 DEFINITIONS.

1. HMCP (Hazardous Material Control Plan). The Contractor's detailed site specific plan for prevention of pollution from storage, use, containment, cleanup, and disposal of hazardous material, including petroleum products related to construction activities and equipment.
2. SPCC Plan (Spill Prevention, Control and Countermeasure). The Contractor's detailed plan for petroleum spill prevention and control measures that meets the requirements of 40 CFR 112.

641-1.03 PLAN AND PERMIT SUBMITTALS. Submission deadlines in this Subsection supersede Subsection 108-1.03.

Submit two signed copies of the HMCP to the Engineer for approval. Submit one signed copy of the SPCC Plan to the Engineer. Deliver these documents to the Engineer at least 14 calendar days before the preconstruction conference.

The Department will review the HMCP submittal, and will return it to the Contractor marked as either requiring modification or as approved by the Department. The Department will keep the SPCC Plan as a record document.

641-2.01 HAZARDOUS MATERIAL CONTROL PLAN (HMCP) REQUIREMENTS. Prepare a HMCP for prevention of pollution from the storage, use, containment, cleanup, and disposal of hazardous material, including petroleum products related to construction activities and equipment. (See 40 CFR 117 and 302 for listing of hazardous materials.) Compile Material Safety Data Sheets in one location and reference the location in the HMCP.

List the types and approximate quantities of response equipment and cleanup materials available on site. Include a list and location map of cleanup materials, at each different work site and readily available off site (main site, material site, batch plant, storage yard, explosives dump, equipment or fueling yard, etc). Vehicles and other mobile equipment must carry oil absorbent pads.

Specify the line of authority and designate a Contractor field representative for spill response, and one coordinator from each subcontractor. Provide 24 hour contact information for each representative or coordinator.

List and give the location of hazardous materials, including office materials, to be used or stored on site, and estimated quantities. Store hazardous materials in covered storage areas, such areas must also function as or include a secondary containment system.

Identify the locations where storage, fueling and maintenance activities will take place, describe the maintenance activities, and list controls to prevent the accidental spillage of petroleum products and other hazardous materials. Store spill response materials appropriate to the hazards associated with that site in sufficient quantity at each identified location.

Detail procedures for containment and cleanup of hazardous substances. Detail a plan for the prevention, containment, cleanup, and disposal of soil and water contaminated by accidental spills. Detail a plan for dealing with unexpected contaminated soil and water encountered during construction.

Detail methods for disposing of waste petroleum products and other hazardous materials generated by the project. Identify haul methods and final disposal areas, such areas must be permitted for hazardous material disposal.

641-2.02 SPILL PREVENTION, CONTROL AND COUNTERMEASURE (SPCC) PLAN REQUIREMENTS.

Prepare and implement a SPCC Plan when required by 40 CFR 112, including:

1. When petroleum spills may reach navigable waters; and
2. Total above ground petroleum storage capacity is greater than 1,320 gallons (including vehicle and equipment fuel tanks, but not counting containers that have a capacity less than 55 gallons).

Comply with 40 CFR 112 and address the following issues in your SPCC Plan:

1. Operating procedures that prevent petroleum spills;
2. Control measures installed to prevent a spill from reaching navigable waters; and
3. Countermeasures to contain, clean up, and mitigate the effects of a petroleum spill.

You may self-certify the SPCC Plan if total above ground petroleum storage capacity is 10,000 gallons or less, and you meet all the requirements for self-certification of 40 CFR 112. Otherwise the SPCC Plan must be sealed, signed and dated by a Professional Engineer registered in the State of Alaska.

CONSTRUCTION REQUIREMENTS

641-3.01 GENERAL. Comply with the requirements of the approved HMCP, the submitted SPCC Plan, and all state regulations and federal regulations and permits that pertain to the handling, storage, cleanup, and disposal of petroleum products or other hazardous substances. Contain, clean up, and dispose of discharges of petroleum and other hazardous materials.

Comply with the requirements of 18 AAC 75 and AS 46, Oil and Hazardous Substances Pollution Control. Report petroleum spills as required by federal, state and local law, and as described in the HMCP and SPCC Plan.

Perform fueling operations in a safe and environmentally responsible manner as specified in the Alaska Construction General Permit. Fuel storage facilities must be within an impermeable diked area having a holding capacity at least ten percent greater than that of the largest independent fuel container. Place absorbent pads under fill ports while fueling, and under equipment during maintenance or repairs. Install secondary containment under all stationary equipment powered by liquid fuels, such as, welders, compressors, pumps, generators, and hydraulic power units.

SPECIAL PROVISIONS

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Keep a copy of the HMCP and SPCC Plan at the project site or locally available (within 30 miles by road from project site).

641-4.01 METHOD OF MEASUREMENT. This item will not be measured for payment. All administration, work, and materials required under this Section will be paid for under pay item 641.2000.0000.

641-5.01 BASIS OF PAYMENT. At the contract lump sum price to perform all work under this Section.

Payment will be made under:

PAY ITEM		
Item Number	Item Description	Unit
641.2000.0000	Pollution Control	LS

**SECTION 642
CONSTRUCTION SURVEYING AND MONUMENTS**

01/20/15 (N34)

642-3.01 GENERAL. Delete the fifth paragraph and substitute the following: Follow the Department's Construction Surveying Requirements, or if GPS survey is approved by the Engineer, use the Alaska Survey Manual GPS Surveys 2010 (rev. 8/15/10).

Add the following to the last sentence in the second to the last paragraph: or the Alaska Survey Manual GPS Surveys 2010 (rev. 8/15/10).

642-3.02 CROSS-SECTION SURVEYS. Add the following to the first paragraph: or the Alaska Survey Manual GPS Surveys 2010 (rev. 8/15/10).

Delete numbered paragraph 4 of the second paragraph in its entirety and substitute the following: Department's Construction Surveying Requirements or the Alaska Survey Manual GPS Surveys 2010 (rev. 8/15/10).

**SECTION 643
TRAFFIC MAINTENANCE**

03/07/19 (N40)

643-5.01 BASIS OF PAYMENT.

11. Traffic Control. Add the following schedule:

TRAFFIC CONTROL RATE SCHEDULE

TRAFFIC CONTROL DEVICE	PAY UNIT	UNIT RATE
Construction Signs	Each/Day	\$ 6.50
Special Construction Signs	Square Foot	\$ 28.00
Type II Barricade	Each/Day	\$ 3.30
Type III Barricade	Each/Day	\$ 11.00
Traffic Cone or Tubular Marker	Each/Day	\$ 1.10
Drums	Each/Day	\$ 3.30

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TRAFFIC CONTROL DEVICE	PAY UNIT	UNIT RATE
Temporary Guardrail	Linear Foot	\$ 25.00
Portable Concrete or Steel F Shape Barrier (12.5 foot standard length or\$8/foot)	Each	\$ 100.00
Temporary Crash Cushion/ non-redirective Water filled barrier (all required per end)	Each	\$ 2,500.00
Temporary Crash Cushion / non-redirective Water filled Barrels (all required per end)	Each	\$ 3,285.00
Temporary Crash Cushion / non-redirective Sand filled Barrels (all required per end)	Each	\$ 4,325.00
Temporary Crash Cushion / Redirective	Each	\$ 9,230.00
Plastic Safety Fence	Foot	\$ 1.00
Temporary Sidewalk Surfacing	Square Foot	\$ 2.00
Flexible Markers (Flat Whip, Reflective)	Each	\$ 60.00
Flagging	Hour	\$58.00
Electronic Boards, Panels and Signals		
Sequential Arrow Panel	Each/Day	\$ 36.00
Portable Changeable Message Board Sign	Each/Day	\$ 130.00
Portable Traffic Signals (Two)	Each/Day	\$361.00
Cars and Trucks w/driver		
Pilot Car (4x2 ½ ton truck, or any car)	Hour	\$72.00
Watering Truck – up to 4900 gallon capacity	M-Gallon	\$ 28.00
Watering Truck – more than 4900 gallon	M-Gallon	\$ 21.00
Street Sweeping (Regenerative Sweeper, Vacuum Sweeper, Mechanical or Power Broom with vacuum)	Hour	\$ 214.00
40,000 GVW Truck with Crash Attenuator	Hour	\$ 162.00
Interim Pavement Markings		
Painted Markings	Linear Foot	\$ 0.30
Preformed Pavement Marking Tape (removable or non-removable)	Linear Foot	\$ 1.75
Temporary Raised Pavement Markers	Each	\$ 1.00
Word or Symbol Markings	Each	\$ 40.00
Temporary Cover Markings	Linear Foot	\$ 4.00
Removal of Pavement Markings	Linear Foot	\$1.25

Delete Section 644 in its entirety and substitute the following:
04/08/21 (N41)

SECTION 644
SERVICES TO BE FURNISHED BY THE CONTRACTOR

644-1.01 DESCRIPTION. Furnish and maintain facilities and services specified in the Contract for the Department's project administrative personnel to use during the project. Services include heat, electrical power (NEC compliant), water and any others required to operate the facilities. All furnished facilities remain the property of the contractor when the work is completed.

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The Engineer may delete any 644 Items, by Directive within five working days after the Preconstruction Conference. If any 644 Items are deleted within the specified period, Subsection 109-1.09, Eliminated Items, shall not apply to the deleted 644 Items.

644-2.01 FIELD OFFICE. Furnish and maintain a suitable office for the Engineer to use during construction. Make the Field Office available for occupancy 2 weeks before commencing work on the project through one week after Project Completion. The Field Office shall be within one half of one mile from the project.

1. Submit office proposal to the Engineer prior to procurement or transporting office to the project. The Engineer will approve the office general condition, location, access, features, and physical layout prior to beginning any office setup work. If this office is part of your building, completely partition it from the rest of the structure and provide a separate outside door equipped with a lock.
2. Provide at least the following minimum requirements, or as approved by the Engineer:
 - a. Floor space of at least ft²
 - b. Window area of at least ft²
 - c. Lockable outside door(s)
 - d. each plastic folding tables, 8 ft. long
 - e. Shelf space of at least linear feet
 - f. Adequate heating and cooling devices, and fuel or power to run the devices, to maintain an office temperature between 65° and 75°F.
 - g. Adequate ventilation
 - h. Continuous supply of drinking water from an approved source or commercial supplier
 - i. A minimum of sanitary facilities exclusively for Department use that include adequate sink with water supply, hand soap, hand sanitizer, toilet paper, and paper towels
 - j. Janitorial services at least weekly
 - k. Wet/dry vacuum with a minimum capacity of 5 gallons and a minimum of 4 horsepower. Provide filters and dust bags as needed.
 - l. Provide electrical service as indicated in 644-2.09, #1 Field Office
 - m. Internet Service and Phone:

Furnish and install a high speed internet service and three telephones, with all necessary ancillary equipment.

The internet system shall have a send and receive capability supporting Mbps download speed or higher and Mbps upload speed at all times. The internet system shall have unlimited data. Include a wireless router and an appropriately sized battery backup for the internet system. The system shall be for the exclusive use of the Engineer.

The telephone system shall consist of commercially available telephones with the necessary equipment for each line. Provide one telephone that includes a built in digital answering machine.

Internet and telephone service shall be supplied and operational no more than two weeks after the field office has been set up on site. Service plans shall be provided and remain in effect for the duration of the use of the field office.

- n. One multifunction Laser Color Printer/Scanner/Copier meeting the following requirements:

New or like-new condition
Printing/copying at least 32 ppm
Scan speed of 40 ppm at 400 DPI in color, at a minimum
Print/Scan/Copy 8.5" x 11" and 11" x 17" in color, at a minimum
Supports network scanning (FTP and SMB Support)
Supports network printing (PCL and Postscript)
Network card included
Automatic Document Feeder

Furnish toner and perform repairs and maintenance as necessary.

The Printer/Scanner/Copier remains property of the Contractor upon completion of the contract.

- o. Make the field office accessible according to the requirements of *Americans with Disabilities Act Accessibility Guidelines* (ADAAG). Provide at least one designated handicap parking space.
- p. One AED (Automated External Defibrillator), with carrying case and properly marked wall cabinet. Provide training on how to use the AED.
- q. One combination Smoke and Carbon Monoxide Detector per structure, minimum. Provide combination Smoke and Carbon Monoxide Detectors in any location requested by the Engineer.
- r. One 25 Person Trauma First Aid Kit. List of required contents available at <http://dot.alaska.gov/nreg/files/25-Person-Trauma-Kit-Contents.pdf>
- s. mobile hotspots with unlimited data plans and car charger.
3. Provide electrical power to the Department's portable concrete compressive strength lab if there are any bridge items in the bid schedule as identified in 644-2.09, #9.
4. Provide electrical power to the Department's portable nuclear storage trailer as identified in 644-2.09, #8.
5. Provide the following to the Department's portable asphalt lab if there are any asphaltic materials in the bid schedule and item 644.0002. Field Laboratory does not appear in the bid schedule.
- a. electrical service as identified in 644-2.09, #4 Asphalt Laboratory.
- b. internet service as specified for the Field Laboratory.

All long distance calls made by State personnel will be paid by the State. Installation and maintenance fees, local calls, connection fees and internet service provider fees, and all other fees shall be paid by the Contractor. Paper used by the copier/scanner/printer will be provided by the State.

644-2.02 FIELD LABORATORY. Furnish and maintain a field laboratory for the Engineer to use exclusively throughout the contract. Provide a completely functional installation 2 weeks before commencing construction work through one week after Project Completion.

1. Grade and compact a site for the lab acceptable to the Engineer. Locate and level the structure on this site. If subsequent ground movement causes an unlevel or unstable condition, re-level or re-locate the facility as directed.
2. Provide a weatherproof structure suitable to field test construction materials, with the following minimum functional requirements:
- a. Floor space of 300 ft²
- b. Two 10-ft² windows that open and lock
- c. Lockable door(s)

- d. Work bench(es), 2-1/2 x 16 feet total, 3 feet high
- e. Shelf space, 1 x 16 feet
- f. One 18-inch deep sink with attached industrial faucet with hand sprayer attachment and approved drain
- g. A gravity-fed 250-gallon tank or pressurized constant water supply of acceptable quality
- h. Electrical service as indicated in 644-2.09, #2 Field Laboratory
- i. A sanitary facility exclusively for Department use that includes adequate sink with water supply, hand soap, hand sanitizer, toilet paper, and paper towels
- j. Heating and cooling equipment suitable to maintain a uniform room temperature of 65° to 75°F
- k. Storage cabinet, 3 ft x 3 ft x 3 ft, lockable, securely fixed to an inside wall with a hinged door opening outward
- l. Office desk and 2 chairs
- m. One combination Smoke and Carbon Monoxide Detector per structure, minimum. Provide Combination Smoke and Carbon Monoxide Detectors at any location requested by the Engineer.
- n. One 25 person Trauma First Aid Kit. List of required contents available at <http://dot.alaska.gov/nreg/files/25-Person-Trauma-Kit-Contents.pdf>
- o. Internet Service and Phone:

Furnish and install a high speed internet service and a telephone, with all necessary ancillary equipment.

The internet system shall have a send and receive capability supporting Mbps download speed or higher and Mbps upload speed at all times. The internet system shall have unlimited data. Include a wireless router and an appropriately sized battery backup for the internet system. The system shall be for the exclusive use of the Engineer.

The telephone system shall consist of commercially available telephones with the necessary equipment for each line. Provide one telephone that includes a built in digital answering machine.

Internet and telephone service shall be supplied and operational no more than two weeks after the field laboratory has been set up on site. Service plans shall be provided and remain in effect for the duration of the use of the field laboratory.

- 3. If the lab is a mobile unit mounted on axles and wheels, block the structure under the frame so that the wheels do not touch the ground and the blocking rests firmly on the prepared site.
- 4. Provide a separate weatherproof shed within 20 feet of the main lab structure (Shaking Shed). Grade and compact a site for the Shaking Shed acceptable to the Engineer. Locate and level the structure on this site. If subsequent ground movement causes an unlevel or unstable condition, re-level or re-locate the facility as directed.
 - a. The Shaking Shed shall have the following minimum functional requirements:
 - (1) Floor 8 ft x 12 ft, ceiling height 8 ft
 - (2) Door 4 ft wide and window 5 ft² that opens, both lockable
 - (3) electrical service as identified in 644-2.09, #3 Field Laboratory Out Building
 - (4) Work table 3 ft x 1-1/2 ft x 3 ft high, capable of supporting 250 pounds and affixed to an inside wall as directed
 - (5) Concrete-slab floor, 8 ft x 8 ft x 4 inches thick, cast-in-place or pre-cast. Install anchor bolts in the floor to accommodate the mounting pattern of the Gilson sieving machine at a location as directed.

Found the slab directly on the prepared site such that it is continuously supported.

5. Provide a weatherproof pole shed adjacent to the Shaking Shack. Grade and compact a site for the Splitting shed acceptable to the Engineer. Locate and level the structure on this site. If subsequent ground movement causes an unlevel or unstable condition, re-level or re-locate the facility as directed.
 - a. The Splitting shed shall meet the following minimum requirements
 - (1) 12' x 24' Pole shed structure with 8' minimum ceiling height.
 - (2) Pole spacing 4' to 6'
 - (3) Water proof roof
 - (4) 2x4 construction, or manufactured structure approved by the Engineer.
 - (5) 6 each 4' T8 LED lighting fixtures with bulbs spaced evenly across the roof structure
 - (6) Manufactured, industrial strength, welded-metal shelving with total 52 square feet of shelving
 - (7) 2 walls
 - (8) Smooth rigid floor as approved by the Engineer
6. For all types of installations, if the entryway is located higher than a single 7-inch rise, provide the following:
 - a. Stairway, 3 feet wide x 11-inch tread x 7-inch rise
 - b. Landing, 4 ft x 4 ft centered on the entryway
 - c. Handrail(s) firmly affixed to the stairway
7. Provide the following lab equipment and services:
 - a. Propane necessary for the lab operation, including two 100-lb tanks, regulators, hoses, fittings, and incidentals for a functional system
 - b. Specialized sampling equipment such as belt templates or belt sampling devices as required
 - c. Fuel and power necessary to continuously operate the facilities
8. Provide the following to the Department's portable asphalt lab if there are any asphaltic materials in the bid schedule.
 - a. electrical service as identified in 644-2.09, #4 Asphalt Laboratory.
 - b. internet service as specified for the Field Laboratory.

644-2.03 CURING SHED. Furnish and maintain a suitable weather tight shed for curing concrete test cylinders, with a suitable tank(s) for curing concrete test cylinders.

Provide a tank(s) large enough to contain at least 6 each 4" x 8" test cylinders from each pour that you propose to make during any 28-day period. Use a tank(s) at least 18 inches high, insulated, and constructed of heavy duty plastic or non-corrosive metal. Construct a lid to provide access to the tank(s).

Provide suitable heating to maintain the temperature in the tank between 70° and 77°F at all times when curing the test cylinders. In addition, provide suitable thermometers in the shed and tank(s) to check the temperature.

Provide a supply of calcium hydroxide (high-calcium hydrated lime) sufficient to maintain a fully saturated water bath in the tank(s). Provide a source of potable water.

Provide one combination smoke alarm and carbon monoxide detector.

Provide electrical service as identified in 644-2.09, #5 Curing Shed

644-2.05 VEHICLES. Furnish and maintain vehicles in good condition that are less than six years old and with less than 100,000 miles on the odometer for the exclusive use of the Department throughout the project. Provide full-size four-wheel drive pickups or sport utility vehicles. The Special Provisions will state the required number and type of vehicles. Provide vehicles from two weeks before commencing work to one week after Project Completion. Maintain the vehicles in satisfactory running condition throughout the duration of the contract. Provide insurance, fuel, fluids, lubricants, tire repair/replacement, and windshield repair/replacements as needed. If a vehicle is down for more than 24 hours, provide a replacement Vehicle of the same type at no additional cost.

The State of Alaska is responsible for damage to any vehicle caused by its own negligent operation.

The Engineer will approve the vehicles prior to transporting them to the project site. In addition to use on the project, all of the vehicles will be allowed to make round trips to the Department's regional headquarters. Remove all vehicles from the project at the end of the Contract.

<u>Number of Vehicles</u>	<u>Type</u>

Equip each vehicle as follows:

1. Four wheel drive
2. Automatic transmission
3. Power steering
4. Air conditioning
5. Fire extinguisher & basic first aid kit
6. Jack and lug wrench
7. Load range E tires in good condition
8. Two full size load range E spare tires in good condition mounted on rims
9. 360-degree Permanent Beacon
10. 2 sets of keys
11. CB Radio with 48" Antenna for all projects more than 50 miles from Fairbanks.
12. 3 each AKDOT&PF magnetic stickers. Plans available at <http://dot.alaska.gov/documents/DOT-SOA-Construction-Magnets-Specs.pdf>

Materials Truck

Number of Vehicles

--

Meet the above requirements for a vehicle and the following:

1. 3/4 Ton Crew Cab Pickup
2. Minimum 500 lb hydraulic tailgate lift attached to the bed of the truck

644-2.06 NUCLEAR TESTING EQUIPMENT STORAGE SHED. Design, furnish and maintain a weatherproof, heated, and ventilated nuclear densometer/testing equipment storage shed for the Engineer to use exclusively throughout the contract. Install the building at least 15-feet from an occupied area at a location approved by the Engineer. Install the shed at least one week before the commencement of construction activities and maintain it until one week after Project Completion. Provide sufficient floor area for the nuclear testing equipment and a portable electric heater to maintain a minimum room temperature of 50°F. Design the building with enough floor area to provide sufficient clearance between the equipment, heater, and combustibles. Provide a commercial grade metal-clad exterior entrance door of 3'-0" min width by 6'-8" height with dead-bolt lockset. Hang the door so that hinge pins are not accessible from the exterior. Provide the Engineer with 2 keys to control access. Provide a 5/16" x 10 foot long welded steel

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security chain securely attached inside the structure with tamperproof hardware for the Engineer to secure the testing equipment. Provide electrical service as identified in 644-2.09, #7 Nuclear Testing Equipment Storage Shed. Secure the structure to the ground with tamperproof anchors to resist wind loads and prevent unauthorized movement of the building. The Nuclear Testing Equipment Storage Shed remains the property of the Contractor. Remove the shed from the site following project completion. The Nuclear Testing Equipment Storage Shed must be windowless.

644-2.07 STORAGE CONTAINER. Furnish, transport and maintain a weathertight, lockable, steel enclosed 20 foot long x 8 foot wide x 8 foot high wooden floored container for the storage of the Department's materials, supplies and testing equipment (but not nuclear equipment). Provide twenty equally spaced fastening points on the interior walls that are capable of securing the Department's contents. Door opening dimensions of the storage container shall be greater than 60 square feet. Supply necessary equipment to lift and move container with minimal disturbance to the Department's contents. The container shall not be moved by skidding or hook lift. The Contractor shall be listed as the shipper on all documents listing and acknowledging receipt of the Department's goods for shipment.

Deliver an empty and clean container to the Regional Materials Laboratory, or location acceptable to the Engineer, three weeks prior to transporting to the project site. Allow 7 days for the Department to load the container. Transport the loaded container to the project site. Set up container at a location approved by the Engineer at least one week before the commencement of construction activities and maintain it until one week after Project Completion.

1. Provide electrical service and other facilities as follows:

- a. Provide a stairway with railing, built to meet the International Building Code, if there is more than 12-inch difference in floor entry and existing ground elevation.
- b. Provide electrical service as identified in 644-2.09, #6 Storage Container.

Return the container to the Regional Materials Laboratory, or location acceptable to the Engineer, upon project completion. Allow 7 days for the Department to unload the container. The storage container remains your property after you complete the work.

644-2.08 FIELD COMMUNICATIONS. Provide internet and phone communication systems as directed by the Engineer.

644-2.09 ELECTRICAL POWER. Furnish and maintain a constant source of power to the facilities specified in the contract for the Department's use during the project. Provide a completely functional installation 2 weeks before commencing construction work through 2 weeks after Project Completion.

1. FIELD OFFICE. Provide electrical services as follows:

- a. Heating/Cooling adequate to maintain temperatures between 65° to 75°F
- b. Electrical current: 120/240 VAC, 60 cycle on 24 hour basis
- c. Wiring system to support a 40 amp user load demand with two 20-amp circuits
- d. Eight conveniently spaced outlets on the interior wall, consistent with local codes
- e. Eight 8ft LED minimum 5000 lumen lamps or sixteen 4ft LED minimum 2000 lumen lamps, between 2800K and 5000K color temperature

2. FIELD LABORATORY. Provide electrical services as follows:

- a. Heating/Cooling adequate to maintain temperatures between 65° to 75°F
- b. Electrical current: 120/240 VAC, 60 cycle on 24 hour basis
- c. Wiring system to support a 40 amp user load demand with two 20-amp circuits, GFI Protected
- d. Six conveniently spaced outlets on the interior wall, consistent with local codes

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- e. Eight 8ft LED minimum 5000 lumen lamps or sixteen 4ft LED minimum 2000 lumen lamps, between 2800K and 5000K color temperature
 - f. Exhaust fan: minimum 300 CFM
3. SHAKING SHED. Provide electrical services as follows:
- a. Heating/Cooling adequate to maintain temperatures between 65° to 75°F
 - b. Electrical current: 120/240 VAC, 60 cycle on 24 hour basis
 - c. Wiring system to support a 20-amp user load demand, GFI Protected
 - d. Three conveniently spaced outlets on the interior wall, consistent with local codes
 - e. Two 8ft LED minimum 5000 lumen lamps or four 4ft LED minimum 2000 lumen lamps, between 2800K and 5000K color temperature
 - f. Exhaust fan: minimum 300 CFM
4. ASPHALT LABORATORY. Provide electrical services as follows:
- a. Electrical current: 120/240 VAC, 60 cycle on 24 hour basis
 - b. 100-amp service
5. CURING SHED. Provide electrical services as follows:
- a. Heating/Cooling adequate to maintain temperatures between 70° to 77°F
 - b. Two 100-watt incandescent or four 4ft LED minimum 2000 lumen lamps, between 2800K and 5000K color temperature
6. STORAGE CONTAINER. Provide electrical services as follows:
- a. Electrical current: 120/240 VAC, 60 cycle on 24 hour basis
 - b. Wiring system to support a 20-amp user load demand, GFI Protected
 - c. Two conveniently spaced outlets on the interior wall, consistent with local codes
 - d. Four 100-watt incandescent or eight 4ft LED minimum 2000 lumen lamps, between 2800K and 5000K color temperature
7. NUCLEAR TESTING EQUIPMENT STORAGE SHED. Provide electrical services as follows:
- a. Heating/Cooling adequate to maintain minimum temperatures of 50°F
 - b. Electrical current: 120/240 VAC, 60 cycle on 24 hour basis
 - c. Two 100-watt incandescent or four 4ft LED minimum 2000 lumen lamps, between 2800K and 5000K color temperature
 - d. Wiring system to support a 20-amp user load demand
8. NUCLEAR TESTING EQUIPMENT STORAGE SHED (STATE PROVIDED). Provide electrical services as follows:
- a. Electrical current, 120/240 VAC, 60-cycle on 24-hour basis
 - b. Wiring system to support a 20-amp user load demand
9. PORTABLE CONCRETE COMPRESSIVE LABORATORY. Provide electrical services as follows:
- a. Electrical current: 120/240 VAC, 60 cycle on 24 hour basis
 - b. Wiring system to support a 20-amp user load demand

If 644.0015____, Nuclear Testing Equipment Storage Shed is deleted the electrical power requirement are still required per 644-2.09, #8.

If the contract contains bridge items that require concrete or grout provide electrical power to the Department's Portable Concrete Compressive Laboratory per 644-2.09, #9.

644-3.01 METHOD OF MEASUREMENT. Section 109 and as follows:

Storage Container. By the number of storage containers specified, to include all components, installed and accepted as completed units and ready for materials and equipment storage.

644-4.01 BASIS OF PAYMENT.

Vehicles. Includes all resources, including fuel, oil, maintenance, and insurance to furnish the specified number of fully operational vehicles for the duration specified in the contract.

Lump Sum Items. Payment for lump sum items will be made as follows:

1. A percentage of the lump sum amount, to be determined by the Engineer, will be paid as full compensation for furnishing the facility at the site.
2. The balance of the lump sum amount will be prorated over the anticipated active construction period with a portion included as part of each interim payment, for maintenance, repairs, providing all utilities, and for removing it from the site. If anticipated construction period changes, the final increment will be held until final payment.

Storage Container. At the contract unit price to include all labor, materials, tools, equipment and supplies required to deliver the storage shed to the regional office for loading, to deliver it to the project office, to install it before commencement of construction, to maintain it for the duration of the project, to remove the shed and electrical service after project completion, to deliver it to the regional office for unloading, and to remove the storage shed. Electrical service and utility costs are subsidiary to this item.

Field Communications. Installation and maintenance of equipment and monthly invoice costs will be paid for by Contingent sum under Item 644.2002.0000, Field Communications. Provide invoices from vendor for installation, maintenance, and monthly subscription costs. When this bid item appears in the Bid Schedule, internet and phone service are not subsidiary to 644.0001. ____ Field Office.

Payment will be made under:

PAY ITEM		
Item Number	Item Description	Unit
644.0001.____	Field Office	LS
644.0002.____	Field Laboratory	LS
644.0003.____	Curing Shed	LS
644.0006.____	Vehicle	LS
644.0015.____	Nuclear Testing Equipment Storage Shed	EACH
644.0016.____	Storage Container	EACH
644.2002.0000	Field Communications	CS
644.2010.0000	Nuclear Testing Equipment Storage Shed	LS

**SECTION 660
SIGNALS AND LIGHTING**

660-1.01 DESCRIPTION. *Add the following to the first paragraph:* This work shall include installing Dynamic Messaging Sign, controller cabinet, controllers, and all additional work and materials as noted or detailed on the Plans, in the Specifications, and in these Special Provisions.

660-1.02 DEFINITIONS.

2. **Luminaire.** *In the second sentence, delete “including socket” and substitute the following:* including socket, lamp, and ballast or LEDs and driver.

Add the following:

5. **Interconnect.** In Section 660, unless otherwise specified, interconnect refers to the use of twisted pair copper wires (telemetry cable) that is used to transmit and receive data between field devices and/or a Traffic Operations Center. See Section 662 for Fiber Optic Signal Interconnect System.

6. **Dynamic Message Sign (DMS).** In Section 660, unless otherwise specified, DMS is industry term that applies to various types of changeable sign technology that is used to transmit and display messages from a Traffic Operations Center.

7. **Sign Mounting Structure.** Structural components and associated hardware used to physically attach the DMS to the steel pipe support.

660-2.01 MATERIALS. *Add the following:*

Anchor Bolts:	Subsection 740-2.02
Structural Steel	Section 504
Drilled Shaft	Section 515

Submit certification from the suppliers for all steel products incorporated into the signal and lighting items indicating origin with the material catalog cuts or the shop drawings in accordance with Subsection 106-1.01, Source of Supply and Quality Requirements.

1. **Equipment List(s) and Drawings.** *In the first sentence, delete “30 days” and substitute the following:* 15 days.

a. **Materials on the Qualified Products List:** *Delete in its entirety and substitute the following:* The Qualified Products List does not apply to the 660 items. Provide catalog cuts of materials to the Engineer for review and approval.

d. **Materials Not Requiring Certification:** *Delete in its entirety and substitute the following:* Incidental materials incorporated into the work (such as nuts, ties, bolts, washers, etc.) must meet all applicable Specifications and be installed per all manufacturer’s recommendations. Only submit these materials for review and approval if they are included on the Materials Certification List (MCL).

2. **As-Built Plans.** *Add the following:* Place one (1) copy of the controller cabinet diagram and the intersection and phase diagram as reviewed by the Engineer in a clear plastic envelope and attach to the inside of each controller cabinet.

660-3.01 GENERAL.

1. Scheduling of Work: *Add the following:* Contact the regional DOT&PF Traffic Section (telephone 907-451-2323) 24 hours in advance of any work on a signal or lighting system. Contact shall be made through the Engineer.

After staking pole, cabinet or transformer foundations, verify there will be no overhead or underground utility conflicts with foundations or conduits. Locate and protect all existing underground and overhead utilities. The location of cables, conduits, J-boxes, foundations and poles that are shown on the plan sheets are approximate and it is your responsibility to verify the actual location when working in the area. See Subsection 105-1.06.

State technicians will perform all necessary signal controller timing and programming changes. All other work shall be by the Contractor. Notify the Engineer five working days (Monday – Friday) prior to commencing signal modification work. This will allow State technicians time to prepare necessary programming and timing changes, and to coordinate their activities with the Contractor.

Existing signing and traffic markings shall not be allowed to conflict with new signal modifications. New signing and traffic marking modifications shall not conflict with existing signals and shall be kept current with signal modifications.

Conduct all work with the existing traffic signal systems remaining in operation unless authorized otherwise by the Engineer.

The signal system may be turned off if necessary for signal modification work when authorized by Subsection 660-3.01. 7. f. (1) the Engineer. Signal outages may only be scheduled for Monday through Thursday, between the hours of 9:00 p.m. and 6:00 a.m. Signal outages may not occur on observed holidays. Prior to turning signal systems off, set the signal to flashing operation while R1-1 STOP signs (48"x 48") are posted for the approaches which flash red. After these approaches are posted with STOP signs, the signal system may be turned off, and STOP signs posted for all remaining approaches. Two STOP signs are required for each approach. Mount each STOP sign with a high level warning device at a mounting height of 5 feet.

The Contractor must complete the signal and signing modifications for any one approach during one night's shift (9:00 p.m. to 6:00 a.m.) where signal systems are allowed to be turned off. Wiring modifications, including signal controller cabinet wiring, must be completed and ready for inspection and testing by State technicians at 6:00 a.m. of the same day. The Contractor must have an electrician present during the inspection and testing process. The State technician must place the signal system back into normal operation after the Contractor has corrected any deficiencies.

Remove all temporary STOP signs during flash operation. The Contractor shall return signal systems that have been turned off, to flashing operation before the work is completed, prior to the arrival of the State technician. At least one signal head per signal phase must flash, and only after the Engineer has inspected the work to insure correct flashing operation colors.

All incidental materials and other items which are not shown on the Plans, assembly drawings, or specified herein, which are necessary to complete the system, must be furnished and installed as though such materials and other items were shown on the Plans, assembly drawings, or specified herein.

Protect all metallic materials against corrosion. Hot-dip galvanize all ferrous metals such as bolts, braces, bodies, clamps, fittings, guards, nuts, pins, rods, shims, thimbles, washers, and miscellaneous parts not of corrosion-resistant steel, in accordance with ASTM A 123 or A 153, except where other equivalent protection treatment is specifically approved in writing by the Engineer.

2. **Safety Precautions:** *Add the following:* Existing circuits listed on the wiring diagrams and plan sheets were obtained from as-built information and must be verified prior to work involving those circuits.

Delete numbered paragraphs 3. through 8. in their entirety and substitute the following:

3. **Excavating and Backfilling.** Complete excavation and backfill required to install the signal and lighting components embedded in the roadway as shown on the Plans, including foundations, conduits, junction boxes, and loop detectors before final lift paving. Provide traffic control to complete this work according to the requirements of Section 643. Place excavated materials where it will not interfere with surface drainage.

Support and protect conduits and utilities scheduled to remain in service when encountering them during excavation.

Excavate trenches wide enough to install the number of conduits specified and to compact the bedding and backfill materials according to these Specifications.

To install conduits, excavate trenches deep enough to allow for 6 inches of bedding material, the depth of the largest conduit, and the minimum burial depth specified between the top of the conduit and finished grade of the ground above the conduit. Keep the longitudinal profile of trench bottoms free of irregularities that would prevent the assembled conduit run from continuously contacting the top of the bedding material.

When conditions allow HDPE conduit to be installed by a plowed technique, restoring the area disturbed from the process, shall be accomplished according to Subsection 204-3.01. Density testing may be waived and compactive effort substituted at the discretion of the Engineer. This work is subsidiary to conduit installation. Use Selected Material, Type A for backfill.

Dispose of, according to Subsection 203-3.01, excavated materials that remain after completing backfill work and excavated material not meeting the requirements of Selected Material, Type C, as defined in Subsection 703-2.07. Disposal of this material is subsidiary to the 660 Pay Items.

Dewater foundation and conduit excavations immediately before and during embedding and backfilling operations. Backfill excavations with materials that meet the following requirements:

- a. Backfill foundations with material that meets the requirements of Selected Material, Type A that passes through a 3 inch sieve.
- b. Within the limits of the typical section, embed conduits and backfill trenches using material that meets the requirements of the lift where it is located, reusing excavated materials if it meets the requirements of the applicable lift.
- c. In other locations, embed conduits and backfill trenches using material that meets the requirements of Selected Material, Type C, reusing excavated materials if it meets this requirement.
- d. Import, when ordered, embedment and backfill materials that satisfy the preceding materials requirements.

Embed conduit(s) between two 6 inch lifts of material cleaned free of rocks exceeding a 1 inch maximum dimension. Grade and compact the first lift to provide a surface that continuously contacts the assembled conduit run.

Within 6 feet of paved surfaces and around foundations, backfill in uniform layers no more than 6 inches deep and compact each layer according to Subsection 203-3.04. In other locations, compaction may be as approved by the Engineer.

4. **Welding.** Complete welding according to Section 504. Welding and approved shop drawings.

Submit shop drawings of the proposed work with the welding plans for approval. The shop drawings shall include material specifications, component dimensions, the types of welds that will be made, and the proposed type and extent of weld inspection.

Repair the holes that were used to mount equipment, in reused poles and mast arms by welding in disks flush with the adjoining surface. For the disk material, use steel that matches the ASTM designation, grade, and thickness of the steel used to fabricate each pole. Cut disks that match the dimensions of the hole being repaired from pieces of steel plate bent to match the pole's radius at the hole. Grind the welds smooth and flush with the adjoining pole and disk surfaces. Repair the damaged finish according to Subsection 660-3.01.8.

5. **Removing and Replacing Improvements.** The Contractor shall complete the following work at the Contractor's expense.

- a. Remove improvements that block completion of the work detailed on the Plans as specified herein.
- b. Reconstruct with new materials the nonreusable improvements the Contractor removed to complete the work.
- c. Replace with new materials the reusable items damaged by the Contractor, that are specified for reuse.
- d. Reconstruct with new materials improvements damaged or removed by the Contractor not conflicting with the work and not scheduled for removal.

Nonreusable improvements consist of cast in place items, including: asphalt concrete pavement, sidewalks, curb and gutter, lawns, and traffic markings. Reusable improvements include the items that were made before installation. Excavated material may not be used as backfill in the base course if excavation depth exceeds the thickness of the base course.

Complete reconstruction work, including materials, according to the applicable sections of the Alaska SSHC, and leave the work in a satisfactory and serviceable condition. In completing the reconstruction work, match the alignments, widths, thicknesses, shapes, sizes, typical sections, cross sections, and finishes of the existing improvements.

If removing a portion of sidewalk or curb and gutter, remove an entire segment between the weakened plane contraction joints or between an expansion joint and a weakened plane contraction joint.

Before removing a segment of Portland or asphalt cement concrete material, cut completely through the material with a saw along the outline of the area to be removed. Make cuts neat and true and prevent shatter outside the area removed.

To replace lawns, leave the top of the backfilled excavation low enough to install 4 inches of compacted topsoil. Match the top of the topsoil with the bottom of the vegetative mat. Apply seed and keep the seeded areas watered according to Section 618.

Remove, keep alive, and replant trees, shrubs, and plants according to Section 621. Replace the trees, shrubs, and plants that do not survive with plants of like size and type.

6. Salvaging and Reusing Electrical Equipment. When the Plans include existing electrical equipment scheduled for removal or relocation, remove, and store the equipment listed in the following paragraph without damaging it. Deliver removed equipment not scheduled for reuse to the local District Maintenance Station, or place specified on the Plans or Special Provisions. Notify the district superintendent or person specified by telephone one week before planned delivery date.

Salvage the controller assemblies, load centers, and video cameras. The Contractor shall replace at the Contractor's expense salvaged equipment damaged or destroyed before or during delivery or reinstallation.

Controller assemblies and load centers include the cabinet and equipment contained in the cabinet (that is to be replaced) before Contract award.

Remove from the highway right-of-way materials associated with the equipment removed or relocated and not scheduled for reuse, including conduits, junction boxes, conductors, and foundations. Raze the tops of foundations abandoned in place according to Subsection 660-3.02. Fill the holes left by removing junction boxes and foundations with Selected Material, Type A and compact as directed.

Within 15 days of the Notice to Proceed, complete an inventory of the materials that will be salvaged in the presence of the Engineer. Note the location and condition of the materials. When material specified for reuse is found in an unserviceable condition, the Engineer will determine whether to repair it or replace it with new material that will be paid for as extra work under Subsection 109-1.05. Retain a copy of the inventory and give the original documents to the Engineer.

When the Plans specify reinstalling existing equipment at new locations and installing State furnished equipment, complete the following work at the Contractor's expense.

- a. For poles, install new foundations, furnishing the new nuts, bolts, washers, and conduits needed to complete the installations.
- b. For lighting poles, install new illumination tap wires and fused disconnect kits.
- c. For luminaires, clean the luminaires inside and out and install new lamps of the same wattage.
- d. For signal heads, furnish and install the mounting brackets needed to complete the relocation, and clean the signal heads inside and out.
- e. For poles and undisturbed poles from which the Plans specify removing equipment, repair the holes that were made to mount equipment according to Subsection 660-3.01.4 Welding and repair the finishes according to Subsection 660-3.01.8 Repairing Damaged Finishes.

When ordered, the Engineer will pay for repairing existing damaged finishes on existing equipment according to Subsection 660-3.01.8 as extra work.

If deciding to use new equipment rather than reusing the equipment specified, notify the Engineer of the change and include a submittal according to Subsection 660-2.01.1.

Deliver the salvaged materials undamaged to the local DOT & PF Maintenance and Operations Yard.

Contact the local state Electrician one week before planned delivery.

7. Field Tests. Electrical circuits must pass the following tests before the Engineer will accept the work for payment. Perform these tests in the presence of the Engineer, and document the results of each test on a per circuit basis. Retain a copy of test results and give the original documents to the Engineer. Furnish equipment needed to perform these tests.

Replace or repair at the Contractor's expense, and in an approved manner, faulty materials and work revealed by these tests. After making repairs, repeat tests on the repaired circuit and continue this process until circuits have passed required tests. The Department reserves the right to have the Contractor retest circuits, and to use the retest results to accept or reject individual circuits.

a. Grounds. Before completing the circuitry and functional tests, physically examine conduits ends, junction box lids, load centers, and the foundations for signal posts and poles, lighting poles, and controller cabinets to ensure the grounding system required by Subsections 660-3.06 and 661-3.01 has been installed and splices and connections are mechanically firm.

b. Continuity. Test each loop detector circuit for continuity at the roadside junction box before splicing the loop detector to the lead-in cable. Each loop detector must have a resistance less than 0.5 ohms.

After splicing the loop detectors to the lead-in cables, test each pair at the controller or detector cabinet. Each pair must have a value less than 5 ohms for single pair lead-in cables and 10 ohms for multipair lead-in cables. The continuity test ohm reading at the cabinet must be greater than the ohm reading measured for the loop detector at the junction box.

c. Insulation Resistance (megohm) Test. Complete this test to verify the integrity of each conductor's insulation after pulling the conductors and cables into position and before terminating the conductors. At 500 VDC, each conductor's insulation shall measure a minimum resistance of 100 megohms or the minimum specified by the manufacturer. With single conductors, complete the test between each conductor and ground. In each multiconductor cable, complete the test between conductors and between each conductor and ground.

After splicing the loops to the shielded pairs in the lead-in cables, measure each pair in the lead-in cables at the controller or detector cabinet between one conductor and the cabinet ground rod. Upon acceptance, document these tests in writing, for each circuit, and submit one (1) copy to the Engineer and one (1) copy to Traffic Signal Maintenance.

d. Inductance Test. Measure each detector loop and lead-in cable system at the controller or detector cabinet. The inductance must be in the range of 50 to 500 microhenries.

e. Circuit. Energize every signal indication circuit with lamps installed before installing the load switches.

f. Functional. Perform the following tests on each signal and lighting system after the component circuits have satisfactorily passed the tests for continuity, grounding, insulation integrity, and circuitry.

(1) For each new traffic signal system, complete at least 24 hours of flashing operation, followed by not less than 5 days of continuous, satisfactory operation. The Engineer may decide to omit the flashing portion of the test for modified signal systems and for new signals that replaced existing signals that remained in operation during the construction phase.

If the Engineer omits flashing operation and the system performs unsatisfactorily, correct the condition and repeat the test until the system runs for five days with continuous, satisfactory operation.

Begin the signal functional tests between 9:00 a.m. and 2:00 p.m. on any day, except a Saturday, Sunday, a legal holiday, or the day before the legal holiday.

Before each system turn on, aim signal faces according to Subsection 660-3.08 and ensure equipment specified on the Plans is installed and operable, including: pedestrian signals and push buttons; signal backplates and visors; vehicle detectors; highway lighting; and regulatory, warning, and guide signs.

- (2) Perform the functional test for each highway lighting system and sign illumination system until the systems burn continuously 5 days without the photocell, followed by a 5 day operational test using the photocell.
- (3) Perform the functional test for each flashing beacon system for not less than 5 days of continuous, satisfactory operation.
- (4) Perform a continuous 5 day burning test on each pedestrian overpass and underpass lighting system before final acceptance.

A shut down of the electrical system due to a power interruption does not constitute discontinuity of the functional test if the system functions normally when power is returned.

8. Repairing Damaged Finishes. Examine new, reused, and State furnished equipment for damage to its finish before putting the equipment into service. Repair the damaged finishes found according to the following:

- a. Galvanized. Repair damaged areas more than 12 inches away from welds and slip fit areas, by applying minimum 7.8 mils of zinc based alloy applied according to ASTM A780.

If the damaged areas are within 12 inches of welds and slip fit areas, make the repair by applying a minimum 7.8 mils of zinc rich paint applied according to ASTM A780.

- b. Painted. Repair damage to painted finishes according to the following

- (1) Wash the equipment with a stiff bristle brush using a solution containing two tablespoons of heavy duty detergent powder per gallon of water. After rinsing, wire brush surfaces to remove poorly bonded paint, rust, scale, corrosion, grease, or dirt. Remove dust or residue remaining after wire brushing before priming.
- (2) Factory or shop cleaning methods may be used for metals if equal to the methods specified herein.
- (3) Immediately after cleaning, coat bare metal with pretreatment, vinyl wash primer, followed by 2 prime coats of zinc chromate primer for metal.
- (4) Give signal equipment, excluding standards, a spot finishing coat on newly primed areas, followed by 1 finishing coat over the entire surface.
- (5) Give nongalvanized standards 2 spot finish coats on newly primed areas.

Paint coats may be applied either by hand brushing or by approved spraying machines. Perform the work in a neat and workmanlike manner. The Engineer reserves the right to require the use of brushes for the application of paint, should the work done by the paint spraying machine prove unacceptable.

Add the following:

9. Regulation and Code. Complete work according to the standards of the NEC, the NESC, and local safety codes as adopted and amended by the Authority Having Jurisdiction.

660-3.02 FOUNDATIONS.

1. **Cast-in-Place and Precast Foundations.** *Add the following to the first paragraph:*

Adhere to Section 515 for all foundations identified as drilled shafts on the Plans.

3. **All Foundations.** *Add the following:*

- e. Protect foundation anchor bolts from damage before installing controller cabinets or DMS pole.

The method of protection must be approved by the Engineer. This work does not relieve the contractor of any responsibility specified under Subsection 107-1.15.

660-3.03 CONDUIT. *Delete this subsection in its entirety and substitute the following:* Electrical conductors shall be installed in conduit, except for overhead wiring, wiring inside poles, and when otherwise specified. Use rigid metal conduits (RMC) and fittings for raceways, including bored casings, except when the Plans specify using polyethylene conduits. Install conduits of the sizes specified along the routes detailed on the Plans. When routing is not shown, route conduits as directed by the Engineer.

1. Install conduits at least 30 inches below the finished grade of the ground above the conduit, except conduits that will be sealed under a minimum 4 inch thick Portland cement concrete sidewalk may be installed a minimum of 18 inches below the top back of curb or surface above the conduit, whichever is lower.
2. Install conduits that cross unpaved areas and paved roadways that will be overlaid in excavated trenches. Excavate, bed conduits, and backfill trenches according to Subsection 660-3.01.3, Excavating and Backfilling.
3. Install conduit(s) under paved roadways and approaches that will not be overlaid in excavated trenches. Jacking conduits into position is allowed. However, if subsurface conditions prevent the successful completion of the work, install the conduit(s) by boring or drilling methods without additional compensation.
4. If encountering obstructions during jacking or drilling operations obtain approval and cut small holes in the pavement to clear the obstruction. Locate the bottom inside face of the bore pit no closer than the catch point of a 1.25:1 slope (a horizontal to vertical ratio) from the edge of pavement. Install approved means of protection around pits.
5. Sweep both rigid metal and polyethylene conduits through the open bottom of junction boxes by installing 90 degree rigid metal elbows on the ends of conduit runs. To each elbow, install a nipple that terminates 5 to 12 inches above the bottom edge of each junction box.
6. Install the tails of loop detectors without elbows through the walls of junction boxes at elevations that ensure the loops drain into the box. Extend the ends a minimum of 2 inches beyond the inside wall of the box.
7. Drill a 3/8 inch drain hole in the bottom of the lower straight section of elbows and in the bottom of conduits at the low points of conduit runs. Smooth the edges of the drilled holes on the inside of elbows to prevent scraping the conductors. Cover the holes with a wrap of approved filter cloth secured with 2 self-clinching nylon cable ties.
8. Keep conduits clean. Install grounding bushings and approved plastic insert type plugs on the ends of conduit runs before backfilling around the conduit ends.

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9. At the low points of conduit runs, install sumps containing a minimum 2 cubic feet of washed porous backfill material that conforms to Subsection 703-2.10. Compact the aggregate sumps as directed to prevent settlement of the trench backfill.
10. Install conduits that must cross existing facilities such as storm drain pipes, duct systems, and other underground utilities at the minimum depths specified, going under the facilities if necessary. Install additional drains and aggregate sumps at the low spots, if any.
11. Position conduits in trenches, junction boxes, and foundations to provide clearances of at least 2 1/2 inches around 2 inch conduits and at least 2 inches around conduits larger than 2 inches.
12. Fabricate rigid metal conduits less than 10 feet long from standard lengths of conduit. Cut conduits squarely to ensure the threading die starts squarely on the conduit. Cut the same number of threads as found on the factory threaded ends. Ream the inside of conduit ends cut in the shop or field to remove burrs and sharp edges. Do not use slip joints or pieces of running thread pipe.
13. Coat drilled holes, shop and field cut threads, and the areas with damaged zinc coating with zinc rich paint.
14. When standard couplings cannot be used to join conduit components, use approved threaded unions.
15. Bury a continuous strip of 4 mils thick, 6 inch wide polyethylene marker tape above underground conduit runs. Install the tape 9 inches (\pm 3 inches) below finished grade, using two strips side by side to mark road crossings. Furnish tapes with a black legend on a red background.
16. When the Plans specify using polyethylene conduit, install RMC in structures and foundations, between type 2 and 3 load centers and the nearest junction box, and on the surfaces of poles and other structures.
17. In foundations, install 90 degree elbows and conduits of the size and quantity shown on the Plans. Extend the conduits a maximum of 3 inches above the top of the foundations for posts and poles with breakaway bases and 4 inches above the top of foundations for fixed base structures.
18. Seal conduits leading to electrical equipment mounted on soffits, walls, and other locations below the grade of the serving junction box with an approved duct sealing compound.
19. Install expansion fittings in conduits that cross expansion joints.
20. Install a polypropylene pull rope with a minimum 200 pound tensile strength in future use or spare conduits, and reinstall the plugs. Double back pull rope, at least two feet, into both ends of each conduit.
21. The Contractor may install conduits larger than the sizes specified. If used, it must be for the entire length of the run. Reducing couplings or bushings are not allowed. Complete work associated with installing conduits larger than specified without extra compensation.
22. Clean existing conduits that will remain in service using a heavy duty air compressor that delivers at least 125 cubic feet of air per minute at a pressure of 110 pounds per square inch. Clean the conduits before pulling in new cables and after removing cables to be removed or replaced as follows:
 - a. When the conduits contain cables that will remain in service, leave the cables in place during the cleaning, and
 - b. Ream empty conduits with a mandrel or cylindrical wire brush before blowing them out with compressed air.

23. When modifying existing conduit runs, complete the work as required for new installations using the same sizes and types of conduit. When extending existing conduits, add no more than a 90 degree horizontal bend to the extension.
24. When installing a junction box in a continuous run of existing conduit, remove a length of conduit in each conduit run and complete the work of installing the conduits, elbows, and nipples as required for a new installation.
25. When adjusting existing junction boxes to a new grade, remove cables and replace the nipples as required to provide the clearances specified for new installations.
26. Remove the ends of abandoned conduits from junction boxes that will remain in service.
27. When Plans call for connecting polyethylene conduit to RMC use a UL listed electrofusion coupler rated for direct bury application. The coupler must be rated for same wall thickness as the adjoining conduits. Thread the ends of the RMC with the same number of threads as found on the factory threaded ends of RMC. Ream the inside of conduit ends cut in the shop or field to remove burrs and sharp edges.
28. Prior to HDPE buried conduit installation, provide a short demonstration section of conduit with an electrofusion coupling cut out and split for destructive testing and approval of fusion.
29. Assure that the conduit is open, continuous, and free of water and debris prior to installing cable. Pull a stiff bristle brush through the entire length of the conduit run immediately prior to the cable being installed. Grade conduit uniformly straight and without sags.
30. Make any butt connections between high-density polyethylene conduit sections above ground prior to laying in the trench. Couple HDPE conduit to rigid metal conduit for all surface exposures. Butt-weld the conduit using the manufacturer's recommended procedures and equipment or couple with compatible molded HDPE electrofusion couplings (as acceptable with the conduit manufacturer). Connections to RMC may be made below grade as necessary to connect with existing infrastructure using care to prevent foreign matter from entering the conduit. If using coilable conduit, each run may only be one section so there won't be any butt-welded connections needed. All bending of conduit will be by means recommended by the manufacturer.

660-3.04 JUNCTION BOXES. *Add the following to the fifth paragraph:* Install a sump (stone drain) to the dimensions shown on the plans or equaling the length and width of the junction box and to a depth of 18 inches. Sump material shall be a washed porous backfill material that conforms to Subsection 703-2.10. A mortar brick base, pavers, concrete block or stepping stones shall line the entire bottom perimeter of all new, relocated, or adjusted Type I, IA, II and III junction boxes, as shown on the Plans. Compact the aggregate sumps as directed to prevent settlement of the trench backfill. Compact gravel drain material under J-boxes as directed by the Engineer to prevent settlement of foundations, J-boxes, and adjacent improvements.

Add the following: When noted, or when new conduits are routed to an existing junction box, the existing junction box shall be adjusted. When new junction boxes are used to replace existing junction boxes they may require modifications as approved by the Engineer.

660-3.05 WIRING. *Delete the last sentence of the first paragraph and substitute the following:* Run signal cabling continuously without splices from the controller cabinet to the termination lugs in the signal housing. Do not splice conductors within cabinets, poles, signal heads, and luminaries.

Add the following to numbered subparagraph 7: Spare lighting conductors shall be capped in the pole bases and load centers by cutting the wire flush with the end of the insulation and bending the conductor back against itself and securing with three layers of electrical tape to prevent any possibility of making contact with ground or current carrying conductors

In numbered subparagraph 11 delete the fourth paragraph and substitute the following: Insert a loose woven polyester web that allows for a full ¼ inch of insulating compound to flow between the splice and the inside of the mold. Fill the PVC molds with non-re-enterable polyurethane electrical insulating and sealing compound that is nontoxic, is non-corrosive to copper, and does not support fungi or mold growth.

In numbered subparagraph 13 delete the word “bases” and substitute the following: base terminal compartments.

660-3.06 BONDING AND GROUNDING. Delete this subsection in its entirety and substitute the following: Bond and ground branch circuits according to the NEC and the following requirements: Make noncurrent carrying but electrically conductive components, including: metal conduits, junction box lids, cabinets, transformer cases, and metal posts and poles, mechanically and electrically secure to an equipment grounding conductor. Make fixtures mounted on metal poles, including signal components and luminaires, mechanically and electrically secure to the pole.

Install grounding bushings with insulated throats on the ends of metallic conduits.

Install a bare stranded copper wire for the equipment grounding conductor in conduits, except those conduits installed for future use. Install size #8 AWG grounding conductors, except in those conduits that contain circuit conductors larger than #8 AWG. In this case, install a wire equal in size to the largest circuit conductor. Attach the grounding conductors to the grounding bushings, leaving 12 inches of slack between each bushing. Connect grounding conductors together using irreversible compression type connectors to form a fully interconnected and continuous grounding system.

Retrofit existing spare conduits that will contain new cables exclusively with new grounding bushings. When the Plans require installation or removal of conductors from existing conduits, retrofit with new grounding conductors sized according to the preceding paragraph.

Bond junction box lids to the grounding conductor using copper braid with a cross sectional area equal to a #8 AWG and eyelet spaced at 6 inch intervals. Copper braid shall be a minimum of three feet long for Type I and IA junction boxes and a minimum of six feet long for Type II and III junction boxes. Connect bonding jumpers to the grounding conductors using irreversible compression type connectors. Replace missing or damaged conduit and junction box lid bonding jumpers.

Join the equipment grounding conductors from the conduits to the #4 AWG grounding electrode conductor using irreversible compression connectors at Portland cement concrete foundations. For pile foundations, attach the equipment grounding conductor from the conduit to the pile cap adapter with a listed mechanical grounding connector.

When installing signal poles, signal posts, and lighting standards with frangible coupling bases, run a 5 feet long grounding conductor from the grounding bushing on the conduit to the grounding lug located in the handhole of each pole.

Bond slip base type standards and pedestals by using 2 conductors from the conduit, one attached with a ground rod clamp to an anchor bolt and the other connected to the grounding lug located in the handhole of each pole.

Ground one side of the secondary circuit of a transformer.

Install a 3/4 inch by 10 feet copper clad ground rod inside each controller cabinet foundation and a 6 AWG bare stranded copper wire for the grounding electrode conductor.

When routing a new conduit into an existing junction box or replacing an existing junction box, new and existing conduits shall have the grounding improved to current specifications.

Ground rods shall be installed in J-boxes when required for an electrically secure system.

660-3.07 TRAFFIC CONTROLLER ASSEMBLIES.

1. **Shop Tests.** *Delete the first three paragraphs and substitute the following:* Deliver the controller units, auxiliary equipment, and fully wired cabinets (including wiring diagrams and manuals) to:

Department of Transportation and Public Facilities
Signal Maintenance Shop
2301 Peger Road
Fairbanks, Alaska 99709
Attn: Traffic Safety Engineer

The Department will not sign for or accept shipments from suppliers, vendors or shipping companies. The Contractor must be present at time of delivery if materials are shipped directly from vendor to the Department, and the Contractor shall be solely responsible for the materials being delivered.

All items must arrive together in one shipment. Partial shipments will not be accepted and will be returned to the Contractor.

Notify the Traffic & Safety Engineer, through the Engineer, two weeks prior to equipment arrival so scheduling of testing can be arranged.

Allow 6 weeks for shop testing.

Use traffic signal equipment that meets the operational and functional requirements of the Plans and Specifications when tested according to NEMA Standards Publication No. TS 2-1992, *Traffic Controller Assemblies*.

Delete the last paragraph.

3. **Controller Operation.**

- f. **Controller Priorities.** *Delete the second paragraph and substitute the following:* Provide emergency vehicle preemption operations in accordance with NEMA Standards Publication No. TS 2-1992, *Traffic Controller Assemblies*, Section 3.7 *Preemption* and the following:

660-3.08 SIGNAL AND LIGHTING STRUCTURES. *Add the following:* Apply antiseizing compound to the following fasteners: frangible couplings, mechanical grounding connectors, bolts that secure handhole covers and signal mounting hardware to poles and mast arms. Remove the fasteners from luminaire mounting brackets, fused disconnect kits, grounding bushings, and signal faces that secure the visors, and apply antiseizing compound to these fasteners before completing the installation.

Before passing conductors through the holes made in posts, poles, and mast arms for wireways, remove the burrs and sharp edges from the inside and outside of these holes.

Until each traffic signal and/or flashing beacon goes into operation, keep the vehicular and pedestrian signal faces covered with beige colored canvas shirts sized to fit the signal faces shown on the Plans. Each signal shirt shall feature elasticized openings that fit over the visors and at least two straps to secure it to the signal. Provide shirts with a legend that reads "out of service" and a center section that allows an operator to see the indications during system tests.

When not shown on the Plans, determine the shaft lengths of lighting and signal poles and signal mast arm connector plate locations to provide the plan mounting heights of luminaires and traffic signal heads.

4. Signal Head Mounting. *Add the following:* Prior to drilling holes or installing pole/post mounted pedestrian or traffic signals, the Contractor with the Engineer shall check for visibility problems and when required revise mounting as approve by the Regional Traffic Safety Engineer.

Immediately correct any misaligned signal heads, pedestrian heads, or nonconforming work found by the Engineer or his designee within 12 hours of notification.

Once the Contractor has changed any signal lamps within a signal head, the Contractor assumes responsibility for alignment of that head until it is accepted by the Department.

Generally, pedestrian signals are arranged in pairs with one pair per crosswalk. The Contractor must ensure that only one pedestrian signal per pair is disconnected at any one time. Failure to do so will cause the intersection to automatically be placed in flashing operation. Install pedestrian signals according to manufacturer's recommendations.

With two piece mast arms, do not install signal heads within 12 inches on either side of the slip type field splice.

Attach each side mounted terminal compartment with two 1/2" x 13 bolts, with washers, threaded into holes tapped into the side of the pole at the location shown on the Traffic Signal Hardware Detail Sheet on the Plans. Install the vertical pipe members plumb.

When installing 5 sections vertically stacked signal heads on the sides of poles, secure the vertical pipe to the pole using a steel conduit hanger mounted 6 inches below the top horizontal pipe.

5. Pedestrian Push Button Installation. *Delete the second sentence in the second paragraph and substitute the following:* Install push button signs above each push button.

Add the following:

6. Sign Mounting Structure. Design a structural support system and provide the structural components necessary to connect the DMS to the steel pipe support. Calculations, plans, and specifications must be signed and sealed by a Licensed Professional Engineer in the State of Alaska and meet the requirements of the AASHTO *LRFD Specifications for Highway Signs, Luminaires, and Traffic Signals, First Edition* with the latest interim revisions and other specifications as appropriate. Consider all relevant loading conditions. The Engineer will determine the applicability of loads in the event of a disagreement. Do not exceed the maximum loads shown on the Plans.

Submit all design calculations, plans, and specifications to the Engineer for approval 30 days prior to ordering or fabricating the sign, mounting structure, steel pipe support, and foundation.

660-3.09 MAINTAINING TEMPORARY AND EXISTING ELECTRICAL SYSTEMS. *Add the following to the second paragraph:* 48 hours prior to any traffic signal system shutdown and/or changeover, the Contractor must supply the Northern Region Traffic Safety Engineer with a detailed plan and set of procedures proposed for any such shutdown or changeover. This plan should include but not be limited to:

- Date of proposed change over
- Time period during the day for proposed change over
- Proposed traffic control plan during the change over

The Northern Region Traffic & Safety Engineer must approve this plan prior to implementation.

Add the following subsection:

660-3.11 MANUFACTURER ASSISTED START UP. Provide an on-site manufacturer's representative for the following systems:

GE LightGrid Wireless Control System

A representative for the manufacturer shall be on site during system startup to troubleshoot and provide guidance on modifications as necessary.

Wavetronix Radar Presence Detection System

Submit a pre-construction plan for positioning and orienting the radar presence detectors to be approved by a Wavetronix Radar Presence Detection System Manufacturer's representative.

Wavetronix Radar Presence Detection System Manufacturer shall be on site during system startup to trouble shoot and provide guidance on modifications as necessary.

Traffic Controller Assembly

The Contractor shall retain the services of a representative from the controller equipment manufacturer (Manufacturer's Representative), subject to the approval of the Engineer. The Manufacturer's Representative shall have previous experience with either the Northern Region DOT&PF or Central 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 controller unit, amplifiers, and related equipment shall be performed by or directly supervised by a qualified person serving as the Manufacturer's Representative.

On-Site manufacturer assisted start up is required.

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 traffic signal controller testing and start-up with the Northern Region DOT&PF, or the Central Region DOT&PF
- d. Familiarity with both the NEMA TS1 and TS2 specifications
- e. Experience setting up video detection
- f. Competent to program the Controller Unit
- g. Competent to program the MMU permissive card
- h. Competent to implement and adjust timing plans
- i. Competent to implement coordinated timing plans
- j. Competent to read cabinet wiring diagrams and troubleshoot cabinet components

- k. Competent to troubleshoot interconnect cable
- l. Competent to test inductive loop detectors and setup detector amplifiers
- m. Competent to conduct training on installed components

2. Cabinet Preparation. The Manufacturer's Representative shall provide oversight and supervision of the controller cabinet preparation. The Manufacturer's Representative shall be on-site for the duration of this work. Cabinet Preparation, includes, but is not limited to:

- a. Field Test. Conduct field test including needed adjustments and repairs as described in Subsection 660-3.01.7.
- b. Control Cable Wiring. The Manufacturer's Representative will oversee the connection of control cables within the controller cabinet to the terminal blocks.
- c. Interconnect Wiring. The Manufacturer's Representative will oversee and test connect wiring to the terminal blocks.
- d. Labeling. The Manufacturer's Representative will check labeling of traffic signal components and correct or cause to be corrected deficiencies. Labeling will be done according to 660-3.05.14. Labeling occurs in both the traffic signal cabinet and j boxes associated with the traffic signal. Complete this work before any functional testing of the signal heads.
- e. Schedule. Upon completion of the controller cabinet preparation the Contractor and Manufacturer's Representative shall submit a schedule for controller programming, detector testing, installation field-testing, signal start-up and training of Department personnel to the Engineer for approval. Once the schedule is approved the Manufacturer's Representative shall:
 - (1) Review timing plans provided by the Engineer. The Manufacturer's Representative may recommend adjustments to timing to be considered and accepted by the Engineer.
 - (2) Program the controller unit based upon the accepted timing plan.
 - (3) Connect the programmed controller unit and electronics accessories in the cabinet as required to make the signal fully operational.
 - (4) Oversee field testing. Coordinate field testing with the Engineer to allow participation by Department staff. Schedule the start-up day following successful field testing and 1 to 5 days of flashing operations. Flashing operations can immediately follow acceptable field testing.
 - (5) Oversee the change of the signal from flashing operations to fully actuated operations
 - (6) Place current timing plans in the controller cabinet by the close of business the day the signal is turned on.
 - (7) Provide intersection diagrams compatible with the Aries software.
 - (8) Be available for onsite timing adjustments for a minimum of 24 hours after signal turn-on.

3. Test Reports.

- a. Contractor and the Manufacturer's Representative will provide the Engineer with reports detailing test procedures and results of test.

The report will include at a minimum:

- (1) Inductive Loop Test including measured values of Inductance, quality factor, continuity and insulation resistance.
- (2) Proper signal display illumination
- (3) Proper pedestrian display illumination
- (4) Correct number of signal faces per phase
- (5) Proper signal head alignment

- (6) Proper functioning of pedestrian buttons
- (7) Proper functioning of EVP system
- (8) Flash programming correct
- (9) Ensure ped indication is black during flash
- (10) Conflicting traffic control signs removed

Add the following subsection:

660-3.12 TRAFFIC SIGNAL MODIFICATIONS. Required work is detailed on the Plan sheets and notes and the following. Work related to the Traffic Signal Communications System will be paid for separately.

The Contractor will have 10 hours to "changeover" the new controller assembly. Changeover includes but is not limited to: removing the existing controller assembly, replacing with new controller assembly, landing new and existing wires, programming the new controller unit, and bringing the signal back to full functionality. The 10 hour window will only occur on the days Monday through Thursday at a time determined by the Engineer. The Contractor will be assessed a Traffic Price Adjustment for an unauthorized lane closure according to Subsection 643-3.06.

Traffic control during the changeover will be paid for under section 643 Pay Items. At a minimum, traffic control will include the following:

- A portable changeable message board in advance of each approach with the message "Traffic Signal Work, New Traffic Pattern Ahead, from 00:00 AM/PM mm/dd/yy to 00:00 AM/PM mm/dd/yy"
- A flagger for each approach

Traffic signal modifications are subject to the full Standard Specification for Highway Construction, the Special Provisions and the following:

1. Traffic Controller Cabinet: When a new traffic controller cabinet is called for, ensure legible labeling of all cabinet cables including but not limited to; control, detector, Opticom (EVP), UPS, interconnect, and telephone. Label loops and signal heads individually.
2. Traffic Signal Heads: When new traffic signal heads are required, provide with new LED units and new mounting hardware. If new heads are not called for, replace any missing visors or backplates subsidiary to the Traffic Signal System Pay Item.

When replacing traffic signal or pedestrian indications conform to Subsections 740-2.14 and 2.15 and maintain brand consistency throughout intersection. When new heads are provided aim heads according to Table 660-2.

3. Conduits: Unless new conduits are called for reuse existing conduits. When new conductors are being added to existing conduits, conform to sections 660-3.03, 3.05, and 3.06.
4. EVP Components: When called for on the Plans provide EVP components including all cables and mounting hardware. Ensure proper operation of EVP system.
5. Load Center: When called for on the Plans provide fully functioning Load Center. If no separate load center item exists, the load center will be paid for subsidiary to the Traffic Signal System Pay Item.
6. Conductors: Reuse existing conductors except where the Plans call for new conductors.

Salvage decommissioned reusable traffic signal equipment, components/materials and deliver to Department of Transportation and Public Facilities, Signal Maintenance Shop, at 2301 Peger Road within 72 hours of removal. Decommissioned components damaged as part of the salvage effort must be replaced with new components at no additional cost.

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Add the following subsection:

660-3.13 DMS. Required work is detailed on the Plan sheets and notes and the following operational functionality requirements for the dynamic message signs (DMS) to be supplied under this contract. Further materials requirements are detailed in Section 740. The contractor shall provide all the materials, software, and services necessary to install DMS and associated equipment that fully comply with the functional requirements specified herein, including incidental items that may have been inadvertently omitted.

General The DMS housing shall provide walk-in service access for all LED display modules, electronics, environmental control equipment, air filters, wiring, and other internal DMS components.

The DMS shall contain a full display matrix measuring a minimum of 54 rows high by 150 pixel columns wide. The matrix shall display messages that are continuous, uniform, and unbroken in appearance to motorists and travelers.

Each display pixel shall be composed of multiple red, green, and blue LEDs. Other pixel technologies, such as fiber optic, flip disk, combination flip disk-fiber optic, combination flip disk-LED, liquid crystal, LED Lenses and incandescent lamp will not be accepted.

The pixel matrix shall be capable of displaying alphanumeric 18" high characters in accordance with the definition defined by NEMA TS 4 Hardware Standards for Dynamic Message Signs Standards

The DMS shall be able to display messages composed of any combination of alphanumeric text, punctuation symbols, and graphic images across multiple frames.

Legibility DMS messages shall be legible within a distance range of 150 ft to 1,100 ft from the DMS display face under the following conditions:

- When the DMS is mounted so its bottom side is positioned between five feet and 20 feet (above a level roadway surface)
- Whenever the DMS is displaying alphanumeric text that is 18-inches high
- 24 hours per day and in most normally encountered weather conditions
- During dawn and dusk hours when sunlight is shining directly on the display face or when the sun is directly behind (silhouetting) the DMS
- When viewed by motorists and travelers that have 20-20 corrected vision
- When the motorist eye level is 3 feet to 12 feet above the roadway surface.

Dimensions DMS housing dimensions shall not exceed 8 ft high by 24 ft wide. The front-to-back housing depth shall not exceed 4.5 ft at its widest point, including the rear ventilation hoods. DMS weight shall not exceed 3000 pounds.

Power Requirements Maximum AC power shall not exceed 1200 watts, when the following circuits are operational and fully loaded:

- LED display pixel matrix, with 100% of the pixels operating at their maximum possible drive current
- DMS environmental control system
- Utility outlet circuit
- DMS sign controller

Typical DMS AC operating power shall not exceed 1200 watts with the following circuit loadings

- LED display pixel matrix, with 25% of the pixels operating at their maximum possible drive current
- DMS sign controller

DMS shall operate from a 120/240 VAC, 60Hz, single-phase power source, including neutral and earth ground.

Sign Construction The DMS housing shall be constructed to have a neat, professional appearance. The housing shall protect internal components from rain, ice, dust, and corrosion in accordance with NEMA enclosure Type 3R standards, as described in NEMA Standards Publication 250, Enclosures for Electrical Equipment (1000 Volts Maximum).

The DMS housing bottom side shall contain small weep holes for draining any water that may accumulate due to condensation. Weep holes and ventilation/exhaust hoods shall be screened to prevent the entrance of insects and small animals.

DMS and sign controller components shall operate in a minimum temperature range of -40°F to +165°F (-40°C to +74°C) and a relative humidity range of 0 to 99%, non-condensing. DMS and sign controller components shall not be damaged by storage at or temporary operational exposure to a temperature range of -40°F to +185°F (-40°C to +85°C).

External DMS component hardware (nuts, bolts, screws, standoffs, rivets, fasteners, etc.) shall be fabricated from hot dipped or mechanically galvanized steel, stainless steel, aluminum, nylon, or other durable corrosion-resistant materials suitable for the roadway signage application.

DMS and sign controller components shall be 100% solid-state, except for the environmental control fans and thermostats. All high voltage electrical components (exceeding 24 VDC) used in the DMS and the sign controller shall be UL (Underwriter's Laboratory) listed and meet all local NEC codes applicable to DMS applications.

The presence of ambient radio signals and magnetic or electromagnetic interference, including those from power lines, transformers, and motors, shall not impair the performance of the DMS system. The DMS system shall not radiate electromagnetic signals that adversely affect any other electronic device, including those located in vehicles passing underneath or otherwise near the DMS and its sign controller.

660-5.01 BASIS OF PAYMENT. *Add the following:* The Department will pay for the electrical power for all electrical systems that are scheduled to become a permanent part of the work.

The Traffic Signal System pay item includes all materials and labor for installation or modification of the traffic signal system as outlined on the Plans and Specifications. All conduit, cable, detectors, and other materials and labor required for the installation or modification of the OPTICOM preemption system, pant-tilt-zoom (PTZ) video camera system, and the Wavetronix radar presence detection system are included in this pay item. Interconnect is included in this pay item when Pay Item 660(101) is not included in the Bid Schedule. New load centers and detection loops are not included in this pay item.

The Highway Lighting System pay item includes all materials and labor for installation or modification of the highway lighting system as outlined on the Plans and Specifications. This pay item includes all conduits and cables used exclusively for illumination at an intersection where a traffic signal is being installed. This pay item also includes the luminaires installed on combination traffic signal mast arm poles. Items not included in this pay item are conduits and junction boxes shared by a traffic signal system and new load centers. This pay item includes the GE LightGrid outdoor wireless control system. This item does not include off-site software hosting fees paid directly to GE for the LightGrid operation.

The Sign Illumination System Complete, DMS Electronic Message Sign pay item includes all materials and labor for installation or modification of the traffic signal system as outlined on the Plans and Specifications. All conduit, cable, detectors, and other materials and labor required for the installation or modification of the Dynamic Messaging Sign, pant-tilt-zoom (PTZ) video camera system, and the pole, and foundation are included in this pay item.

The Traffic Count System pay item includes all materials and labor for installation or modification of the traffic count system as outlined on the Plans and Specifications. This pay item includes all detector loops, cables, conduits, junction boxes, and cabinets used exclusively for the traffic count system. Items not included in this pay item are conduits and junction boxes shared by the highway lighting or traffic signal systems and new load centers.

The Interconnect System pay item includes all materials and labor for installation or modification of a telemetry based interconnect system as outlined on the Plans and Specifications. This pay item includes all conduits, junction boxes, cables, terminal blocks, and all other materials and labor required for installation of the interconnect system. Items not included in this pay item are conduits and junction boxes shared by a traffic signal system.

Payment Includes labor, equipment, and materials required to provide fully functional traffic signals and lighting systems, permanent and temporary, using new equipment. Remanufactured or rebuilt equipment will not be permitted.

Subsidiary to each Pay Item including but not limited to (Except when included as a separate Pay Item):

- (1) General construction requirements,
- (2) Bonding and grounding,
- (3) Bored Casings,
- (4) Completing tests,
- (5) Conductors,
- (6) Conduit,
- (7) Dewatering excavations,
- (8) Excavation, trenches in rock or soil, bedding, backfill for foundations, conduits, components,
- (9) Foundations including concrete to complete foundations,
- (10) J-boxes including adjustment to final grade,
- (11) Labeling conductors,
- (12) Maintaining temporary and existing electrical systems,
- (13) Minor routing changes directed by the Engineer
- (14) Preparing as-builts
- (15) Removal and disposal of existing/new unused foundations, conduit, conductors, and J-boxes,
- (16) Removing, repairing and replacing improvements
- (17) Removal of signs and reinstallation required to install foundations, conduits, and J-boxes,
- (18) Repairing damage to finishes on new equipment
- (19) Salvaging reusable equipment and materials and delivering to the location specified, see 660-3.01(6) for additional requirements.
- (20) Wiring
- (21) Maintaining temporary traffic signal system
- (22) Cleaning luminaire lens and reflectors when re-lamping

660 Pay Items do not include: roadway planing, roadway paving, drainage structures, erosion, sediment and pollution control, signing, striping and pavement markings, traffic control, load centers, disconnect switches, transformers, and components of the fiber optic traffic signal communication system. Removal and replacement of concrete sidewalk will be paid for under Pay Item 608(1A).

Item 660.0001.0000, Traffic Signal System Complete. Will be paid by signal system, complete and accepted in place. Item includes all work, materials, and labor for the signal heads, radar detection sensors, opticom preemption system, pan-tilt-zoom (PTZ) camera system, controller cabinets, controllers, wiring, auxiliary equipment, installation and configuration of system modem/interface unit, and all necessary appurtenances required to complete the installation and testing as noted on the Plans, Specifications and directed by the Engineer.

Item 660.0003.0000, Highway Lighting System Complete. Will be paid by lighting system, complete and accepted in place. Item includes all work, materials, and labor for the wiring, auxiliary equipment, electrical improvements, and all necessary appurtenances required to complete the installation and testing as noted on the Plans, Specifications and directed by the Engineer.

Item 660.0004.0000, Sign Illumination System Complete, DMS Electronic Message Sign. Will be paid by sign illumination system, complete and accepted in place. Item includes all work, materials, and labor for the Dynamic Messaging Sign, radar detection sensors, pan-tilt-zoom (PTZ) camera system, controller cabinets, controllers, wiring, pole, foundation, sign mounting structure, auxiliary equipment, installation and configuration of system modem/interface unit, and all necessary appurtenances required to complete the installation and testing as noted on the Plans, Specifications and directed by the Engineer.

Add the following pay items:

PAY ITEM		
Item Number	Item Description	Unit
660.0001.0000	Traffic Signal System Complete	LS
660.0003.0000	Highway Lighting System Complete	LS
660.0004.0000	Sign Illumination System Complete, DMS Electronic Message Sign	LS

**SECTION 702
ASPHALT MATERIALS**

11/16/20 (N82)

702-2.01 ASPHALT BINDER. Delete the first paragraph and substitute the following: Meet AASHTO M 320 for PG 52-28 binder.

Meet AASHTO M 332 for PG 52E-40 binder, except that J_{NR} Diff (AASHTO T 350) and Direct Tension (AASHTO T 314) do not apply. PG 52E-40 binder shall have a minimum Percent Recovery_{3.2} of 75% according to AASHTO T 350.

**SECTION 707
METAL PIPE**

04/30/17 (N48)

707-2.01 CORRUGATED STEEL PIPE, PIPE ARCHES, AND UNDERDRAINS. Add the following: All seams on pipes manufactured with helical corrugations shall have a continuous weld extending from end to end of each length of pipe in conformance with AASHTO M 36. Seams shall be welded in such a manner that they develop 90% of the average ultimate strength of the base metal. A test shall be performed by an independent lab in accordance with AASHTO T 241 Section 4 during the year in which the pipe is fabricated. The Supplier shall maintain quality control test results and provide them upon request. A copy of the test results containing the information specified in Section 4.6 of AASHTO T 241 shall be furnished to the Engineer.

A Supplier of welded helically corrugated pipe which qualifies for inclusion in the current publication of the Department's QUALIFIED PRODUCTS LIST is not required to perform the test.

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**SECTION 707
METAL PIPE**

01/20/15 (N49)

707-2.03 CORRUGATED ALUMINUM ALLOY CULVERT PIPE AND UNDERDRAINS. *Delete the first sentence and substitute the following:* This pipe shall conform to the requirements of AASHTO M 196 except that helical corrugations shall not be allowed.

Delete Section 724 in its entirety and substitute the following:

12/10/20 (N51)

**SECTION 724
SEED**

724-2.01 DESCRIPTION. This specification provides the requirements for grass seed, used to provide a living vegetative cover.

724-2.02 MATERIALS. Furnish seed true of genus and species. Meet applicable requirements of the State of Alaska *Seed Regulations*, Alaska Administrative Code, Title 11, Chapter 34 (11 AAC 34), and the Federal Seed Act, 7 CFR Part 201. Seed shall meet or exceed the percentages of purity and germination as specified in Table 724-1.

The Contractor may propose an alternate seed mix to the Engineer. Alternate seed mix proposals must include confirmation that the Alaska Plant Materials Center finds the proposed seed mix suitable for use on the project, and that the vendor can provide the proposed seed mix in quantities adequate for the project. The Engineer will determine the acceptability of the proposed alternate for use on the project.

Grass seed shall be furnished in standard containers on which shall be shown the following information:

- (1) common accepted name of the specie (kind) and cultivar (variety) of the seed;
- (2) country or state where the seed was grown;
- (3) total percentage by weight of pure seed;
- (4) total percentage by weight of all weed seed;
- (5) total percentage by weight of inert matter;
- (6) total percentage by weight of other crop seed;
- (7) name and approximate number per pound of each kind of restricted noxious weed seed;
- (8) percentage of germination of the seed, together with the month and year the seed was tested;
- (9) percentage of hard seed, if any is present;
- (10) name and address of the person labeling the seed or selling, offering, or exposing the seed for sale within the state; and
- (11) lot number or other lot identification.

If furnished as a premixed seed, the containers shall state that the seed is a mixture; the name of the species and cultivars of seed; and total percentage by weight of each species of seed present in order of predominance; and the information listed above: (4), (5), (7), (8), (10) and (11).

Furnish seed certified to be free of prohibited noxious weeds or quarantined pests, and certified to contain no more than the maximum allowable tolerances for restricted noxious weeds, according to 11 AAC 34. Prohibited and restricted noxious weeds are listed in 11 AAC 34.020, and can be viewed at the following URL: <http://plants.alaska.gov/invasives/noxious-weeds.htm>

Seed found to contain prohibited noxious weeds or quarantined pests will be rejected, according to 11 AAC 34.020(a) and 11 AAC 34.105 through 34.180, respectively.

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Seed found to contain restricted noxious weed seed in excess of the maximum allowable tolerance per pound will be rejected, according to 11 AAC 34.020(b).

The Contractor shall furnish to the Engineer duplicate copies of a statement signed by the vendor certifying that each lot of seed has been tested by a recognized seed testing laboratory. Seed that has not been tested within nine (9) months shall be rejected. The Contractor shall not remove tags from the seed containers. Seed containers that do not have tags shall be rejected. Discrepancies in the lot numbers listed on the statement to the lot numbers indicated on the tags of the seed containers shall be grounds for rejection. Seed which has become wet, moldy, or otherwise damaged in transit or storage will not be accepted. The Contractor shall immediately remove rejected seed from the project premises.

TABLE 724-1
SEEDING REQUIREMENTS

SPECIES (KIND)	CULTIVAR (VARIETY)	PERCENT PURITY	PERCENT GERMINATION	PURE LIVE SEED (PERCENT PURITY X PERCENT GERMINATION)
American Sloughgrass	Egan	90	80	72
Annual Ryegrass	---	85	80	68
Alpine Bluegrass	Gruening	90	90	81
Beach Wildrye	Benson, Reeve	95	40	38
Bering Hairgrass	Norcoast	95	75	71
Bluejoint	Sourdough	95	75	71
Brome	Manchar, Polar	90	80	72
Glaucous Bluegrass	Tundra	95	80	76
Kentucky Bluegrass	Merion, Nugget, Park	95	80	76
Perennial Ryegrass	---	85	80	68
Polargrass	Alyeska, Kenai	95	75	71
Red Fescue	Arctared, Boreal, Pennlawn	98	80	78
Timothy	Climax, Engmo	95	90	85
Tufted Hairgrass	Nortran	95	75	71
Wheatgrass	Wainwright	95	85	81

**SECTION 725
FERTILIZER**

01/20/15 (N52)

725-2.02 MATERIALS. *Add the following:* Fertilizer which has become wet, moldy or otherwise damaged in transit or storage will not be accepted. The Contractor shall immediately remove rejected fertilizer from the project premises.

SECTION 727
SOIL STABILIZATION MATERIAL

8/02/2018 (N54)

727-2.01 MULCH. *Delete this subsection in its entirety and substitute the following:* All mulch, excluding trace mulch, shall provide 100% ground coverage. Apply mulch at the manufacturer's recommended application rate and increase as needed to achieve 100% ground coverage. All mulch, including trace mulch, shall meet one of the following:

1. Wood Cellulose Fiber or Natural Wood Fiber. Fiber shall be produced from natural or recycled (pulp) fiber, such as wood chips or similar wood materials, or from newsprint, corrugated cardboard, or a combination of these processed materials. Fiber shall not contain any rock, metal, or plastic. Fiber shall be treated with a green dye nontoxic to plant and animal life to facilitate inspection of the placement of the material. Fiber shall be manufactured in such a manner that after addition and agitation in slurry tanks with water, the fibers in the material will become uniformly suspended to form a homogenous slurry. When hydraulically sprayed on the ground, the material shall allow the absorption and percolation of moisture. The organic matter content shall be at least 90 percent on an oven-dry basis. The moisture content shall be no more than 15 percent as determined by oven dried weight. Each package of the cellulose fiber shall be marked by the manufacturer to show the dried weight. Product must be nontoxic to plant and animal life.

Wood Cellulose Fiber or Natural Wood Fiber may be used to stabilize slopes flatter than 4H:1V. On slopes 4H:1V or steeper Wood Cellulose Fiber or Natural Wood Fiber may be used if an approved tackifier is used, in addition to Wood Cellulose Fiber or Natural Wood Fiber, according to the Manufacturer's recommendations. Wood Cellulose Fiber or Natural Wood Fiber may not be used after August 1.

2. Wood Strand. Wood Strand shall be a blend of loose, long, thin wood pieces derived from native conifer or deciduous trees with high length to width ratio. A minimum of 95-percent of the wood strands shall have lengths between 2 and 10 inches, with a width and thickness between 1/16 and 3/8 inches. Wood Strand shall not contain resin, tannin, or other compounds in quantities that are detrimental to plant life. Sawdust or wood shavings shall not be used as Wood Strand. Wood Strand may be used on slopes flatter than 4H:1V. Wood Strand may not be used after August 1.
3. Straw. All straw material shall be in an air dried condition, free of noxious weeds, seeds, and other materials detrimental to plant life. Hay is not acceptable. Straw shall be suitable for spreading with mulch blower equipment. Straw may be used on slopes flatter than 4H:1V. Straw may not be used after August 1.
4. Bonded Fiber Matrix (BFM). The BFM shall be a hydraulically-applied blanket/mulch/covering composed of long strand, thermally processed wood fibers and crosslinked, hydro-colloid tackifier. The BFM may require a 24-48 hour curing period to achieve maximum performance. Once cured, the BFM shall form an intimate bond with the soil surface to create a continuous, absorbent, flexible erosion resistant blanket that allows for rapid germination and accelerated plant growth. BFM may be used to stabilize slopes between 2H:1V and 4H:1V. BFM may be used after August 1.
5. Fiber Reinforced Matrix (FRM). The FRM shall be a hydraulically-applied, flexible erosion control blanket/mulch/covering composed of long strand, thermally processed wood fibers, crimped, interlocking fibers and performance enhancing additives. The FRM shall require no curing period and upon application shall form an intimate bond with the soil surface to create a continuous, porous, absorbent and erosion resistant blanket that allows for rapid germination and accelerated plant growth. FRM may be used to stabilize slopes 2H:1V and steeper. FRM may be used after August 1.

A list of pre-approved products can be found in Table 1.

Table 1. Pre-Approved Mulch Products List

Product Name	Product Type	Manufacturer
Astro-Mulch	Wood Cellulose Fiber	Thermo-Kool Inc. Wasilla, AK
Fibermulch	Wood Cellulose Fiber	Thermo-Guard Insulation Spokane, WA
NaturesOwn High Density Paper Hydroseeding Mulch	Wood Cellulose Fiber	Hamilton Manufacturing, Inc. Twin Falls, ID
Hydro-Spray	Wood Cellulose Fiber	National Fiber Belchertown, MA
EcoFibre	Natural Wood Fiber	Profile Products LLC Buffalo Grove, IL
EcoFibre plus Tack	Natural Wood Fiber	Profile Products LLC Buffalo Grove, IL
Terra Novo Wood Fiber Plus Tackifier	Natural Wood Fiber	Terra-Novo Inc. Bakersfield, CA
Conwed Fiber 1000	Natural Wood Fiber	Profile Products LLC Buffalo Grove, IL
Rainier Fiber plus Tack	Natural Wood Fiber	Fiber Marketing International Spokane, WA
Terra Wood with Tack	Natural Wood Fiber	Profile Products LLC Buffalo Grove, IL
Excel Fibermulch II	Natural Wood Fiber	American Excelsior Co. Rice Lake, WI
Mat-Fiber Plus	Natural Wood Fiber	Mat, Inc. Floodwood, MN
Mat-Fiber	Natural Wood Fiber	Mat, Inc. Floodwood, MN
EcoAegis	Bonded Fiber Matrix (BFM)	Profile Products LLC, Buffalo Grove, IL
ProMatrix Engineered Fiber Matrix	Bonded Fiber Matrix (BFM)	Profile Products LLC, Buffalo Grove, IL
Verdyol Virgin BFM	Bonded Fiber Matrix (BFM)	Erosion Control Blankets Manitoba, Canada
Rainier Fiber Bonded Fiber Matrix	Bonded Fiber Matrix (BFM)	Fiber Marketing International Spokane, WA
Profile Hydro-Blanket BFM	Bonded Fiber Matrix (BFM)	Profile Products LLC Buffalo Grove, IL
Soil Guard	Bonded Fiber Matrix (BFM)	Mat, Inc. Floodwood, MN
Flexterra FGM	Fiber Reinforced Matrix (FRM)	Profile Products LLC Buffalo Grove, IL
Flex Guard	Fiber Reinforced Matrix (FRM)	Mat, Inc. Floodwood, MN
Hydra CX	Fiber Reinforced Matrix (FRM)	Tensar North American Green Poseyville, IN

**SECTION 740
SIGNALS AND LIGHTING MATERIALS**

740-2.02 SIGNAL AND LIGHTING STRUCTURES. *Add the following to numbered paragraph: Design:* Design poles for 100 mph with a 1.3 gust factor.

740-2.03 WOOD POLES. *Change the subsection to read:* **WOOD POLES, GUYS AND ANCHORS.**

Add the following: Use 8-inch double helix round anchors with beveled cutting edges (DIXIE No. D8472R or approved equal). Use triple eye ¾-inch x 7 feet (CHANCE No. 12632P or approved equal) anchor rods. Use 5/16-inch diameter 10,000 lb. galvanized steel strand messengers and guys. Place guys before conductors are strung at locations shown on the Plans. Attach guys to the anchor rod and pole as required by the utility owner. Use yellow 8-foot guy guards on all guys and attach in accordance with manufacturer's recommendations (Preformed No. PG-5718 or approved equal). Install all anchors and rods in direct line with the strain unless noted or detailed otherwise.

Install anchors so that approximately 6 inches of the rod will remain exposed. In cultivated areas or other locations as deemed necessary, the anchor rod projection may be increased to prevent burial of the eye rod.

740-2.05 CONDUCTORS. *Replace Table 740-2 with the following:*

**TABLE 740-2
CONDUCTOR TERMINATION TABLE**

CONDUCTORS PER CABLE	CIRCUIT	WIRE COLOR	AWG. NO.	BAND LEGEND
5	Vehicle Red Vehicle Yellow Vehicle Green Common Neutral Spare	Red Orange Green White Black	14	Head No.
7	Vehicle Red Arrow Vehicle Yellow Arrow Vehicle Green Arrow Common Neutral Spare Spare Vehicle Yellow Flashing Arrow	Red Orange Green White White/Black Blue Black	14	Head No.
7	Vehicle Red Vehicle Yellow Vehicle Green Common Neutral Spare Vehicle Yellow Arrow Vehicle Green Arrow	Red Orange Green White White/Black Black Blue	14	Head No. (s)
5	Pedestrian Don't Walk Pedestrian Walk Common Neutral Spare Spare	Red Green White Orange Black	14	Head No.
5	Photo Electric Control Load to Contactor Neutral Spare Spare	Black Red White Orange Green	14	PEC

CONDUCTORS PER CABLE	CIRCUIT	WIRE COLOR	AWG. NO.	BAND LEGEND
4	Flashing Beacon Neutral Spare Spare	Black White Red Orange	8	AAWF
2	Pedestrian Pushbutton Neutral	Black White	14	Head No. Located Under
2	Flashing Beacon Neutral	Black White	14	Head No.
2	Preemption Neutral	Black White	14	"PRE"
3	Highway Luminaire Highway Luminaire Highway Luminaire Spare	Black Red White	8 or 6	Circuit No. Circuit No.
3	Service to Controller Neutral Spare	Black White Red	6	"SIG" No Band No Band
3	Sign Luminaire Sign Luminaire Sign Spare	Black Red White	8	SIGN SIGN

Replace No. 5. with the following:

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.

Replace "6 twisted pairs" in the second sentence of the 4th subparagraph of No. 6. with the following:
7 twisted pairs.

Replace Table 740-3 with the following:

**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			

Delete Subsection 740-2.06 and substitute the following:

740-2.06 ELECTRICAL CONDUIT AND FITTINGS. 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 on the Plans, use a smooth wall, schedule 40, high-density polyethylene (HDPE) pipe that conforms to UL Standard 651 A and NEMA TC-7-2013.

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 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.

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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.

740-2.09 CONTROLLER ASSEMBLIES through **740-2.13 SPECIAL AUXILIARY EQUIPMENT.** *Delete in their entirety and substitute the following sections:*

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 includes the following equipment:

- (1) Econolite KCME – 10,000 Master (with Level 4 software)
- (2) KMC Telemetry Module
- (3) Aries Zone Manager (latest version) by Econolite
- (4) GDI 2400 Modem

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:

Econolite ASC/2 Type I, ASC/3 Type I and the following modules:
KMC Preemption
KMC NIC/Coordination Module
KMC Telemetry Module

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

740-2.10 CONTROLLER UNIT.

Actuated Controller Unit (CU).

Provide solid state, Type A2N Actuated Controller Units (CU) meeting the requirements of Section 3 of the NEMA Standard Publication TS 2-2003 V02.06, *Traffic Controller Assemblies* with NTCIP Requirements.

- 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
- 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.

- 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.
- Provide controllers with display heaters or enhancements to improve viewing in temperatures below 0° F.
- Provide controllers having an interface compatible with SYNCRO-7 traffic modeling software.

Furnish Econolite Cobalt ATC Touch controller unit or approved equal also meeting the following requirements:

HARDWARE

1. Enclosure

- 1.1. The controller shall be compact so as to fit in limited cabinet space. It shall require no more than 7" shelf depth. External dimensions shall not be larger than 8.5" x 15.2 1/4" x 6.375" (H x W x D)
- 1.2. The top and bottom of the chassis shall be made from extruded aluminum and include an integral handle on the back for easy transport.
- 1.3. The sides shall be constructed of injection molded polycarbonate.
- 1.4. The front panel shall meet specifications set forth in Section 5 (Front Panel)

2. Electronics

- 2.1 The electronics shall be modular in design and shall consist of vertical circuit boards. Horizontal circuit boards shall not be acceptable.
- 2.2 In the interest of reliability, no sockets shall be used for any electronic device. All devices shall be directly soldered to the printed circuit board. Surface mount parts shall be used for the majority of the electronic components in the controller.
- 2.3 A built-in, high-efficiency switching power supply shall generate the primary, +5VDC internal voltage, an isolated +24 VDC for internal and external use, VSTANDBY, LINESYNC, POWERUP and POWERDOWN signals. All voltages shall be regulated.
- 2.4 The 120 or 220VAC fuse shall be mounted on the front of the controller. Protection for the 24VDC supply shall be provided by a resettable electronic fuse.
- 2.5 All printed circuit boards shall meet the requirements of the NEMA Standard plus the following requirements to enhance reliability:
 - a. Both sides of the printed circuit board shall be covered with a solder mask material.
 - b. The circuit reference designation for all components and the polarity of all polarized capacitors and two-lead diodes shall be clearly marked adjacent to the component. Pin 1 for all integrated circuit packages shall be designated on all printed circuit boards.
 - c. All printed circuit board assemblies shall be coated on both sides with a clear moisture-proof and fungus-proof sealant.
- 2.6 Timing of the controller traffic application shall be derived from the AC power line.

2.7 To facilitate the transfer of user-programmed data from one controller to another, a Datakey receptacle for using a separate 2070-style, serial flash memory device shall be an available hardware option. In addition, two USB sockets and one SD Card socket shall be provided for memory devices that can be used for data transfer. These data transfer devices shall be easily removable and directly accessible from the outside of the controller. The controller will not require this Datakey, USB memory thumb drive, or SD Card to be present for proper operation.

2.8 All controller software shall be stored in Flash Memory devices. The controller software shall be easily updated without the removal of any memory device from the controller. The use of removable PROMS or EPROMS from the controller shall not be acceptable. The controller shall include an option that allows updating software using a Windows based computer, a USB memory thumb drive, or an SD card.

3. ATC Engine Board

3.1 The controller shall include an ATC engine board compliant to ATC standard 5.2b and proposed version 6.10.

3.2 The engine board shall include a PowerPC 83XX family processor with QUICC engine.

3.3 The engine board shall have a minimum of the following memory:

- a. 128 Mbytes of DDR2 DRAM memory used for application and OS program execution
- b. 64 Mbytes of FLASH memory used for storage of OS Software and user applications
- c. 2MB of SRAM memory used for non-volatile parameter storage

3.4 The engine board shall provide the seven ATC serial ports, Ethernet, USB and all other control signal required by ATC standard.

3.5 The operating system shall be Linux 2.6.35 or later.

4. Graphical User Interface

4.1 The controller shall include an advanced graphics card.

4.2 The graphics card shall enable:

- a. Graphical display of status and programming selections

4.2.a.1 The status displays shall include direction arrows for each of the phases and overlaps.

4.2.a.2 The selection of programming sections menus shall be by use of icons.

4.2.a.3 Programming shall use touch data entry, allowing touch gestures to select yes/no, select enable/disable, pull-down list selections, and more.

- b. Touch selection of status and programming

- c. Swiping to advance from one screen to the next

4.3 Program values shall be entered through either the keypad or the touch screen.

4.4 The controller shall allow connection of a tablet to the controller.

- a. The tablet connection shall be by Wi-Fi connection either by a Wi-Fi to USB adapter or an Ethernet to Wi-Fi adapter.
- b. Once connected it shall be possible to observe the exact same graphics displays as are visible on the touch screen of the controller.
- c. It shall be possible to change the controller's programming values from the tablet while it is connected.

5. Front Panel

5.1 The front of the controller shall consist of a panel for the display, keyboard and connectors for all necessary user connections.

5.2 The display shall be a seven-inch (7"), color, TFT (Thin Film Transistor) LCD (Liquid Crystal Display) 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.

5.3 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.

5.4 The front panel shall include a built in speaker for enhanced controller audio feedback.

5.5 The front panel shall include a tri-color status LED.

6. Ethernet Ports

6.1 The controller shall have the capability of supporting Ethernet communications, using TCP/IP communications protocols.

6.2 The controller shall provide four front-panel Ethernet ports

6.3 Two of the ports shall be connected to Ethernet switch ENET1 and the other two shall be connected to Ethernet switch ENET2

7. USB Ports

7.1 The controller shall provide two USB 2.0 ports.

7.2 USB ports shall be used for USB thumb drives to update software, upload or download configuration, or uploading logged data.

8. Connectors

8.1 All non-optional interface connectors shall be accessible from the front of the controller in the NEMA Configured Controller models. Configurations shall be offered to accommodate different versions, as follows:

- 8.1.1 NEMA TS2 Type 1
- 8.1.2 NEMA TS2 Type 2
- 8.1.3 NEMA TS1

8.2 The D connector shall be compatible with the Econolite Model ASC/2, ASC/2S, and ASC/3 D connectors.

8.3 To facilitate special applications the controller shall have the capability of assignment of any input or output function to any input or output pin respectively on the interface connectors, with the exception of Flashing Monitor, Controller Voltage Monitor, AC+, AC-, Chassis Ground, 24VDC, Logic Ground and TS2 Mode bits.

8.4 The controller shall as a minimum have the following communications ports:

- 8.4.1 Port 1 SDLC for communications to other devices in the cabinet
- 8.4.2 Port 2 serial port for systems communications
- 8.4.3 Console serial port for local communications

An optional telemetry module shall utilize TDM/FSK data transmission at 1200 baud or 9600 baud over two pairs of wires. This module shall include the Econolite 25-pin D-sub connector.

8.5 Serial communications shall operate at from 1200 to 115.2 K baud.

9. Serviceability

9.1 All electronic modules including the power supply shall be easily removable from the controller using a screwdriver as the only tool. All power and signal connections to the circuit boards shall be via plug-in connectors.

10. Hardware Options

For each new controller unit required by the the contract, provide the following optional hardware.

10.1 Optional Data Key

10.1.1 A Datakey and receptacle shall be available for use as a database storage device (backup) or as a database transfer module. It shall be capable of storing a minimum 2MB of data.

10.1.2 The Datakey shall be hot swappable, so that it can be inserted and removed without powering down the controller.

10.1.3 The Datakey shall be capable of storing the entire controller database and shall retain the information without use of battery or capacitor backup.

10.1.4 The controller shall not require this key to be present during normal operation.

10.1.5 If the Datakey is present, the controller shall automatically backup the database to the data key 20 minutes following the last data change.

DISPLAY

1. General

1.1 A **Title Bar** that provides selection of Home, Main Status, Logged Events, I/O status, Network Status, Consistency Checks, and USB status shall always be visible at the top of the screen. Also the current date and time and Function Key Options.

2. Dynamic Displays

2.1 Dynamic displays listed below shall be provided to show the operational status of the controller. Additional displays shall be offered for programming. It shall be possible to jump from a status screen to the appropriate programming screen and return after viewing is complete.

2.2 When the cursor is pointed to a dynamic location on the screen, an audible shall be provided when the display changes

2.3 When the cursor is moved around the status screen and the help key is pressed, a context sensitive help shall be displayed.

2.4 The **Main Status Display** shall indicate a summary of the coordination plan in effect and if in-sync or in transition. Also a graphic that shows the phase sequence, the phases in each ring, the phase direction in the form of a direction arrow, or a left turn arrow pointing in the basis direction of travel. Each phase shall indicate when the phase has detector call, recall, a ped call, or ped recall. The background for the phase shall indicate green when the phase is green, yellow when yellow, and red when in all red clearance. Also, there shall be an indication of the current timing interval in effect and the current timing value.

2.5 It shall be possible to place vehicle, pedestrian, preemption, and TSP calls from the keyboard while displaying status information.

2.6 The **Event Log Display** shall indicate current logged events for controller events, detector events, detector activity, and MMU events.

2.6.1 Controller events shall include at a minimum pattern changes and power failures.

2.6.2 Detector events shall include the detector number of the detector failed and the mode of failure to include no activity, constant calls, or erratic calls.

2.6.3 Detector activity shall include the volume and occupancy of the detectors enabled for logging.

2.6.4 MMU events shall include all of the failure messages reported by the MMU.

2.7 The **Input Output Status Display** in the controller mode shall indicate the status of vehicle and pedestrian signal outputs including check and phase next, vehicle and pedestrian omit inputs, preempt input status including calls and active, overlap signal outputs, special function output status, and logic processor flag status. It shall be possible to switch to displaying MMU input/output status, detector or T/F BIU input/output status, or Power Supply status shall be displayed in combination with vehicle and pedestrian calls. The display shall also show the split plan, timing plan, sequence, action plan, and day plan in effect. Also displayed shall be, current coordination pattern information, local and system cycle count, time-based control status, hold, force-off, vehicle permissive, pedestrian permissive, split count down, split extension, and offset from ring 1.

- 2.8 The **PREEMPTOR STATUS DISPLAY** shall indicate the status of vehicle, pedestrian overlap, and overlap signal outputs shall be displayed in combination with vehicle and pedestrian calls. Priority (railroad, fire, emergency) preemptors and bus preemptors with calls, preemptor active, inhibit, and delay status. When a preemptor is active, the display shall also indicate preemptor interval, timing, duration, and dwell status. A portion of the display shall indicate the controller status during preemption including current status, interval, and timing by phase and ring and the status of vehicle and pedestrian signals for each phase.
- 2.9 The **TIME BASE STATUS** display shall indicate the current time and date, the current day and week program, the active program step for both coordination pattern and Time-of-Day (TOD) functions, the start time of the next eleven program steps and the day the next day plan will start. The programmed selections of the active coordination pattern and TOD pattern shall also be displayed.
- 2.10 The **Communications Status** displays shall be communications status displays for Ethernet, Port 1 (SDLC), Port 2 (terminal) Port 3, and NTCIP.
- 2.10.1 An Ethernet status display shall indicate the line speed, the line status, the total number of transmit, and receive counts and the number of transmit and receive error counts.
- 2.10.2 Port 1 (SDLC) status display shall indicate the frame responses from the MMU, the terminal and facilities, BIUs, and the detector BIUs.
- 2.10.3 Ports 2 and 3 status display shall indicate the interconnect format, transmit, valid data, data error, carrier detect, and the last valid command.
- 2.10.4 An NTCIP status display shall indicate the total number of SNMP and STMP transmit and receive counts.
- 2.11 The **DETECTOR STATUS** display shall indicate activity for up to 64 detectors. The display shall show detector calls as they are processed by the controller. The display shall also show the extension and delay timers for the selected detector. In addition the failure status of the detector shall be displayed.
- 2.12 The **FLASH/MALFUNCTION MANAGEMENT UNIT (MMU)** status display shall indicate flash status plus MMU channel, conflict, and monitoring function status. A separate display shall indicate the results of the controller's comparison of its MMU programming to the programming in the controller.
- 2.13 The **Consistency and Warning Checks** display shall indicate the status of these two checks. Consistency checks shall include the results of tests that make sure interrelated database functions are compatible with each other. Warning checks are intelligent diagnostics designed to indicate any data entries that, by themselves or in combination with other entries, may result in unexpected operation.

3. Traffic Applications Programming Displays

- 3.1 Traffic applications shall be selected from the title bar of the touch screen,
- 3.2 The **Approaches** icon shall allow the operator to select signalization, vehicle detection, or pedestrian detection programming.

- 3.2.1 Signalization shall include programming for the type for each movement as vehicle or pedestrian, the phase or overlap assigned to the movement, the direction of travel by selecting either direction arrows or left turn arrows, and dimming.
- 3.2.2 Vehicle Detection shall include selection of 1 of 4 detector plans and in each plan, the detector to phase assignment, the detector type, the delay and extension time, NTCIP volume and/or occupancy logging, type TS2 or ECPI, cross switching, and other phases called.
- 3.2.3 Pedestrian Detection shall include the phase or phases called and the type as either Ped push button or Bike input.
- 3.3 The **Phase Order** icon shall provide programming for the phase sequence, the phase to ring assignment, and barrier placement. It shall also include backup prevention, no serve phase, and simultaneous gap programming.
- 3.4 The **Overlap** icon shall provide programming of the overlap type, the lag timing, and the phases included in the overlap.
- 3.5 The **Flash** icon shall provide programming for startup flash and automatic flash entry and exit phases and overlaps. It shall include start up flash time and all red start up time.
- 3.6 The **Timing Plan** icon shall provide selection of 1 of four timing plans. It shall be possible to name the plans. Each plan shall be programmed by phase for green minimums, passage, green maximums, pedestrian timing, clearance times, phase demand options, and guaranteed minimum timing. It shall be possible to program timing by using a moving along a slider bar, by incrementing the bar, using a touch keypad, or by using the keypad.
- 3.7 The **Phase Options** icon shall provide for green flashing rates, ped clearance timing options, start of vehicle extension options, rest in walk, phase service options, non-actuated phase assignment, and pre-timed phases.
- 3.8 The **Event Plans** icon shall provide for naming TOD events such as flash, free, or the name of the coordination plan. It shall include naming and programming the day plans, and scheduling the day plans.
- 3.9 The **Preemption Plans** icon shall include all of the programming for rail road, emergency vehicle and bus preemption. It shall also include Transit Signal Priority (TSP) programming.
- 3.10 The **Logic Processor** icon shall include naming and programming of the 100 logic processor statements.

The **Settings** icon shall include setting for display brightness, sound volume, and date and time. It shall also include setup of user security.

Programming

1. Programming Methods

1.1. The methods listed below shall be available for controller configuration and timing entries. The manufacturer shall be able to provide as off-the-shelf items all of the firmware and software required to affect the listed methods and to implement network operation with system host PC's or approved tablets.

1.1.1 Manual data entry via the touch screen or the front panel keyboard

1.1.2 Downloading via telemetry from a host PC in a central server in an enterprise system.

1.1.3 Downloading from a portable PC-compatible computer via a serial or Ethernet cable.

1.1.4 Transfer from one controller to another, or restoring for a back-up copy, using a data key, USB thumb drive, or an SD card.

1.1.5 Uploading or downloading from an approved android tablet using a Wi-Fi connection.

1.1.6 A PC web interface shall allow the operator to view the current status and programming for the controller. It shall be possible to change programming from a remote device like a PC and if the device is connected to the controller, the programming changes shall take effect the next time that interval or function is used.

2. Programming Security

2.1 A minimum of three access levels shall be available to provide programming security.

2.1.1 The highest or administrator level shall have access to all programming entries including setting access codes.

2.1.2 The second or data change level shall have read-write privileges for all programming entries except access codes and CRC enable/disable.

2.1.3 The third or data display level shall only have access to read programmed data and status screen.

2.2 User selectable, access codes shall be provided for the administrator and data change and read only access levels. Each user shall have a user name that is entered using from 6 to 15 characters. Access codes shall initially be set to provide unrestricted access.

2.3 If there has been no keyboard activity the controller shall automatically logoff the user after 30 minutes.

3. Programming Utility Functions

3.1 A copy function shall permit copying all timing data from one phase to another. It shall also permit copying all timing plans from one timing plan to another, one detector plan and detector options plan to another, all coordination pattern data from one pattern to another and one sequence to another. This feature will facilitate data entry when programming any two or more phases with the same timing values, or detectors with the same programming, and/or two or more coordination patterns with the same pattern data.

3.2 The controller unit shall contain a backup data base with user specified values stored in non-volatile memory. A copy function shall permit transferring the backup database to the active database. The user shall be able to create their database and copy it to the default database.

3.3 A sign-on message shall allow the user to view the controller software version number. It shall also be possible to display the sign-on message by keyboard selection. The sign-on display shall allow a user-defined message of up to two lines with 38 characters per line.

3.4 The controller shall have the capability to output a memory image of the user programmed settings and intersection configuration data in binary format. This shall allow transferring the memory image data to a data key, USB thumb drive, or SD card.

Actuated Control Functions

The controller software shall provide all actuated control functions and operations required by the NEMA TS2 Standard. In addition, it shall provide the features described in the following sub-sections.

1. Phase Sequence

1.1. The phase sequence of the controller shall be programmable in any combination of 16 phases, using up to 16 concurrent groups, and four timing rings.

1.2. Up to 16 unique phase sequences shall be user configurable and used in the controller.

i. Four additional fixed sequences shall conform to the following TxDOT "Diamond" configurations:

- a. 3-phase diamond
- b. 4-phase diamond
- c. NEMA 8-phase diamond
- d. 2 intersection diamond control

1.3. Phase sequence information shall be changeable from the keyboard and stored in data memory.

1.4. The standard phase sequence of the controller shall also be capable of being altered by coordination, TOD, or external alternate sequence command, by selection 1 of the 16 configurable sequences or 1 of the 4 "diamond" sequences.

1.5. An exclusive pedestrian phase feature shall be provided which will time and display the pedestrian indications with the vehicle movements remaining in all red.

2. Timing Intervals

2.1. Timing intervals shall be programmable from 0-255 in one-second increments or from 0-25.5 in one-tenth second increments, depending on the function.

2.2. Four independent timing plans shall be provided. Any plan shall selectable on a TOD basis, by coordination pattern, or for one cycle following preemption.

2.3. Each timing plan shall contain the following interval timings:

Minimum Green	Maximum 3
Bike Green	Dynamic Maximum
Delay Green	Dynamic Maximum Step
Conditional Service Minimum Green	Yellow Clearance
Walk	Red Clearance
Walk 2	Red Maximum
Walk Maximum	Red Revert
Pedestrian Clearance	Actuations before Reduction
Pedestrian Clearance 2	Seconds per Actuation
Pedestrian Clearance Maximum	Maximum Initial
Pedestrian Carryover	Time before Reduction
Vehicle Extension	Cars Waiting
Vehicle Extension 2	Time to Reduce
Maximum 1	Min Gap
Maximum 2	Steps to Reduce

- 2.3.1 The bike green interval shall replace the phase minimum green if the interval time is larger than the min green time and if a detector input designated as a bike detector has been activated.
- 2.3.2 Two Walk and Pedestrian Clearance intervals shall be provided for each phase per timing plan. The second Walk and Pedestrian Clearance shall be activated by a time base action plan.
- 2.3.3 Two vehicle extension intervals shall be provided for each phase per timing plan. The active vehicle extension interval shall be selected by a time base action plan.
- 2.3.4 If enabled, a Delay Green timer shall delay the vehicle phase from starting until the timer has expired. This shall provide an additional all red for the vehicles movement and allow the pedestrian indications to precede the vehicle movement.
- 2.3.5 The Pedestrian Walk interval shall extend from Walk to the smaller of the Walk Max time or the phase maximum in effect with a constant input from the "Walk Extension detector". The Pedestrian Clearance interval shall also extend Pedestrian Clearance to the smaller of the Pedestrian Clearance Max time or the phase maximum in effect with a constant input from the "Walk Extension detector."
- 2.3.6 Volume density intervals shall include actuations before and cars waiting. Actuations before added shall provide a user-specified number of actuations that must occur before adding variable (added) initial time. Cars waiting shall provide a user specified number of actuations, or cars waiting, that must occur before starting gap reduction. Gap reduction shall be initiated by either time before reduction or cars waiting, whichever reaches its maximum value first.
- 2.3.7 The controller shall be capable of dynamically extending the maximum green time for each phase based on vehicle demand. Three maximum green intervals shall be selectable per phase based on TOD, coordination pattern or external input. The initial interval shall be selectable as Max 1, Max 2, or Max 3. If the phase terminates due to max-out for two successive cycles, then the maximum green time in effect shall automatically be extended by a dynamic max step interval on each successive cycle until it is equal to dynamic maximum. If the phase gaps out for two successive cycles, then the maximum green time shall be reduced by the dynamic max step time until it reaches to the original max value.
- 2.3.8 Each phase shall have a red maximum timing interval. An input (red extension) shall extend the all red period of the assigned phase as long as the detector input is true. This input must be true within the all red time of the assigned phase to be able to extend the all red period. If this detector fails then the all red extension feature shall be disabled.

2.4 Guaranteed minimum interval values shall be settable and shall not be overridden by the controller. Values shall be provided for the following intervals:

- 2.4.1 Minimum green
- 2.4.2 Walk
- 2.4.3 Pedestrian clearance
- 2.4.4 Yellow clearance
- 2.4.5 Red clearance
- 2.4.6 Overlap green

3. Overlaps

3.1 The controller shall provide sixteen internally-generated overlaps (A - P). All Overlap functions shall be programmable from the controller keyboard.

3.2 Overlaps shall be individually programmable as standard (normal), other (to include minus green / yellow, protected, pedestrian protected and protected permissive flashing arrow), with lag overlap timing capabilities. The green, yellow and red and lag interval timings shall be individually programmable with respect to the activation or termination of the parent phase, respectively.

3.2.1 The standard overlap shall require only included phases to be configured

3.2.2 A protected overlap shall operate according to the following rules:

a. Overlap shall be green, yellow or red like a normal overlap except its outputs shall be blank when the protected phase is green, or the controller is transitioning to a non-included phase.

3.2.3 Minus green / yellow overlaps shall operate according to the following rules:

a. Overlap shall indicate green when any of the overlap phases are green or when in transition between overlapped phases and a modifier phase is not green.

b. The overlap shall be yellow when an overlapped phase is yellow and the modifier phase is not yellow and none of the overlapped phases are next.

3.2.4 A pedestrian protected overlap shall be green under the following conditions:

a. When an included phase is green and the protected pedestrian is NOT in walk or pedestrian clearance

b. When the controller is in transition between included phases and a pedestrian protected phase is not next

c. After servicing an included phase pedestrian demand if there is enough time before max out to service the overlap minimum green

3.2.5 The controller shall provide an overlap selection for Protected/Permissive Left Turn PPLT Flashing Yellow Arrow FYA operation. PPLT/FYA shall allow selection of the protected phase, permissive phase, flash yellow output to either the overlap output, or a pedestrian clearance (yellow) output. The PPLT/FYA shall also allow the yellow arrow to continue flashing once the permissive through phase reaches yellow clearance. PPLT/FYA shall be enabled on a time of day basis.

3.3 The controller shall provide the capability of sixteen pedestrian overlaps. These shall be capable of overlapping the pedestrian displays of any combination of phases with a pedestrian movement.

4. Conditional Service

4.1 The controller shall provide a programmable conditional service feature. When selected, the controller shall service an odd-numbered phase once normal service to that phase has been completed and enough time for additional service exists on the concurrent even phase.

4.2 A conditional service minimum green time shall be programmable for each phase. This interval shall ensure a minimum green if the phase is conditionally served.

4.3 It shall be possible to program the controller to re-service the even phase after conditionally serving an odd phase. Once an even phase has been conditionally re-served, the odd phase shall not be conditionally served again until returning to the concurrent group that is timing.

5. Additional Features

5.1 The following features shall be programmable for each phase in each of four separate timing plans:

- 5.1.1 Locking/non-locking detector memory
- 5.1.2 Vehicle recall
- 5.1.3 Pedestrian recall
- 5.1.4 Maximum recall
- 5.1.5 Soft recall
- 5.1.6 No-rest phase
- 5.1.7 Enable Added Initial

5.2 Also programmed by phase shall be:

- 5.2.1 Phase in use
- 5.2.2 Exclusive Pedestrian phase

5.3 Soft recall shall return the controller to the programmed phase in the absence of other calls.

5.4 If a phase is designated as a no-rest phase the controller shall not rest in the phase, and proceed to the next phase with serviceable demand, or if no demand is present the next soft recalled phase.

5.5 The controller shall permit power start and external start to be programmed by phase and interval. Start intervals shall be green, yellow red , or yellow with overlaps forced yellow.

5.6 During a power start condition, the controller shall be capable of timing an all-red or flash interval before the power start phase(s) and interval are displayed. The controller shall support the MUTCD 2009 that requires a minimum of 6 seconds of all red following red/red flash.

5.7 The controller shall provide guaranteed passage operation on a per phase basis. When selected, this feature shall provide a full passage (vehicle extension) interval when a phase gaps out with a gap in effect less than the vehicle extension interval (preset gap).

5.8 The controller shall provide both single and dual entry operation. When selected, dual entry shall cause the controller to ensure that one phase is timing in each ring.

5.9 It shall be possible via keyboard selection to inhibit the service of a phase with other phase(s) within the same concurrent group.

5.10 The controller shall provide the following additional selectable pedestrian functions:

- 5.10.1 Actuated phase rest in WALK
- 5.10.2 Flashing WALK output
- 5.10.3 Pedestrian clearance protection during manual control
- 5.10.4 Pedestrian clearance through yellow
- 5.10.5 Pedestrian timing shall be capable of being carried over from one phase to another

- 5.11 Programming shall be provided to inhibit re-service of odd phases (left turns) within the same concurrent group. Also, programming shall be provided to place a demand on a phase in another concurrent group to cause the controller to leave the concurrent group prior to servicing the odd phases in the same concurrent group.
- 5.12 The controller shall provide a programmable simultaneous gap termination feature. When programmed, phases in both rings shall gap out together in order to terminate the green interval and cross the barrier.
- 5.13 The controller shall provide automatic flash selection per the requirements of the MUTCD. Both the flash entrance and exit phases shall be programmable through the keyboard, and flashing shall be controlled by either setting the fault/voltage monitor output to be FALSE or by flashing through the load switch driver outputs. If flash desired through the load switches, both the phase and overlap outputs shall be flashed either yellow or red as selected by the operator. Automatic flash shall be selectable by external input, system command, or TOD action plan.
- 5.14 The controller shall provide dimming for selectable load switch outputs. Dimming shall be accomplished by inhibiting the selected outputs for alternate half cycles of the 120 VAC line. Dimming shall be controllable by time of day and an external input; both functions must be TRUE for dimming to occur. Programming shall permit individual dimming of the Green/Walk, Yellow/Ped Clear, Red/Don't Walk outputs for each load switch. Based upon controller programming the controller shall automatically compute the MMU channel compatibility. The compatibility computed shall be based on phases-in-use, phase concurrency, valid pedestrian movements, vehicle and pedestrian overlaps, and pedestrian carryover.

Coordination

Coordination functions to control intersection cycle lengths, system offset relationships, and phase split percentages shall be provided as a standard feature, with no need for additional modules or software.

1. Coordination Patterns

- 1.1. A minimum of 120 coordination patterns shall be provided. Each pattern shall allow selection of an independent cycle length, offset value, and split pattern. The coordination patterns shall be selected using telemetry (system), hardware, or non-interconnected (time base) coordination commands. Offset and Split values shall be entered in either seconds or percentage.
- 1.2. The coordination patterns shall be selected by the coordination command using the following formats:
- a. Pattern - This format shall allow selecting the coordination patterns directly, that is, commanding Plan 1 selects Pattern 1. Pattern command shall include 1-120 patterns, pattern 254 shall select free, and pattern 255 shall select flash.
 - b. Standard - This format shall allow selecting the coordination patterns using a pattern number derived from a cycle offset-split command. Each pattern shall be assignable to a specific cycle-offset-split combination. The coordination pattern shall be selected programmed by the user to each pattern used.
 - c. TS2 - This format shall allow selecting the coordination patterns as a function of Timing Plan and one of three offsets. With this format a minimum of 20 Timing Plans shall be available for selection of one of sixty coordination patterns.

1.3. The following functions shall be programmable in each coordination pattern:

- a. Cycle length
- b. Split pattern number
- c. Offset value
- d. Dwell/Add time
- e. Actuated coordination
- f. Timing plan
- g. Actuated walk rest
- h. Phase sequence
- i. Phase re-service
- j. Action plan
- k. Maximum select
- l. Fixed/Floating force off
- m. Split timing per phase in seconds of percentage
- n. Directed split preferences
- o. Coordinated phase split extension
- p. Crossing artery pattern
- q. Permissive timing
- r. Ring extension
- s. Split demand pattern
- t. Ring displacement
- u. Coordinated phase
- v. Split value by phase
- w. Omit by phase
- x. Min recall by phase
- y. Max recall by phase
- z. Pedestrian recall by phase
- aa. Special function outputs

1.4. The following functions shall be programmable for each of the 120 Split patterns:

- a. Coordinated phase
- b. Split value by phase
- c. Omit by phase
- d. Min recall by phase
- e. Max recall by phase
- f. Pedestrian recall by phase
- g. Max and Pedestrian recall by phase

2. Cycle Length

2.1. One cycle length shall be provided for each coordination pattern. The cycle shall be adjustable over a range of 30-999 seconds in 1-second increments.

2.2. The cycle length shall serve as the reference time for all coordination timing.

3. Synchronization

3.1. For systems with a single system sync pulse, coordination timing shall be synchronized to the leading edge of that pulse, which shall serve as the master zero reference for all offset timing.

3.2. For hardwire systems with multiple sync pulses, the coordinator shall lock onto the correct.

3.3. sync by trying different syncs and checking for reoccurrence during successive cycles.

3.4. After a valid system sync pulse has been received the coordinator shall check for the proper occurrence of the system sync pulse during each subsequent cycle. If a sync pulse does not occur, the coordinator shall self-sync and continue to operate with the last set of coordination commands for a programmable number of cycles from 0-255. If a sync pulse does not occur within the programmed period (or until the first sync pulse is received), the coordinator shall revert to the non-interconnected coordination mode.

4. Offset

4.1. Offset shall normally be defined as the time period from the system sync pulse to the beginning of the leading coordinated phase green (local zero). The coordinator shall also be capable of referencing the offset to the beginning of the lagging coordinated phase green, coordinated phase yield, start of yellow point or the start of the ring 1 coordinated phase

4.2. Offsets shall be programmable using both percent and seconds. The range shall be from 0-99% of the cycle length in 1% increments or 0-255 seconds in 1-second increments.

4.3. Offset changes shall be achieved by adding or subtracting cycle time over a maximum of three cycle periods to allow a smooth transition to the new offset. Other offset change methods shall be adding 20% or a user-selectable value to each cycle or to snap to the sync point once the permissive period are complete and the coordinated phases are green.

4.4. Offset correction using dwell shall also be selectable.

5. Split

5.1. Each split shall provide a split interval for each of sixteen phases. The split interval shall be programmable using percent or seconds. The range shall be from 0-99% of the cycle length in 1% increments or 0-255 seconds in 1-second increments.

5.2. Split interval settings shall determine the maximum time, including vehicle clearance (yellow and red), for a non-coordinated phase, or the minimum time for a coordinated phase. Phase termination shall be controlled by establishing a force-off point for each phase within the cycle. Except for the coordinated phases the force-off point shall be selectable to be a fixed point within the cycle or allowed to float. If floating force-offs are selected each phase shall time no more than its own split interval.

5.3. During coordination, it shall be possible to operate a coordinated phase as actuated or non-actuated. If a coordinated phase is actuated, vehicle detections shall permit the coordinator to extend a phase beyond the normal yield point. Extended coordinated phase green shall be selectable using the same range as split interval settings (percent or seconds). If actuated coordinated phases are used they shall be able to have actuated or non-actuated (walk rest) pedestrian movements.

6. Permissive Periods

6.1. Permissive periods shall be provided to control the time period during which coordinated phases are released to service calls on non-coordinated phases.

6.2. All permissive timing shall begin at the lead coordinated phase yield point. A yield point shall be automatically computed for the coordinated phase in each ring. The coordinated phase yield points shall allow the coordinated phases to yield independent of each other. The yield point shall be the point at which the coordinated phase is released to allow the controller to service calls on

non-coordinated phases. The computation shall take into account the coordinated phase split interval plus pedestrian and vehicle clearance times.

6.3. Automatic permissive period operation shall be provided by automatically calculating a permissive period for each non-coordinated phase. The permissive period shall consist of a separate vehicle and pedestrian period computed from the phase split interval and the vehicle/pedestrian minimum time. The controller shall answer a call only during the associated phase permissive period. However, once the controller has been released to answer a call, all remaining phases shall be served in normal sequence.

6.4. Single permissive period operation shall be provided by defining a single time period per cycle beginning with the yield point during which the controller is allowed to answer phase calls for any phase. The duration of this period shall be selectable in each coordination pattern.

6.5. Dual-permissive period operation shall also be provided. During the first permissive period, the controller shall answer only vehicle or pedestrian calls on the phases following the coordinated phase. If the controller yields to a call during this period, calls on the remaining phases are served in normal rotation. During the second permissive period, the controller shall answer calls on all remaining phases except the first permissive phase. The duration of the two permissive periods, and the time at which to start the second permissive period (displacement), shall be selectable in each coordination pattern.

7. Phase Re-service

7.1. If actuated coordinated phases are in use it shall be possible to re-service non-coordinated phases within the same cycle if sufficient time remains. A phase shall be re-served only if the permissive period for the phase indicates there is sufficient time remaining in the cycle to service the phase.

7.2. Phase re-service shall be capable of being enabled/disabled in each coordination pattern.

8. Transition Cycles

8.1. It shall be possible to program the controller to ignore the pedestrian timing when calculating the minimum cycle length for offset correction.

8.2. The controller shall provide a smooth and orderly transition when changing from free operation to coordinated operation and from one coordination command to another.

8.3. During a free-to-coordinated transition, the controller shall initiate a pick-up cycle beginning upon receipt of a sync pulse and a valid coordination command. The controller shall then enter coordination mode upon crossing a barrier or if resting in the coordinated phases.

8.4. Each coordination command shall select a pattern. A command change shall be implemented concurrent with a sync pulse. Cycle, offset, and split changes shall not take effect until local zero.

9. Local Split Demand

9.1. The coordinator shall provide a minimum of two split demand detector inputs, which shall allow the selection of a preferred split plan based on intersection demand.

9.2. If the split demand detector indicates continuous vehicle presence during a programmed monitoring period beginning with the onset of a selected phase green, the coordinator shall force a selectable split plan to be in effect during the next cycle. This split plan shall remain in effect for a selected number of cycles from 0-255. A specific split plan shall be capable of being selected in each coordination pattern.

10. Adaptive Split Demand

10.1. The coordinator shall provide a method to select the split using measurement of each phase's green utilization. From the measurement the coordinator shall determine which phase or phases had excess time that was not used during the last measurement period. Then the excess time shall be added to the first set of preferential phases. If the first set of preferential phases gapped out during the last measurement period, then the excess time will be added to a second set of preferential phases. If both sets of preferential phases gapped out during the last measurement period then the time shall be added to the beginning of the coordinated phases.

11. Free Mode

11.1. The coordinator shall provide a free mode of operation, where all coordination control is removed.

11.2. Free mode operation shall be selectable by coordination commands, by external input or by keyboard entry.

11.3. The coordinator shall revert to the free mode when active controller inputs or functions would interfere with coordination. Such inputs or functions shall include the following:

- a. Manual control enable
- b. Stop time
- c. Automatic flash
- d. Preemption

11.4. The coordinator shall provide an active free mode, where coordination control is removed but the coordinator continues to monitor system sync so as to keep its timing in step with the system or TOD if operating under TOD or central system control.

12. Manual Control

12.1. The controller shall allow manual override of the current coordination command from the keyboard. The manual command shall allow selection of any coordination pattern to be in effect.

13. Interconnect Modes

13.1. The coordinator shall be capable of operating with any of the following interconnect types:

- a. Non-interconnected coordination (time-based)
- b. Telemetry
- c. Hardwired
- d. Fiber Optic

13.2. The coordinator shall be compatible with fixed-time interconnect, which provides the sync pulse superimposed on the offset lines. It shall also operate within an interconnected system using a separate sync line. The non-interconnected coordination mode shall serve as a backup when using telemetry, fiber optic, or hardwired interconnect.

Preemption

The controller shall provide a minimum of ten preemption sequences that can be programmed as either railroad-fire-emergency or bus vehicle preemption sequences. Preemption capability shall be standard and shall not require additional modules or software.

1. Railroad-Fire-Emergency Vehicle Preemption

- 1.1. The ten railroad-fire-emergency vehicle preemptors shall be selectable as a priority or nonpriority type. Priority preemptor calls shall override non-priority preemptor calls. Lownumbered priority preemptors shall override higher-numbered priority preemptor calls. Nonpriority preemptor calls shall be serviced in the order received.
- 1.2. Each preemptor shall provide a locking and non-locking memory feature for preemptor calls. If a preemptor is in the non-locking mode and a call is received and dropped during the delay time, the preemptor shall not be serviced.
- 1.3. Preemptor timing intervals shall be programmable from 0-255 in one-second increments or 0-25.5 in one-tenth second increments, depending on function. Delay, max presence, and duration timing intervals shall be programmed from 0 – 65535 seconds in one-second increments.
- 1.4. A programmable delay time interval shall be provided to inhibit the start of the preemption sequence. This interval shall begin timing upon receipt of a preemption call. This time shall be programmable from 0-65535 seconds in one-second increments.
- 1.5. An inhibit time shall be provided as the last portion of the delay time interval. During this time, phases that are not part of the preempt sequence shall be inhibited from service. This time shall be programmable from 0-255 seconds in one-second increments.
- 1.6. A programming option shall be available that allows termination of all phases prior to entering preemption.
- 1.7. A programmable extend input shall cause the preemptor to remain in the dwell interval following the removal of the preempt call. If a preempt call is reapplied during this time, the preemptor shall revert to start of dwell interval. This time shall be programmable from 0-25.5 seconds in one-tenth second increments.
- 1.8. A programmable duration time shall be provided to control the minimum time that a preemptor remains active. This time shall be programmable from 0-65535 seconds in one second increments.
- 1.9. A programmable maximum presence time shall be provided to control the maximum time that a preemptor input remains active and still be recognized by the controller. Once failed, the input must return to inactive state to be recognized again. This time shall be programmable from 0-65535 seconds in one-second increments.
- 1.10. Phases timing at the beginning of a preemption sequence shall remain in effect for a minimum time before the controller advances to the next sequential interval. If the phase has been timing for longer than the programmed preemptor minimum time, the controller shall immediately advance to the next sequential interval. Minimum times shall be programmable for the following intervals:
 - a. Green/walk/pedestrian clearance
 - b. Yellow
 - c. Red
- 1.11. A phase shall advance immediately to pedestrian clearance if it has been timing a WALK interval at the beginning of a preemption sequence. It shall be possible to time the minimum pedestrian clearance through the yellow interval, or alternately to advance immediately to yellow. During

preemption, pedestrian indicators shall be selectable as being a solid DONT WALK, OFF (blank) or fully operational.

- 1.12. If an overlap is in effect when the preemption sequence begins, it shall be possible to terminate the overlap so that it remains red for the remainder of the preemption sequence. Overlaps terminating or forced to terminate shall time the preemptor minimum yellow and red clearance times.
- 1.13. Each preemptor shall provide user-programmable green, yellow and red track clearance intervals. These shall begin timing immediately after the preemptor minimum red interval.
- 1.14. Each preemptor shall provide a user-programmable gate down extension and gate down max green. The gate down extension shall extend the track clearance green time after the gate down input is received. The gate down max green is the maximum the track clearance green time will be extended. If the gate down max green is exceeded the intersection shall be forced to flash.
 - 1.14.1 The forced flash shall be programmable to be either hard or soft. If hard flash is enabled then exiting flash to normal operation shall require either pressing the clear key or the MMU reset. A programmed soft flash shall automatically return to normal once the fault condition no longer exists. For gate down fault this shall be once preemption is deactivated.
- 1.15. Up to four permissive phases shall be selectable as track clearance phases. During the track clearance period, the selected phases shall time the track clearance green, yellow and red intervals once, and then advance to the hold interval. If track clearance phases are not selected the track clearance interval shall be omitted from the preempt sequence. Controller interval timing shall be used if track clearance interval times have been programmed as zero.
- 1.16. The preemption hold interval shall begin immediately after track clearance. It shall remain in effect until the preemptor duration time and minimum hold times have elapsed and the preemptor call has been removed or the preemptor maximum time has been exceeded. During the preemption hold interval, any one of the following conditions shall be selectable:
 - a. Hold phase green
 - b. Limited phase service
 - c. All red
 - d. Flash
- 1.17. Any valid phase, except a track clearance phase, shall be selectable as a hold phase. If hold phases are not selected, the controller shall remain in all red during the hold interval. If flash is selected for the hold interval, up to two permissive phases shall be selectable to flash yellow, and the remaining phases shall flash red. Overlaps associated with the phases flashing yellow shall also flash yellow unless they have been forced to terminate, in which case they shall remain red.
- 1.18. The preemptor shall immediately cause flashing operation if the preemption input and the track interlock input are not in opposite states and the track interlock function is enabled.
- 1.19. Each preemptor shall provide a user-programmable green, yellow and red dwell interval, during which the dwell phase(s) shall operate normally, except that the minimum green interval time shall equal the hold green time. At the completion of the dwell green interval, the controller shall time the dwell yellow and red clearance intervals prior to transfer to the exit phases.
- 1.20. Up to four permissive exit phases shall be selectable to time after the preemption sequence has been completed. These shall serve as transition phases to return the controller to normal

operation. It shall also be possible to place calls on selected phases upon exiting preemption. The option shall be provided to cause the preemptor to exit preemption to the correct phase to maintain coordination.

- 1.21. Each preemptor shall provide a user-selectable exit timing plan. Upon exiting the preemption sequence, this timing plan shall serve as the phase times in effect for one controller cycle for all phases.
- 1.22. Preemptor linking shall permit preemption sequences, where lower-priority preemptors may call the higher-priority preemptors from their preemption sequence.
- 1.23. Each preemptor shall allow programming of an inhibit extension timer. This timer shall be the length of time the max call inhibit can be extended.
- 1.24. Preemptor active outputs shall be provided for each of the preemptors. The output shall be set to ON when the preemption sequence begins and shall remain ON for the duration of the sequence. It shall also be possible to program preempt active outputs to be ON only during preempt hold intervals. Additionally, it shall be possible to program the non-active, non-priority preemptor outputs to flash while another preemptor is active.
- 1.25. Preemptors shall normally override automatic flash. It shall be possible to inhibit this feature for each preemptor.
- 1.26. Each preemptor shall provide the ability to delay the preempt input based on vehicle and pedestrian service request in relation to the coordinated cycle. The preemptor will compare the preempt delay time to the minimum time required to service a phase or pedestrian and then skip the phase or pedestrian movement if there is not enough time left in the delay to service the movement.
- 1.27. Each preemptor shall allow pedestrian movements which were interrupted by a preempt call to be dynamically selected as that Preemptor's exit phases.
- 1.28. Each preemptor shall allow vehicle phases which have been interrupted by a preempt call to be dynamically selected as that Preemptor's exit phases. The preemptor shall calculate the percentage of green time served of phases interrupted by a preempt call. If the amount serviced does not meet the limits defined by the Priority Return % data entries then the preemptor run shall select those interrupted movements as exit phases.
- 1.29. Each preemptor shall allow phases which have been waiting the longest to be serviced or which have the most cars waiting to be dynamically selected as that Preemptor's exit phases.
- 1.30. The conditional delay, interrupted pedestrian, interrupted vehicle and queue delay functions shall be programmed for enable, disable or time of day selection.
- 1.31. Each preemptor shall, if free one cycle is enabled, allow the preemptor to exit to free for one cycle before returning to coordination.
- 1.32. Each preemptor shall, if exit phase once is enabled, allow the preemptor to exit to specific phases in free mode (for a special minimum green time as defined in a new timing plan) before returning to coordination.

2. Bus Preemption

- 2.1. Ten bus preemptors shall provide control for bus or other low-priority vehicles. Bus preemptors shall have low priority and shall be overridden by railroad-fire-emergency vehicle preemptor calls.

2.2. The preemptor shall be programmed to accept either a 6.25 pulse-per-second signal with a 50% duty cycle or a solid input to identify a bus preemptor call. Bus preemptor calls shall be capable of preemptor call memory and shall be served in the order received.

2.3. Bus preemptor timing intervals shall be programmable from 0-255 in one second increments or 0-25.5 in one-tenth second increments depending on the function.

2.4. A re-service time shall be provided to avoid excessive utilization of the same bus preemptor. If a call is received before the re-service time has elapsed, the bus preemptor shall not be re-serviced. If re-service time has not been entered then all phases with a call when leaving the bus preemption sequence shall be serviced before the bus preemptor may be served again.

2.5. Bus preemptors shall provide delay, inhibit, and maximum time functions similar to those for railroad-fire-emergency vehicle preemptors described above.

2.6. Bus preemptors shall provide the following entrance intervals:

2.6.1 Green/walk/pedestrian clearance

2.6.2 Yellow

2.6.3 Red

2.7 At the completion of the entrance red clearance, the bus preemptor shall advance to the hold green interval. During this interval, up to four permissive phases shall be selectable to remain green until the minimum hold time has elapsed and the bus preemptor call has been removed or the preemptor maximum time has been exceeded.

2.8 It shall be possible to program the controller to allow concurrent phases to be serviced for a bus preemptor with only one phase selected as the hold interval phase.

3. Preemption Safeguards

3.1 If a preemptor call is active when power is restored to a controller, the fault/voltage monitor output shall be set to FALSE, placing the intersection in flash. Similarly, if external start is applied during a preemption sequence, the intersection shall be set to flash. Intersection flash shall remain in effect until the preemptor call has been removed and the preemptor duration time has elapsed.

3.2 An input shall be provided to stop timing of the current active preemptor under control of the MMU/CMU.

3.3 A preemptor safety interlock shall be provided to cause the intersection to go into flash whenever the controller has been replaced and/or has not been programmed for preemption. This shall be achieved with an appropriate signal to the MMU/CMU.

4. Optional Transit Signal Priority (TSP)

4.1 The controller shall include a transit signal priority algorithm that provides for transit vehicle movement through the intersection, while not interrupting coordination or skipping phases.

4.2 A check-in detector input shall be provided that senses the arrival of the transit vehicle. When active this input shall initiate TSP.

4.3 A TSP delay shall delay the beginning of TSP operation until a set interval after check-in.

4.4 A check-out detector input shall determine the departure of the transit vehicle.

4.5 Assignment of a single pulse from the check-in detector and check-out detector to the controller inputs shall be programmable to any controller input.

4.6 When under coordination the TSP sequence shall use adjusted split times to accommodate transit vehicles while maintaining coordination.

4.7 When under free operation the TSP sequence shall use adjusted maximum times to accommodate transit vehicle while not skipping phase.

Time-Based Control (Non-Interconnected) Coordination

The controller shall include time-based control. This capability shall be a standard feature and shall not require additional modules or software.

1. Clock/Calendar Functions

1.1. The controller shall provide a TOD clock, which shall be used for all time-based control functions. The only required clock settings shall be the current time (hour, minute and second) and date (month, day and year). Day of week and week of year shall be automatically computed from the date setting. It shall also be possible to set the number of hours that the local standard time is ahead or behind Greenwich Mean Time.

1.2. During normal operation, the TOD clock shall use the power line frequency as its time base. When power is removed, the time shall be maintained by a crystal oscillator for up to 30 days. The oscillator shall have a timing accuracy of +/- 0.005% over the entire NEMA temperature range as compared to the Universal Coordinated Time Standard.

1.3. In addition to entering time and date via the keyboard, it shall be possible to download the information from a central system.

1.4. The controller shall include a time reset input. This feature shall reset the TOD clock to 03:30 whenever the time reset input is TRUE.

1.5. The controller shall provide support for a serial input from a GPS clock that supports NMEA protocol to set the time and date of the controller.

1.6. The TOD clock shall automatically compensate for leap year and shall be programmable to automatically switch to daylight savings time.

2. Time-Based Control

2.1. Time-based control shall utilize a day plan program format. The month program shall consist of 200 programmable schedules, each assignable to one of sixteen day programs. Each day program shall consist of from 1 to 50 program steps which define a program for the entire day. Each program step shall be programmed with a starting time and an action plan number. The day plans shall also be assigned to days of the week and days of the month.

2.2. Time based control shall use action plans to assign:

- a. Coordination pattern number
- b. Vehicle detector plan number
- c. Controller sequence
- d. Timing plan
- e. Vehicle detector diagnostic plan
- f. Pedestrian detector diagnostic plan

2.3. Time based control shall also use action plans to enable:

- a. Automatic flash
- b. System override
- c. Detector log
- d. Dimming
- e. Special functions
- f. PPLT/FYA
- g. Priority return
- h. Ped priority return
- i. Queue Delay
- j. Conditional delay
- k. Auxiliary functions
- l. Logic Processor statements
- m. By-Phase functions
 - 1. Pedestrian recall
 - 2. Walk 2 enable
 - 3. Vehicle extension 2 enable
 - 4. Vehicle recall
 - 5. Vehicle max recall
 - 6. Max 2 enable
 - 7. Max 3 enable
 - 8. Conditional service inhibit
 - 9. Phase omit

2.4. There shall be a minimum of 36 holiday or exception day programs, which override the normal day program. Holiday programs shall be capable of being set as floating (occurs on a specific day and week of the month) or fixed (occurs on a specific day of the year). It shall be possible to program a fixed holiday so that it automatically repeats in the following year.

2.5. It shall be possible to manually force any of the action plans to override the current action plan. The forced plan shall be entered from the keyboard and shall remain in effect until removed.

3. Time-Based Coordination

3.1. A minimum of 200 time base schedule programs shall be available for the day-programs. There shall be up to 16 day plans with up to 50 events per day plan; these shall not have to be entered in any special sequence. It shall be possible to add and delete steps from a day-program without affecting any other day-program. Each of the program steps shall permit selection of the following functions:

- a. Day program assignment
- b. Start time
- c. Action plan

3.2. Selection of system override in an action plan shall allow the coordination pattern selected by the action plan to override the current telemetry or hardwire system commanded coordination pattern.

3.3. When operating in the time-based coordination mode the synchronization point for all cycles shall be referenced to a user selected reference time (sync reference), last event or last sync as selected from the keyboard. The sync reference time is that time at which all cycles shall be reset to zero.

3.4. If the sync reference time is selected, the synchronization point for the cycle selected by the current program step shall be computed using the present time, sync reference time, and cycle length. The synchronization point shall occur whenever the present time is such that an even number of cycle length periods has occurred since the sync reference time.

Detectors

1. Detector Functions

1.1. The controller shall provide a minimum of 64 vehicle detector inputs. Each input shall be assignable to one or more phases and be configured with optional detector functions.

1.1.1 Extend and delay timing shall be provided for each detector.

1.1.2 Each detector shall be capable of operating in a lock or non-lock mode.

1.2 The controller shall also be capable of providing 16 pedestrian detector inputs. Each pedestrian detector shall be assignable to one or more phases.

2. Detector Cross Switching

2.1 The controller shall provide detector cross switching, permitting a vehicle detector to alternately place calls on assigned phases and assigned cross switch phases.

2.1.1 If the assigned phase is not green and the cross-switch phase is green, the detector shall place calls on the cross switch phase.

2.1.2 If the assigned phase is omitted for any reason, the detector shall place calls on the cross switch phase.

3. Detector Types

3.1 Each vehicle detector shall be user-programmable to operate as one of the following seven (7) detector types:

3.1.1 **Type N (NTCIP):** supports all NTCIP detector functionality.

3.1.2 **Type S (Standard):** supports all standard detector functionality except the call and extend options will always be enabled.

3.1.3 **Type D (Disconnect queue/stop bar):** This detector will disconnect from extending the phase during green if either there is a gap in the detector input OR the detectors disconnect time times out. The detector's input must be active before the phase turns green for this detector to operate.

3.1.4 **Type P (Passage queue/stop bar):** If the detector input is active when the phase turns green the detector passage time is reset as long as the input is active. When the detector input becomes inactive the detector passage timer begins running. If addition calls are received before the detector passage timer expires, the detector passage timer shall be reset until the input becomes inactive. Once the detector passage timer times out the detector is disconnected for the balance of the phase green.

3.1.5 **Type C (Calling):** This detector shall place calls on the phase only when the phase is NOT green.

3.1.6 **Type R: (Red Extend):** An actuation on a red extend detector during the red clearance of the assigned phase shall extend the red up to the red max phase time.

3.1.7 **Type G (Green Delay/Extend):** When the phase is red the detector input becoming active to the controller shall be delayed by the amount of time programmed in the delay time. When the phase is green, the detector input shall be extended after removed by the amount of time programmed in the detector extension timer.

3.1.8 **Type B (Bike):** Activation shall cause the phase to use the Bike minimum green in place of the minimum green.

4 System Detectors

4.1 Each detector input shall be capable of functioning as 1 (one) of 16 (sixteen) system detectors.

4.2 Vehicle detectors shall be capable of being assigned to a minimum of 16 speed detectors. Speed shall be detected using both one and two detector configurations. Speed shall be computed using a keyboard entered average vehicle length and loop length for a one- detector configuration. When using two detectors, speed shall be calculated using a keyboard entered distance between detectors and travel time between detectors.

Logic Processor Commands

1. Standard Logic Commands

1.1. One Hundred (100) logic processor commands shall be assessable from the front panel of the controller or through remote database management software.

1.2. Each logic command shall be allowed to be enabled or disabled by TOD control

1.3. Each logic command shall consist of 10 "IF" statements, 5 "THEN" statements and 5 "ELSE" statements. At least 1 "IF" statement and 1 "THEN" statement are required to create a valid command.

1.3.1 "IF" statements shall be logically grouped using Boolean gating including:

1. AND
2. OR
3. XOR
4. NAND
5. NOR

1.3.2 When combined "IF" statements create one single "TRUE" result, the "THEN" statements shall be implemented.

1.3.3 When combined "IF" statements create one single "FALSE" result, the "ELSE" statements shall be implemented.

1.3.4 The "IF" statements shall monitor controller functions and timer including, but not limited to the following:

Phase/Overlap Green	Phase Calls
Phase/Overlap Yellow	Phase Omits
Phase/Overlap Red	Phase Force Offs
Phase/Overlap Active	Detector Fails

Detector Plan Number	Ring Timers
Detector Activity	Preemption Activity
Detector Volume	Preemption Dwell
Detector Occupancy	Preemption Exit
Coordination Timers	Stop Time
Coordination Holds	Manual Control
Phase Holds	Overlap timers (lagging/leading green)
Phase Walks	Active Coordination Plan Number
Phase Don't Walks	TBC parameter
Phase Next	Input / Output Bits
Phase Checks	Logic Flags

1.3.5 The "THEN" and "ELSE" statements shall be used to control functions and events (on/off) in the controller, including, but not limited to, the following:

1.3.6

Set Logic Flags	Set Phase/OVL Greens
Set Phase calls	Set Phase/OVL Yellows
Set Input or Output Bits	Set Phase/OVL Reds
Set Delays	Set Walk / Ped Clear / Don't Walk
Set Load Switch circuits (R/Y/G)	Set Pedestrian Detectors
Set Vehicle Detectors	Set Holds
Omit Phase / Peds	Set Force-offs
Change Max Timers (max1, max2)	Set Red Rest
Set Stop Time	Set Flash
Set Alarms	Set External Start
Set Recalls, CNA1, CNA2, etc	Set Manual Control Enable
Set Coordination Plan	Set Manual Advance
Set Free	Call Preempt
Call TSP	Call Phase
Set Action Plan	Set Timing Plan

2. Extended Options Logic Commands

2.1 An additional one-hundred logic commands (101-200) shall be available in the controller, but hidden from front panel access.

2.1.1 These commands shall be stored and used for easy implementation of common logic required at multiple intersections.

2.1.2 These commands shall only be assessable through computer software and shall be uploaded and downloaded to the controller using the same computer software.

2.2 Once downloaded to the controller, the logic shall be activated using an extended options file.

2.2.1 This file shall be downloaded to the controller and used to initialize the logic statements.

2.2.2 This file shall be used to create a custom menu on the controller. From this menu the user shall be able to enable or disable any of the extended options hidden in the upper one hundred logic commands.

System Communications

1. System Commands

1.1. The telemetry module shall allow the controller to receive, as a minimum, the following commands:

- a. Cycle, offset, and split (coordination pattern)
- b. System sync
- c. Special function commands (minimum of four)
- d. Free and flash mode commands
- e. Time and date
- f. Request for local status
- g. Recall to Max

1.2. All commands must occur more than once in any three-second period in order to be recognized.

1.3. All mode and special function commands shall be cleared after 20 minutes of loss of communication between controller and central system.

1.4. The status of each of the following functions shall be transmitted to the central system in response to a local status request:

- a. Green and yellow status for all phases and overlaps
- b. Walk and pedestrian clearance status for all phases
- c. Vehicle and pedestrian detector status
- d. Phase termination status
- e. Local time
- f. Coordination status
- g. Command source
- h. Sync or transitioning status of coordinator
- i. Conflict flash status
- j. Local flash status
- k. Preempt activity and calls
- l. Volume and occupancy data from a minimum of 16 system detectors
- m. Speed data from a minimum of two speed detectors
- n. Maintenance required (cabinet door open) status
- o. Status of two user-defined alarms

1.5. The status of each of the following parameters shall be calculated on a per-cycle basis and transmitted to the central system for Split Monitor Reporting:

- a. Actual time spent in each phase
- b. Time of day at end of cycle
- c. Phases forced off during cycle
- d. Type of coordination operation
- e. Whether transitioning to new offset
- f. Cycle, offset, and split in effect during last cycle
- g. Flash status if operation is Free

1.6. Upload/Download Capability – The controller shall provide the capability to upload/download the entire intersection database. Phase assignments for overlaps and preemptors shall not be downloaded to preclude unsafe controller operation. Data transfer shall not require the intersection to be in flash.

2. Telemetry

- 2.1. Telemetry shall utilize TDM/FSK data transmission from 1200 baud to 9600 baud over two pairs of wires. These may be leased lines (Type 3002, voice grade, unconditioned) or dedicated cable. Optional external fiber optic or wireless communications capability shall also be available.
- 2.2. The nominal transmitter output level shall be 0 dbm into a 600-ohm load. The receiver sensitivity shall be -34 dbm and shall be adjustable from -40 to +6 dbm.
- 2.3. Parity and error checking shall be employed to assure transmission and reception of valid data. Indicators shall be provided on the telemetry module to show telemetry activity as follows: transmit, receive carrier, and valid data.
- 2.4. In the event of a telemetry failure, the controller shall revert to the non-interconnected coordination mode after it has self-synchronized for a number of cycles, which shall be selectable from 1-254. If the number of cycles is set to 255, the controller will self-synchronize until a synchronization pulse is detected.

3. Communications Protocols

- 3.1. The controller shall have the capability of supporting communications with traffic management systems using industry standard protocols with the installation of appropriate optional software.
- 3.2. At a minimum the controller shall have optional software to support the following protocol:
 - a. NTCIP Level 2 as defined by Section 3.3.6 of NEMA TS2- 2003. NTCIP v02.06 capabilities shall include all NTCIP mandatory and optional objects. The controller vendor shall provide access to all controller data via vendor specific objects. These and all other objects supported by the controller shall be defined in a standard MIB file.

4. Ethernet Communications

- 4.1. The controller shall have the capability of supporting Ethernet communications, using TCP/IP communications protocols.
- 4.2. This communications protocol shall utilize the controller's built-in switches and shall not require Ethernet-to-Serial converters.

5. External Clock

- 5.1. The controller shall have the capability of communicating with an external clock like a GPS or WWV clock for setting its internal time of day clock.
- 5.2. The controller shall include a time reset input. This feature shall reset the TOD clock to 03:30 whenever the time reset input from the GPS or WWV clock is TRUE.

Diagnostics

1. General Diagnostics Features

- 1.1. The controller shall include both automatic and operator-initiated diagnostics. This capability shall be a standard feature and shall not require additional modules or software.

1.2. Automatic diagnostics shall verify memory and microprocessor operation each time power is reapplied to the controller. After power has been applied, diagnostics shall continually verify the operation of essential elements of the controller including at a minimum communications.

2. Detector Diagnostics

2.1. TOD controlled detectors diagnostics shall be provided that allow testing vehicle and pedestrian detectors for no activity, maximum presence, and erratic output.

2.2. A minimum of four detector diagnostic plans shall be provided. These plans shall be selectable on a TOD basis. This shall allow varying the detector diagnostic intervals to correspond with changes in detector activity.

2.3. If a detector is diagnosed as failed, the associated phase shall be placed in one of the following keyboard selectable modes:

- a. Detector fail recall from 1 to 255 seconds
- b. Disable the detector from calling or extending.

2.4. Diagnostics for NEMA TS2 detectors connected to the controller using a Bus Interface Unit (BIU) shall also include detection of watchdog, open and shorted loop, and excessive inductance change failures.

Logging

The controller shall be capable of logging and reporting detector activity, detector failures, and the occurrence of selected events or alarms. Logs shall be capable of being printed or displayed on the front of the controller.

1. Detector Logging

1.1. The controller shall include a detector log buffer capable of logging volume, occupancy and average speed for selected vehicle and speed detectors.

1.2. The detector-logging interval shall be keyboard selectable as 5, 15, 30, or 60 minutes.

1.3. Detector logging shall be capable of being enabled or disabled by TOD.

2. Detector Failure Logging

2.1. The controller shall include a detector failure log buffer capable of storing a minimum of 100 time and date-stamped detector failure events. Once logged, detector failure events shall remain in the log until cleared or the log buffer capacity is exceeded at which time the oldest detector failure events shall be overwritten.

2.2. All detector diagnostic failures shall be recorded in the detector failure log including: no activity, maximum presence, erratic output, watchdog failure, open loop, shorted loop, and excessive inductance change. If a detector recovers after a diagnostic failure, a detector online event shall be stored in the detector failure log.

2.3. Detector failure logging shall be capable of being disabled.

3. Event Logging

- 3.1. The controller shall include an event log buffer capable of storing a minimum of 200 time and date-stamped events or alarms. Once logged, events shall remain in the buffer until cleared or the log buffer capacity is exceeded at which time the oldest events shall be overwritten.
- 3.2. At a minimum the following events shall be logged: communication failures, coordination faults, MMU and local flash status, preempt, power ON/OFF, low battery, and status of a minimum of two alarm inputs. An on-line event shall be logged when an event or alarm returns to normal status.
- 3.3. If security is enabled, an event shall be logged when a user enters a data change. This event shall include the user's ID. It is necessary to log the first change only and not every change. Also an entry shall be recorded when a user logs in and out of the controller.
- 3.4. Event logging shall be capable of being enabled or disabled for each category of event or alarm.

EMULATION

1. Emulation Software.

- 1.1. With each controller provide software designed to emulate the controller. The emulation software shall employ the full functionality of the controller including but not limited to:
 - a. Configuration, timing, coordination, preemption, time base, detector setup, status display, utilities including special logic and diagnostic information. The software shall employ a graphical user interface that looks and acts like the controller. The software shall be designed to operate on the latest Microsoft Windows operating system and be capable of direct interface with Trafficware Synchro 7 or later traffic modeling software.

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 NTCIP Requirements (NEMA TS-2), Section 5 *Terminals and Facilities* and Section 7 *Cabinets*. Cabinet enclosure shall be UL listed.

1. Standard Features. Supply the following standard features:

a. Materials

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

b. Cabinet Dimensions

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

c. Doors

- (1) Provide a cabinet with lockable front and back doors meeting the requirements of NEMA TS-2 Section 7.5. The lock must accept a Best CX series core that will be installed by the Department after the Contract is complete.
- (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 switch:
 - (a) signal ON/OFF switch

- (b) "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.
- (3) Provide a removable, rigid metal cover on the back of the police panel to cover the live switch terminals.
- (4) Permanently label switches in the Police Compartment.

d. Shelves

Provide shelves meeting the requirements of NEMA TS-2 Section 7.6. Provide additional laptop computer shelf mounted approximately 42" above ground level. 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

Unless otherwise designated on 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 existing foundations and on new controller foundations as detailed on the Plans.
- (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.
 - (a) Construct the thermostat so that contacts close on descending temperature and are adjustable between 0 and 30 °F ±5 °F. The contacts must open on rising temperatures of 48°F above the closing temperature. The adjustment must have an indicating pointer. Remote bulb type thermostat shall not be used.
 - (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 fixture. Mount a hooded LED light fixture with a 15 inch flexible "goose neck" from the cabinet front door. Use a fixture UL rated to accommodate a 25 watt lamp with an integral "ON-OFF" rotary switch mounted on the lamp hood. Mount a fluorescent lighting fixture on the inside of the cabinet near the front edge. Use a fixture rated to accommodate an F15T8 lamp operated from a high power factor UL or ETL listed ballast. The lamp must be included. 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 either the front or back doors are open and OFF when both doors are closed.
- (2) 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.
- (3) Provide three (3) paper sets of complete and accurate cabinet drawings, wiring diagram and intersection signal layout with each cabinet. Make cabinet drawings available electronically in AutoCAD v2010 or later format and deliver with paper set.
- (4) 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 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 telemetry interconnect cable with each conductor terminated on individual terminals. Terminate telemetry interconnect cable conductors on individual terminals.
- (5) 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.

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, 30 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) "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 duplex 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 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) Both sides of the Control Panel and the Load-Bay shall be silkscreened on both sides. Aluminum panel for the Power Panel shall be silk screened also.
- (10) 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) Rear load bay cover. Clear plastic cover material shall be a minimum thickness of 0.1". Cover shall be firmly attached at two points. Provide a "DANGER 115 VOLTS A.C." warning label and affix to center of panel.
- (12) Warning Sign. The cabinet must contain a conspicuous warning sign against operation without the malfunction management unit being installed.

2. Special Features. Provide special features if called for on the Plans and as follows:

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 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.

740-2.12 STANDARD AUXILIARY EQUIPMENT. Furnish and install the following auxiliary equipment:

1. **Solid State Flasher.** Use a NEMA Type III flasher unit that conforms to NEMA Standards Publication No. TS 2-1992, *Traffic Controller Assemblies*, Section 6.3 *Solid State Flashers*.
2. **Three-Circuit Solid State Load Switches.** Use load switches that conform to NEMA Standards Publication No. TS 2-1992, *Traffic Controller Assemblies*, Section 6.2 *Three Circuit Solid State Load Switches* and, as a minimum, be supplied with Light Emitting Diode indicators on the DC input circuitry. The load switch must have 3 independent switching circuits, each being an individually replaceable solid state module.
3. **Malfunction Management Unit.** The malfunction management unit must meet the requirements of NEMA Standards Publication No. TS 2-1992, *Traffic Controller Assemblies*, Section 4 *Malfunction Management Unit*. If the circuit connected to the sensing input of the unit exhibits high impedance characteristics caused by dimmers or burned out lamps, furnish and install a low impedance device external to the unit between the input and AC- (Common).
4. **Flash Transfer Relay.** Use flash transfer relays that meet the requirement of NEMA Standards Publication No. TS 2-1992, *Traffic Controller Assemblies*, Section 6.4 *Flash Transfer Relays*.

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 NTCIP Requirements (NEMA TS-2)*.

1. **Inductive Loop Detectors Units.** Provide inductive loop detectors that conform to the requirements of NEMA TS-2, Section 6.5 *Inductive Loop Detector Units*. Unless otherwise called for on the Plans provide 2 Channel Inductive Loop Detectors with audible feedback of detection events. The audible feature must be manually switchable between audible "on" and silent "off."
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.** Supply a system modem/interface unit assembly that is compatible with the existing computerized traffic control system.

The cabinet shall come with a fiber optic ethernet switch. The ethernet switch shall support all of the following minimum requirements; virtual local area networks (VLAN) tagging (IEEE 802.1q) and dynamic bridging (IEEE 802.1). The ethernet switch shall be a Ruggedcom model RS940G or approved equivalent. The following cables, cords and licenses shall be supplied with the fiber optic ethernet switch:

- a. One AC power adapter
- b. Two 1000BaseLX SFP optics ports
- c. Minimum of four 10/100/1000BaseTX ports

At intersections where three or more fiber optic interconnect cables meet or where called for on the Plans, supply Ruggedcom model RX1500 or approved equivalent. The ethernet switch shall support all

of the following minimum requirements; virtual local area networks (VLAN) tagging (IEEE 802.1q) and dynamic bridging (IEEE 802.1). The following cables, cords and licenses shall be supplied with the fiber optic ethernet switch:

- a. One AC power adapter
- b. Four 1000BaseLX SFP optics ports
- c. Minimum of four 10/100/1000BaseTX ports

4. 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 Drawings.

- 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. Use Opticom Priority Control System Model 792H emitters.
- c. Unless otherwise shown on the Plan use Opticom Traffic Control Systems Opticom Detector Model 721 preemption detectors.
- d. 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.
- e. When more than one detector is required per phase, furnish the appropriate number of harnesses for the 764 Phase Selectors to handle the auxiliary detection.
- f. Install Model 138 Optical 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.
- g. The controller, rather than the phase selector or auxiliary logic, must perform interval timing, signal sequences, and phase skips.
- h. 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.
- g. When emitters are required, 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 Drawings 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 792R emitter on a magnetic base, 793R switch and cigarette lighter adapter power cord in a "Camera Bag" case.

5. Bus Interface Unit (BIU). Provide BIU's that fully meet the requirements of NEMA TS-2 Section 8. Unless otherwise called for on the Plans provide BIU's that meet the NEMA designation BIU2.

6. Traffic Logging System. If called for on the Plans, furnish, and install in the controller cabinet, a stand-alone unit that collects, time stamps, and stores data in an unattended manner.

7. Radar Detection System.

a. General.

(1) System Hardware. Use digital wave radar vision system hardware consisting of the following components:

(a) Provide an above-ground stop bar detector (SBD) equivalent to the Wavetronix SmartSensor Matrix® that will detect all vehicles, including bicycles for reliable and accurate presence detection where shown on the Plans

(b) Provide an above-ground continuous tracking advance extended range detector (CTAD) equivalent to the Wavetronix SmartSensor Advance Extended Range® for enhanced dilemma zone detection where shown on the Plans

(c) A Click 650 cabinet interface device (CIB)

(d) Contact closure input file detector rack cards with patch cables

(e) SmartSensor Manager Matrix (SSMM) software

(f) SmartSensor Manager Advance software for automatic and manual sensor configurations

Stop Bar Detector (SBD)

a. General. Provide an above-ground digital wave radar stop bar detector (SBD) equivalent to the Wavetronix SmartSensor Matrix® that will detect all stopped vehicles, including bicycles for reliable and accurate presence detection where shown on the Plans.

b. Product Description. The SBD units shall:

(1) Be able to simultaneously detect and track vehicles through a 90 degree field of view in two dimensions.

(2) Reports real-time presence of both moving and stopped vehicles for up to 10 lanes.

(3) Maximum number of zones: 16.

(4) Maximum number of channels: 16.

(5) User-selectable zone to channel mapping.

(6) AND logic triggers the channel when all the selected zones are active.

(7) OR logic used to combine multiple zones to a channel output.

(8) Channel output extend and delay functionality.

- (9) Algorithms mitigate detections from wrong way or cross traffic.
- (10) Fail-safe mode for contact closure outputs if communication is lost.

c. Detectable Area.

(1) Mounting Location.

- (a) The SBD shall be able to detect and report vehicle information when mounted between 15-35 ft. (4.6-10.7 m) above the road surface.

(2) Detection Range.

- (a) The SBD shall have a 90 degree field of view, and be able to detect and report information on the roadway located with the near boundary at 6 ft. (1.8 m) and a far boundary of 140 ft. (42.7 m) from the base of the pole on which the SBD is mounted.

(3) Lane Configuration.

- (a) Be capable of providing flexible lane configuration support including:

- Up to 10 lanes
- Curved lanes
- Islands and medians

d. Performance.

- (1) Stop Bar – Approach Only Counting Accuracy. For a four-lane, 35 mph approach, the SBD shall detect at least 80 percent of vehicles.

e. Performance Maintenance.

- (1) The SBD shall not require cleaning or adjustment to maintain performance.
- (2) The SBD shall not rely on battery backup to store configuration information.
- (3) Once the SBD is calibrated, it shall not require recalibration to maintain performance unless the roadway configuration changes.

f. Physical Properties. The SBD shall not exceed 5 lbs. (2.3 kg) in weight. The SBD shall not exceed 14 in. by 12 in. by 4 in. (35.5 cm x 30.5 cm x 10 cm) in its physical dimensions. All external parts of the SBD shall be ultraviolet-resistant, corrosion resistant, and protected from fungus growth and moisture deterioration.

- (1) Enclosure. The SBD shall be enclosed in a Lexan EXL polycarbonate.

- (a) The enclosure shall be classified "f1" outdoor weather ability in accordance with UL 746C.

- (b) The SBD shall be classified as watertight according to the NEMA 250 Standard.

- (c) The SBD enclosure shall conform to test criteria set forth in the NEMA 250 standard for type 4X enclosures. Test results shall be provided for each of the following type 4X criteria:

- External Icing (NEMA 250 clause 5.6)

- Hose-down (NEMA 250 clause 5.7)
- 4X Corrosion Protection (NEMA 250 clause 5.10)
- Gasket (NEMA 250 clause 5.14)

(d) The SBD shall be able to withstand a drop of up to 5 ft. (1.5 m) without compromising its functional and structural integrity.

(e) The SBD enclosure shall include a connector that meets the MIL-C-26482 specification. The MIL-C-26482 connector shall provide contacts for all data and power connections.

g. Power.

(1) The SBD shall consume less than 10 W.

(2) The SBD shall operate with a DC input between 9 VDC and 28 VDC.

(3) The SBD shall have an onboard surge protection.

h. Communication.

(1) The SBD shall have two half-duplex RS-485 com ports support.

(a) Dedicated detection comms

(b) Configuration, verification or traffic display without disrupting detection comms

(2) The SBD shall support the upload of new firmware into the SBD's non-volatile memory over Ethernet communication port.

(3) The SBD shall support the user configuration of the following:

(a) Baud rate

(b) Communication port response delay

(c) Contact closure output frequency

(4) Both communication ports shall support all of the following baud rates: 9600, 19200, 38400, 57600 and 115200 bps.

i. Radar Design.

(1) **Frequency Stability.** The circuitry shall be void of any manual tuning elements that could lead to human error and degraded performance over time. All transmit modulated signals shall be generated by means of digital circuitry, such as a direct digital synthesizer, that is referenced to a frequency source that is at least 50 parts per million (ppm) stable over the specified temperature range, and ages less than 6 ppm per year. Any upconversion of a digitally generated modulated signal shall preserve the phase stability and frequency stability inherent in the digitally generated signal.

(a) The SBD shall not rely on temperature compensation circuitry to maintain transmit frequency stability.

- (b) The bandwidth of the transmit signal of the SBD shall not vary by more than 1% under all specified operating conditions and over the expected life of the SBD.
- (c) Matrix of 16 radars.
- (2) Antenna Design. The SBD antennae shall be designed on printed circuit boards.
- (a) The vertical beam width of the SBD at the 6dB points of the two-way pattern shall be 65 degrees or greater.
- (b) The horizontal field of view: 90 degrees.
- (c) The sidelobes in the SBD two-way antenna pattern shall be -40dB or less.
- (d) Transmit bandwidth: 245 MHz
- (e) Un-windowed resolution: 2 ft. (0.6 m)
- (3) RF Channels. The SBD shall provide at least eight RF channels so that multiple units can be mounted in the same vicinity without causing interference between them.
- j. Configuration.
- (1) Automatic and manual configuration of lanes, stop bars and zones.
- (2) Lane positioning increment: 1 ft. (0.3 m)
- (3) Four-sided zones of any shape and size
- (4) Overlapping zones supported
- (5) Sensor reconfiguration without detection disruption supported
- (6) Graphical user interface with traffic pattern display
- (7) Counting and Pulsed channels supported
- (8) Windows Mobile®-based Software. The SBD shall include graphical user interface software that displays the current traffic pattern using a graphical traffic representation.
- (a) The graphical user interface shall also display all configured alerts and provide visual representation of their actuation.
- (b) The graphical user interface shall provide a means of logging the vehicular track files with an update rate of greater than five times per second.
- (c) The graphical interface shall operate on Windows Mobile v5.0 or greater, Windows XP, Windows Vista, and Windows 7 in the .NET framework.
- (d) The software shall support the following functionality:
- Automatically find the correct baud rate
 - Automatically find the correct serial communication port
 - Operate over a TCP/IP connection

- Provide a virtual sensor connection for software usability without a sensor
- Give the operator the ability to save/back up the SBD configuration to a file or load/restore the SBD configuration from a file
- Real-time traffic visualization for performance verification
- Zone and channel actuation display
- Local or remote sensor firmware upgradability

k. Operating Conditions. The SBD shall maintain accurate performance in all weather conditions, including

- (1) Rain, freezing rain, snow, wind, dust, fog and changes in temperature and light, including direct light on sensor at dawn and dusk.
- (2) SBD operation shall continue in rain up to 1 in. (2.5 cm) per hour.
- (3) The SBD shall be capable of continuous operation over an ambient temperature range of -40°F to 165°F (-40°C to 74°C).
- (4) The SBD shall be capable of continuous operation over a relative humidity range of 5% to 95% (non-condensing).

l. Testing.

- (1) FCC. Each SBD shall be Federal Communications Commission (FCC) certified under CFR 47, Part 15, section 15.249 as an intentional radiator.
 - (a) The FCC certification shall be displayed on an external label on each SBD according to the rules set forth by the FCC.
 - (b) The SBD shall comply with FCC regulations under all specified operating conditions and over the expected life of the SBD.
- (2) Tested under IEC 61000-4-5 class 4
- (3) NEMA TS2-2003 Testing. The SBD shall comply with the applicable standards stated in the NEMA TS2-2003 Standard. Third party test results shall be made available for each of the following tests:
 - (a) Shock pulses of 10g, 11 ms half sine wave
 - (b) Vibration of 0.5 g up to 30 Hz
 - (c) 300 V positive/negative pulses applied at one pulse per second at minimum and maximum DC supply voltage
 - (d) Cold temperature storage at -49°F (-45°C) for 24 hours
 - (e) High temperature storage at 185°F (85°C) for 24 hours
 - (f) Low temp, low DC supply voltage at -29.2°F (-34°C) and 10.8 VDC
 - (g) Low temp, high DC supply voltage at -29.2°F (-34°C) and 26.5 VDC
 - (h) High temp, high DC supply voltage at 165.2°F (74°C) and 26.5 VDC

(i) High temp, low DC supply voltage at 165.2°F (74°C) and 10.8 VDC

m. Manufacturing. The SBD shall be manufactured and assembled in the U.S.A.

(1) The internal electronics of the SBD shall utilize automation for surface mount and wave solder assembly, and shall comply with the requirements set forth in IPC-A-610C Class 2, Acceptability of Electronic Assemblies.

(2) The SBD shall undergo a rigorous sequence of operational testing to ensure product functionality and reliability. Testing shall include the following:

(a) Functionality testing of all internal sub-assemblies

(b) Unit level burn-in testing of duration 48 hours or greater

(c) Final unit functionality testing prior to shipment

(d) Test results and all associated data for the above testing shall be provided for each purchased SBD by serial number.

n. Support. The SBD 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, auto-configuration, and use of the SBD to ensure accurate SBD performance.

(a) The manufacturer-provided training shall consist of comprehensive classroom labs and hands-on, in-the-field, installation and configuration training.

(b) Classroom lab training shall involve presentations outlining and defining the SBD, its functions, and the procedures for proper operation. These presentations shall be followed by hands-on labs in which trainees shall practice using the equipment to calibrate and configure a virtual SBD. To facilitate the classroom presentation and hands-on labs, the manufacturer-provided training shall include the following items:

- Knowledgeable trainer or trainers thoroughly familiar with the SBD and its processes.
- Presentation materials, including visual aids, printed manuals and other handout materials for each student.
- Computer files, including video and raw data, to facilitate the virtual configuration of the SBD.
- Laptop computers or Windows CE hand-held devices with the necessary software, and all necessary cables, connectors, etc.
- All other equipment necessary to facilitate the virtual configuration of the SBD.

(c) Field training shall provide each trainee with the hands-on opportunity to install and configure the SBD at road-side. Training shall be such that each trainee will mount and align the SBD correctly.

(2) Technical Assistance. A manufacturer-provided technical representative shall be available to assist with the physical installation, alignment, and configuration of each supplied SBD. Technical support shall be provided thereafter to assist with troubleshooting, maintenance, or replacement of SBDs should such services be required.

- o. Documentation. SBD 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.
 - (1) The SBD manufacturer shall supply the following documentation and specification test results at the time of the bid submittal:
 - (a) FCC CFR 47 certification
 - (b) IEC 61000-4-5 class 4 test report
- p. Warranty. The SBD shall be warranted free from material and workmanship defects for a period of two years from date of shipment.

Extended Range Detector (CTAD)

The CTAD shall:

- (1) Be able to simultaneously detect and report information from up to 25 vehicles on the roadway when they are serially sequenced between the near and far boundaries.
- (2) Turn on a zone output when the range, speed, ETA, and qualified count or instantaneous roadway efficiency requirements for that zone are satisfied.
- (3) Turn on an alert output on when the user-defined zone output combinational logical is satisfied.
- (4) Turn on a normal channel output when any of the channel's alerts is on and the channel's delay and extend time constraints are satisfied.
- (5) Turn on a latched channel output when the on alert is turned on and the delay time is satisfied. The CTAD shall turn off a latched channel output when the off alert is turned on or the max timer expires and the extension time is satisfied.
- (6) Provide vehicle call and extend data on up to eight channels that can be connected to contact closure modules compliant with NEMA TS1, NEMA TS2, 170, and 2070 controller cabinets.
- (7) Be capable of providing data for each tracked detection over the serial ports.

a. Detectable Area.

(1) Mounting Location.

- (a) The CTAD shall be able to detect and report vehicle information when mounted within 50 ft. (15.2 m) of the center of the lanes of interest.
- (b) The CTAD shall be able to detect and report vehicle information when mounted at heights up to 40 ft. (12.2 m) above the road surface.

(2) Detection Range.

- (a) The CTAD shall be able to detect and report information on the roadway located with the near boundary at 50 ft. (15.2 m) and a far boundary of 500 ft. (152.4 m) from the base of the pole on which the CTAD is mounted.

- (b) For incoming traffic, 95 percent of large vehicles within the line-of-site of the CTAD shall be detected and reported before they arrive 400 ft. (121.9 m) from the sensor. For incoming traffic, 90 percent of all motor vehicles within the line-of-site of the CTAD shall be detected and reported before they arrive 400 ft. (121.9 m) from the sensor.

b. Performance.

- (1) Detection Accuracy. The CTAD shall detect at least 98 percent of large vehicles like truck-trailer combinations and at least 95 percent of all motor vehicles within the line-of-sight of the CTAD sensor where multiple detections of multi-unit vehicles are not considered false detections and merged detections of adjacent lane vehicles are not considered missed detections.
- (2) Range Accuracy. The CTAD shall provide range measurements in which 90% of the measurements are accurate within 10 ft. (3 m) when the vehicle is tracked independently.
- (3) Speed Accuracy. The CTAD shall provide per vehicle speed measurements in which 90% of the measurements are accurate within 5 mph when tracked independently.
- (4) ETA Accuracy. The CTAD shall provide estimated time-of-arrival (ETA) measurements in which 85% of the measurements are accurate within one second, when the detected vehicles are tracked independently at a constant speed above 40 mph (64 kph) and are within 2.5 and 5.5 seconds of the stop bar.

c. Performance Maintenance.

- (1) The CTAD shall not require cleaning or adjustment to maintain performance.
- (2) The CTAD shall not rely on battery backup to store configuration information.
- (3) Once the CTAD is calibrated, it shall not require recalibration to maintain performance unless the roadway configuration changes.

d. Physical Properties. The CTAD shall not exceed 5 lbs. (2.3 kg) in weight. The CTAD shall not exceed 14 in. by 12 in. by 4 in. (35.5 cm x 30.5 cm x 10 cm) in its physical dimensions. All external parts of the CTAD shall be ultraviolet-resistant, corrosion resistant, and protected from fungus growth and moisture deterioration.

- (1) Enclosure. The CTAD shall be enclosed in a Lexan EXL polycarbonate.
 - (a) The enclosure shall be classified "f1" outdoor weather ability in accordance with UL 746C.
 - (b) The CTAD shall be classified as watertight according to the NEMA 250 Standard.
 - (c) The CTAD enclosure shall conform to test criteria set forth in the NEMA 250 standard for type 4X enclosures. Test results shall be provided for each of the following type 4X criteria:
 - External Icing (NEMA 250 clause 5.6)
 - Hose-down (NEMA 250 clause 5.7)
 - 4X Corrosion Protection (NEMA 250 clause 5.10)
 - Gasket (NEMA 250 clause 5.14)

(d) The CTAD shall be able to withstand a drop of up to 5 ft. (1.5 m) without compromising its functional and structural integrity.

(e) The CTAD enclosure shall include a connector that meets the MIL-C-26482 specification. The MIL-C-26482 connector shall provide contacts for all data and power connections.

e. Power.

(1) The CTAD shall consume less than 8 W.

(2) The CTAD shall operate with a DC input between 12 VDC and 28 VDC.

f. Communication.

(1) The CTAD shall have two serial communication ports, and both ports shall communicate independently and simultaneously.

(2) The CTAD shall support the upload of new firmware into the CTAD's non-volatile memory over Ethernet communication port.

(3) The CTAD shall support the user configuration of the following:

(a) Baud rate

(b) Communication port response delay

(c) Contact closure output frequency

(4) Both communication ports shall support all of the following baud rates: 9600, 19200, 38400, 57600 and 115200 bps.

(5) The contact closure output frequency shall be user configurable as short as 10 ms, with a default near 130 ms for compatibility.

(6) Contact closure data shall be reliably communicated over homerun cable connections as long as 600 ft. (182.9 m) with latency from the time of channel requirement satisfaction to the eventual reporting of on the back edge of the contact closure card in 15 ms or less.

g. Radar Design.

(1) Frequency Stability. The circuitry shall be void of any manual tuning elements that could lead to human error and degraded performance over time. All transmit modulated signals shall be generated by means of digital circuitry, such as a direct digital synthesizer, that is referenced to a frequency source that is at least 50 parts per million (ppm) stable over the specified temperature range, and ages less than 6 ppm per year. Any upconversion of a digitally generated modulated signal shall preserve the phase stability and frequency stability inherent in the digitally generated signal.

(a) The CTAD shall not rely on temperature compensation circuitry to maintain transmit frequency stability.

(b) The bandwidth of the transmit signal of the CTAD shall not vary by more than 1% under all specified operating conditions and over the expected life of the CTAD.

- (2) Antenna Design. The CTAD antennae shall be designed on printed circuit boards.
 - (a) The vertical beam width of the CTAD at the 6dB points of the two-way pattern shall be 65 degrees or greater.
 - (b) The horizontal beam width of the CTAD at the 6dB points of the two-way pattern shall be 11 degrees or less.
 - (c) The sidelobes in the CTAD two-way antenna pattern shall be -40dB or less.
- (3) RF Channels. The CTAD shall provide at least four RF channels so that multiple units can be mounted in the same vicinity without causing interference between them.

h. Configuration.

- (1) Auto-configuration. The CTAD shall have a method for automatically configuring the sensitivity of detection in at least 5-ft. (1.5-m) increments.
 - (a) The auto-configuration method shall not prohibit the ability of the user to manually adjust the CTAD configuration.
 - (b) The CTAD shall support the configuration of up to eight channel outputs with up to four alerts per channel and up to four zones per alert, resulting in 32 configurable alerts and 128 configurable zones.
- (2) Zone Configuration.
 - (a) The CTAD shall support the configuring of zones in 5-ft. (1.5 m) increments.
 - (b) The CTAD shall support detection zones as long as 450 ft. (137.2 m).
 - (c) The CTAD shall support user configurable high-speed and low-speed detection filters for each zone.
 - (d) The CTAD shall support the configuring of speed filters in 1-mph (1.6-kph) increments.
 - (e) The CTAD shall support user configurable upper and lower estimated time-of-arrival (ETA) filters for each zone.
 - (f) The CTAD shall support the configuring of ETA filters in increments of 0.1 seconds.
 - (g) The CTAD shall provide configurable upper and lower count filters that help determine if a required number of qualified detections are present.
 - (h) The CTAD shall support the configuring of qualified count filters in increments of one.
- (3) Windows Mobile®-based Software. The CTAD shall include graphical user interface software that displays the current traffic pattern using a graphical traffic representation.
 - (a) The graphical user interface shall also display all configured alerts and provide visual representation of their actuation.
 - (b) The graphical user interface shall provide a means of logging the vehicular track files with an update rate of greater than five times per second.

- (c) The graphical interface shall operate on Windows Mobile, Windows 2000, Windows XP and Windows Vista in the .NET framework.
- (d) The software shall support the following functionality:
- Automatically find the correct baud rate
 - Automatically find the correct serial communication port
 - Operate over a TCP/IP connection
 - Provide a virtual sensor connection for software usability without a sensor
 - Give the operator the ability to save/back up the CTAD configuration to a file or load/restore the CTAD configuration from a file
- i. Operating Conditions. The CTAD shall maintain accurate performance in all weather conditions, including
- (1) Rain, freezing rain, snow, wind, dust, fog and changes in temperature and light, including direct light on sensor at dawn and dusk.
 - (2) CTAD operation shall continue in snow or rain up to 4 in. (10 cm) per hour.
 - (3) The CTAD shall be capable of continuous operation over an ambient temperature range of -40°F to 165°F (-40°C to 74°C).
 - (4) The CTAD shall be capable of continuous operation over a relative humidity range of 5% to 95% (non-condensing).
- j. Testing.
- (1) FCC. Each CTAD shall be Federal Communications Commission (FCC) certified under CFR 47, Part 15, section 15.245 or 15.249 as an intentional radiator.
 - (a) The FCC certification shall be displayed on an external label on each CTAD according to the rules set forth by the FCC.
 - (b) The CTAD shall comply with FCC regulations under all specified operating conditions and over the expected life of the CTAD.
 - (2) NEMA TS2-1998 Testing. The CTAD shall comply with the applicable standards stated in the NEMA TS2-1998 Standard. Third party test results shall be made available for each of the following tests:
 - (a) Shock pulses of 10g, 11 ms half sine wave
 - (b) Vibration of 0.5 g up to 30 Hz
 - (c) 300 V positive/negative pulses applied at one pulse per second at minimum and maximum DC supply voltage
 - (d) Cold temperature storage at -49°F (-45°C) for 24 hours
 - (e) High temperature storage at 185°F (85°C) for 24 hours
 - (f) Low temp, low DC supply voltage at -29.2°F (-34°C) and 10.8 VDC

- (g) Low temp, high DC supply voltage at -29.2°F (-34°C) and 26.5 VDC
- (h) High temp, high DC supply voltage at 165.2°F (74°C) and 26.5 VDC
- (i) High temp, low DC supply voltage at 165.2°F (74°C) and 10.8 VDC

k. Manufacturing. The CTAD shall be manufactured and assembled in the U.S.A.

- (1) The internal electronics of the CTAD shall utilize automation for surface mount and wave solder assembly, and shall comply with the requirements set forth in IPC-A-61 OC Class 3, Acceptability of Electronic Assemblies.
- (2) The CTAD shall undergo a rigorous sequence of operational testing to ensure product functionality and reliability. Testing shall include the following:
 - (a) Functionality testing of all internal sub-assemblies
 - (b) Unit level burn-in testing of duration 48 hours or greater
 - (c) Final unit functionality testing prior to shipment
 - (d) Test results and all associated data for the above testing shall be provided for each purchased CTAD by serial number.

l. Support. The 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, auto-configuration, and use of the CTAD to ensure accurate CTAD performance.
 - (a) The manufacturer-provided training shall consist of comprehensive classroom labs and hands-on, in-the-field, installation and configuration training.
 - (b) Classroom lab training shall involve presentations outlining and defining the CTAD, its functions, and the procedures for proper operation. These presentations shall be followed by hands-on labs in which trainees shall practice using the equipment to calibrate and configure a virtual CTAD. To facilitate the classroom presentation and hands-on labs, the manufacturer-provided training shall include the following items:
 - Knowledgeable trainer or trainers thoroughly familiar with the CTAD and its processes.
 - Presentation materials, including visual aids, printed manuals and other handout materials for each student.
 - Computer files, including video and raw data, to facilitate the virtual configuration of the CTAD.
 - Laptop computers or Windows CE hand-held devices with the necessary software, and all necessary cables, connectors, etc.
 - All other equipment necessary to facilitate the virtual configuration of the CTAD.
 - (c) Field training shall provide each trainee with the hands-on opportunity to install and configure the CTAD at road-side. Training shall be such that each trainee will mount and align the CTAD correctly.

- (2) **Technical Assistance.** A manufacturer-provided technical representative shall be available to assist with the physical installation, alignment, and configuration of each supplied CTAD. Technical support shall be provided thereafter to assist with troubleshooting, maintenance, or replacement of CTADs should such services be required.
- m. **Documentation.** CTAD documentation shall include a comprehensive user guide as well as an installer quick-reference guide and a user quick-reference guide.
- (1) The CTAD manufacturer shall supply the following documentation and specification test results at the time of the bid submittal:
- (a) Detection accuracy
 - (b) Range accuracy Earliest range of detection
 - (c) Speed accuracy
 - (d) ETA accuracy
 - (e) FCC CFR 47 certification
 - (f) NEMA 250 Standard for Type 4X Enclosure third-party test data
 - (g) NEMA TS2-1998 Standard third-party test data
- n. **Warranty.** The CTAD shall be warranted free from material and workmanship defects for a period of two years from date of shipment.

Click! 200

- a. **General.** Provide and install a surge suppression module (SSM) equivalent to the Wavetronix Click! 200™. Test results and other documentation demonstrating performance and capabilities shall be provided.
- b. **Product Description.** The SSM shall suppress electrical surges up to 4 kV on DC power lines, RS-485 and RS-232 with CTS/RTS communication lines to any device connected to the SSM. The SSM shall be designed to protect a radar vehicle sensing device (RSVD) equivalent to the Wavetronix SmartSensor™ from surges coming from a traffic cabinet, or protect a cabinet from surges coming from the RVSD.
- c. **Physical.** The SSM shall not exceed 0.3 lbs. (0.14 kg) in weight.
- (1) The SSM shall not exceed 4.5 in. x 4 in. x 0.9 in. (11.4 cm x 10.2 cm x 2.3 cm) in its physical dimensions.
- (2) The SSM shall operate in the temperature range of -29°F to 165°F (-34°C to 74°C).
- (3) The SSM shall operate in humidity up to 95% RH.
- d. **Mounting.** The SSM shall mount to a DIN rail with hot swappable surge protected power and communication buses for quick installation and replacement.
- e. **Connections.** The SSM shall have pluggable screw terminals allowing the user to wire a contact closure data collector to the SSM before installation to make installation easy and to minimize incorrect wiring.
- (1) The SSM shall also have a protected DB-9 connector for the RS-232DTE with CTS/RTS communication bus.
- (2) The SSM shall also have a protected RJ-11 connector for the RS-485 communication bus.

- (3) The SSM shall also have a 5-position connector for connecting power and RS-485 communications to and from the T-bus.
- f. Three-stage Protection. The SSM shall have a three-stage surge suppression design. The first stage shall be gas tubes followed by a second stage using inductors on the DC power lines and TVS diodes on the communication buses. The third stage shall have a resettable fuse (PTC) on the DC power line and varistors on all communication buses.
- g. DC Power Protection. The SSM shall comply with the applicable standards stated in the IEC 61000-4-5 Standard for DC power lines. Test results shall be made available for the following test conditions:
- (1) Surge voltages + 0.5kVA, 1 kVA, 2kVA and 4kVA
 - (2) Common mode (input to ground)
 - (3) Differential mode (input to input)
 - (4) 8x20 μ s waveform
 - (5) ohm generator impedance
 - (6) Minute-long pause between surges
- h. RS-485 Protection. The SSM shall comply with the applicable standards stated in the IEC 61000-4-5 Standard for communication lines. The RS-485 communication bus shall have a clamping voltage of 8 VDC and a 12 VDC differential clamping voltage. Test results shall be made available for the following test conditions:
- (1) Surge voltages \pm 0.5kVA, 1 kVA, 2kVA and 4kVA
 - (2) Common mode (input to ground)
 - (3) Differential mode (input to input)
 - (4) 8x20 μ s waveform
 - (5) 12 ohm generator impedance
 - (6) Minute-long pause between surges
- i. RS-232 with CTS/RTS Protection. The SSM shall comply with the applicable standards stated in the IEC 61000-4-5 Standard for communication lines. The RS-232 communication bus shall have a clamping voltage of 11 VDC. Test results shall be made available for the following test conditions:
- (1) Surge voltages \pm 0.5kVA, 1 kVA, 2kVA and 4kVA
 - (2) Common mode (input to ground)
 - (3) Differential mode (input to input)
 - (4) 8x20 μ s waveform
 - (5) 12 ohm generator impedance

- (6) Minute-long pause between surges
- j. NEMA TS2-1998 Testing. The SSM shall comply with the applicable standards stated in the NEMA TS2-1998 Standard. Test results shall be made available for each of the following tests:
 - (1) Shock pulses of 10g, 11 ms half sine wave
 - (2) Vibration of 0.5 Grms up to 30 Hz
 - (3) 300 V positive/negative pulses applied at one pulse per second at minimum and maximum DC supply voltage
 - (4) Cold temperature storage at -49°F (-45°C) for 24 hours
 - (5) High temperature storage at 185°F (85°C) for 24 hours
 - (6) Low temp, low DC supply voltage at -29.2°F (-34°C) and 10.8 VDC
 - (7) Low temp, high DC supply voltage at -29.2°F (-34°C) and 26.5 VDC
 - (8) High temp, high DC supply voltage at 165.2°F (74°C) and 26.5 VDC
 - (9) High temp, low DC supply voltage at 165.2°F (74°C) and 10.8 VDC
- k. Testing. Each SSM shall be tested by the manufacturer before shipment.
- l. Support. A manufacturer-provided technical representative shall be available to assist with the physical installation, setup, and configuration of each Click! 200 provided. Technical support shall be provided thereafter to assist with troubleshooting, maintenance, or replacement of Click! 200 should such services be required.
- m. Warranty. The SSM shall be warranted to be free from material and workmanship defects for a period of one year from date of shipment.

Click! 650

- a. General. When called for on the Plans, provide and install the number of cabinet interface devices(s) (CID) equivalent to the Wavetronix Click! 650. The CID shall be used to provide power to the SBD and CTAD sensors, protect the controller cabinet from surges, and communicate with the IFCC contact closure devices.
- b. Product Description. The CID can be used in place of Intersection Preassembled Backplates (IPB) or the Click 600. It shall convert real-time serial data from the RVSD to contact closure data in a form factor compatible with 170, 2070, NEMA TS2 and NEMA TS1 input file racks, or SDLC communication to the Controller BIU, allowing the RVSD to emulate loop-based traffic detection systems without replacing existing contact closure data collection infrastructure.
- c. Physical. The CID shall not exceed 5 lbs. (2.25 kg) in weight.
 - (1) The CID shall not exceed 7.8 in. x 10.3 in. x 3.9 in. (19.8 cm x 26.2 cm x 9.9 cm) in its physical dimensions.
 - (2) The CID shall operate in the temperature range of -29°F to 165°F (-34°C to 74°C).
 - (3) The CID shall operate in up to 95% relative humidity.

d. Mounting. The CID shall be a shelf mounted unit capable of being mounted to the side of the controller cabinet using u-channel mounting brackets.

e. Power. The CID shall be capable of providing:

(1) Power supply voltage: 90 to 260 VAC

(2) AC frequency: 50-60 Hz

(3) Maximum Power: 75 W at 80°C

(4) 24 VDC on sensor connectors

f. Connections and Communication.

(1) Power.

(a) AC input: IEC AC input.

(2) Four RJ-11 jacks on faceplate of device for connecting to contact closure devices.

(a) Communicate via RS-485

(b) Jacks make up physical interface of data bus on device and are for sending detection data from CTAD and SBD sensors on to contact closure devices such as rack cards.

(c) Communicate with rack cards via jumper cables

(3) Terminal Block Connectors. Four terminal block connectors on back of device for connecting to SBD and CTAD sensors.

(a) Cable terminal points for sensor power and RS-485 communications

(b) Matching terminal blocks are included with the CID

(c) Matches terminal blocks used for cable termination with Wavetronix intersection preassembled backplates

(4) Four communication ports on faceplate make up physical interface of control bus and are for connecting to the sensors to configure them.

(a) DB-9 port for communicating via RS-232

(b) Two RJ-11 jacks for communicating via RS-485

(c) USB mini-B connector

(d) T-bus port for connecting to a T-bus; allows the CID to send DC power and RS-485 communications to other devices connected to a T-bus

(5) SDLC

(a) One SDLC port on the front of the Device

(6) Ethernet

- (a) One RJ-45 10/100 Ethernet jack on the front of the device

g. Other Features. The CID shall have the following features:

(1) LEDs. The CID shall have four multicolored LEDs with activity indicating functions.

- (a) Red LED (PW) illuminates when device has power

- (b) Blue LED (OK) extinguishes if device has been disabled by surges

- (c) Green LED (TD) illuminates when data is transmitted on the control bus

- (d) Yellow LED (RD) illuminates when data is received on the control bus

(2) Data Bus RJ-11 Jack. Each data bus RJ-11 jack on the faceplate corresponds to one sensor and has the following features:

- (a) Switch for turning the power to each SBD and CTAD sensor on and off

- (b) LED for indicating when that sensor has power

(3) Power Switch. Switch for turning power on and off to entire CID

(4) OLED Panel with Keypad. Panel and keypad for CID device configuration.

(5) Web Interface. Web interface for CID device configuration, accessible through a web browser from a network-connected device.

(6) Configuration. CID configuration shall support up to 64 detector channels.

h. NEMA Testing. The CID shall comply with the applicable standards stated in NEMA TS2-2003. Test results shall be made available for each of the following tests:

- (1) Shock pulses of 10 g, 11 ms half sine wave

- (2) Vibration of 0.5 Grms up to 30 Hz

- (3) 300 V positive/negative pulses applied at one pulse per second at minimum and maximum DC supply voltage

- (4) Cold temperature storage at -49°F (-45°C) for 24 hours

- (5) High temperature storage at 185°F (85°C) for 24 hours

- (6) Low temp, low DC supply voltage at -29.2°F (-34°C) and 10.8 VDC

- (7) Low temp, high DC supply voltage at -29.2°F (-34°C) and 26.5 VDC

- (8) High temp, high DC supply voltage at 165.2°F (74 °C) and 26.5 VDC

- (9) High temp, low DC supply voltage at 165.2°F (74 °C) and 10.8 VDC

- i. **Testing.** Before shipping, each CID shall have passed a manufacturer's test and be FCC compliant.
- j. **Support.** A manufacturer-provided technical representative shall be available to assist with the physical installation, setup, and configuration of each Click! 650 provided. Technical support shall be provided thereafter to assist with troubleshooting, maintenance, or replacement of Click! 650 should such services be required.
- k. **Warranty.** The CID shall be warranted to be free from material and workmanship defects for a period of one year from date of shipment.

Cabling and Connectors

Supply cable and connectors of the appropriate length for the application stated.

- a. **General.** Provide a traffic sensor-to-pole mounted cabinet cable equivalent to the Wavetronix SmartSensor cable.

- (1) **Cable.** The cable shall be the Orion Wire Combo-2207-2002-PVCGY or an equivalent cable that conforms to the following specifications:

- (a) The RS-485 conductors shall be a twisted pair.
- (b) The RS-232 and RS-485 conductors shall have nominal capacitance conductor to conductor of less than 71 pF/Ft at 1 KHz.
- (c) The RS-232 and RS-485 conductors shall have nominal conductor DC resistance of less than 16.5 ohms/1000 ft. at 20°C.
- (d) The power conductors shall be a twisted pair with nominal conductor DC resistance of less than 11.5 ohms/1000 ft. at 20°C.
- (e) Each wire bundle shall be shielded with an aluminum/mylar shield with a drain wire or the entire cable shall be shielded with an aluminum/mylar shield with a drain wire.

- (2) **Connector.** The cable end connector shall meet the MIL-C-26482 specification and shall be designed to interface with the appropriate MIL-C-26482 connector. The connector backshell shall be an environmentally sealed shell that offers excellent immersion capability. All conductors that interface with the connector shall be encased in a single jacket, and the outer diameter of this jacket shall be within the backshell's cable O.D. range to ensure proper sealing. The backshell shall have a strain relief with enough strength to support the cable slack under extreme weather conditions. Recommended connectors are Cannon's KPT series, and recommended backshells are Glenair Series 37 cable sealing backshells.

- b. **General.** Provide a pole mounted cabinet-to-traffic cabinet home-run cable.

- (1) **Cable.** The home-run cable shall be the Alphawire 6023C or an equivalent cable that conforms to the following specifications:

- (a) Operate between -20°C to 60°C
- (b) Rated to 300 volts
- (c) Conductor: Stranded Tinned Copper

- (d) Insulation: Color-Coded Polypropylene
- (e) Shield: Individually Foil Shielded Pairs
- (f) Drain Wire: Stranded Tinned Copper
- (g) UL Type CM, AWM 2493
- (h) CSA CMG FT

SmartSensor Mount

- a. **General.** Provide traffic sensor mounting assembly equivalent to the Wavetronix SmartSensor mount.
- b. **Mounting.** The mounting assembly shall provide at least two axes of rotation to ensure proper installation.
 - (1) The mounting assembly shall be able to support at least a 15-lb. (6.8-kg) load.
 - (2) The mounting assembly shall feature a symmetric hole pattern that mates with fixed and rotational SmartSensor back plates.
 - (3) The mounting assembly shall have two contact points with the pole.
 - (4) The mounting assembly shall be slotted for 3/4" banding.
- c. **Construction.** The mounting assembly shall be constructed of 0.1875" thick or thicker aluminum with 316 stainless steel hardware.
 - (1) The mounting assembly shall be powder coated for oxidation resistance.

Installation Kit

- a. **General.** Provide an installation kit equivalent to the Wavetronix Install Kit, for use while installing and configuring radar vehicle sensing devices (RVSDs) or continuous tracking advance detectors (CTADs), equivalent to the Wavetronix SmartSensor products, or in-cabinet contact closure and communication connectivity devices (ICD) equivalent to the Wavetronix Click! products.
- b. **Product Description.** The RVSD, CTAD or ICD shall be installed and configured using a manufacturer supplied installation kit that includes the following elements: a handheld computer equivalent to the Socket Mobile SoMo 650, a serial to USB adapter equivalent to the Socket Serial USB to serial adapter, a Bluetooth to serial converter equivalent to the Click! 421, and pertinent documentation.

Smartsensor Cable Junction Box

For each radar sensor, provide a 6-conductor Type 4X cable junction box enclosure (WX-SS-710) to connect the Wavetronix 6-conductor pigtail cable (WX-SS-704) to the APT Matrix 2 homerun cable. Place this cable junction box in the upper portion of the nearest Type II traffic junction box; or controller cabinet foundation (for signal poles with traffic conduits running directly to the controller).

740-2.14 VEHICULAR SIGNAL HEADS. *Delete this subsection in its entirety and substitute the following:*
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 "VTCSH-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.

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 D-3359, ASTM D-3363 and ASTM D-522. Coating to be a Dull Black finish meeting Federal Standard 595b-37038.

a. **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:

(1) **Gaskets.** Use one-piece EPDM (ethylene propylene rubber) gaskets to seal LED modules.

(2) **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 indications marking shall include: "Manufactured in conformance with the ITE Vehicle Traffic Control Signal Heads: LED Vehicle Arrow Traffic Signal Supplement (July 1, 2007)."

(3) **Compatibility.** Use LED signal modules that are operationally compatible with currently used controller assemblies (solid state load switches, flashers, and conflict monitors).

(4) **Testing Requirements.**

(a) **All LEDs Functional.** LED modules with any non-functioning individual LEDs at the final inspection will be rejected.

(b) **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:

- 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 applicable ITE specification.
- 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 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

- 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.

(e) 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.

2. Housing.

- a. Use die cast aluminum, meeting ASTM B 85, 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.
- b. Use a one-piece housing with integral top, bottom, sides, and with square doors, for each signal section.
- c. 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.

- d. Provide an opening in the top and bottom of each housing to accommodate standard 1-1/2 inch pipe fittings and brackets.
- e. 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 positioning with the grooves of the mating section or framework.
- f. Fasten individual signal sections together with a cadmium-plated tri-stud connector, lockwashers, and nuts with access holes for the passage of electrical conductors from one section to another.
- g. Provide 2 integral hinge lugs on the left side of each signal housing for mounting the door.
- h. Provide 2 latches with stainless steel wing nut assemblies on the right side of each signal housing to engage the door latches.
- i. 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.
- j. Provide a round opening designed to accommodate any standard traffic signal lens in each signal housing door.

3. **Backplates.** Furnish and attach backplates to all vehicle signal heads except post-mounted flashers.

Construct backplates of 0.1-inch minimum thickness aluminum alloy sheet meeting ASTM B 209, alloy 3003-H14. Use 8 inch wide backplate extensions for 12-inch displays and 5-1/2 inch wide backplate extensions for 8-inch displays. When there are 2 or more backplate sections, fasten them together with aluminum rivets or bolts and peen after assembly to prevent loosening.

Use 5 or 5-1/2 inch wide backplate extensions (borders) for all post mounted and pole side mounted vehicle signal heads. Provide nominal 5-inch wide backplate extensions on all 5 section overhead cluster mounted signals. Provide backplates with nominal borders of 8 inches for the 8-inch sections and 5 inches for 12-inch sections on all combination 8-inch/12-inch vertical mounted signal heads.

Finish the back plates with a black powder coat. The front plates shall have a 3" wide yellow Type IV retroreflective finish or sheeting as a border around the back plate. This finish applies to both new and existing back plates.

740-2.16 PEDESTRIAN PUSH BUTTONS. *Delete this subsection in its entirety and substitute the following:* 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. Push buttons must be ADA-compliant. Furnish DCC-4EVR 120 (rectangle) or Bulldog RBDLM2-B-4H. Substitutions must be approved by the Engineer or designated representative and meet the following criteria: 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.
6. Must have a raised rim or ridges to protect the button from side impacts.
7. Powder coated cast switch housing of dark olive green or black.

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. *Delete this subsection in its entirety and substitute the following:* 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.

Controller assemblies for school zone speed limit sign beacons shall also include a time switch and a second 120 VAC circuit breaker that protects a thermostat and heater.

The NEMA 3R enclosure shall feature a single shelf and a hinged door with a hasp and staple for sealing and locking the cabinet door.

The radio interference and transient voltage 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 and integral strips can be marked with a pen or pencil.

Furnish an RTC Manufacturing model AP41-L 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 at least 4 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.

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.

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 NEMA 3R enclosure shall feature a single shelf and a hinged door with a hasp and staple for sealing and locking the cabinet door.

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

Provide a solid state NEMA Type 3 flasher meeting the requirements of NEMA Standard TS 1-1989, Traffic Control Systems with the following capabilities:

1. Operates on line voltages from 89-135 VAC RMS,
2. Operating temperature range of -40°F to 165°F,
3. Supplies a flash rate of 57±3 flashes per minute to the signal heads,
4. Dual circuit operation.

Use 20 ampere, 600 volt barrier type phenolic terminal blocks with plated brass screw type terminals and integral strips can be marked with a pen or pencil.

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. Under numbered paragraph 1., delete subparagraph c. in its entirety and substitute the following:

- c. Feature an easily removable hinged door or tray used exclusively for mounting the ballast. The ballast shall be mounted to the hinged door or tray.

Add the following subsection:

740-2.24 DMS.

Materials

1. Provide Dynamic Message Sign, (DMS) that conform to the following Standards:

- **General DMS Requirements** – The DMS must be designed in accordance with NEMA Standards Publication TS 4, Hardware Standards for Dynamic Message Signs (DMS), with NTCIP Requirements.
- **Aluminum Welding** – The DMS housing must be designed, fabricated, welded, and inspected in accordance with the latest revision of ANSI/AWS D1.2 Structural Welding Code-Aluminum.
- **Electrical Components** – High-voltage components and circuits (120 VAC and greater) must be designed, wired, and color-coded per the National Electric Code.
- **Environmental Resistance** – The DMS housing must be designed to comply with type 3R enclosure criteria as described in the latest revision of NEMA Standards Publication 250, Enclosures for Electrical Equipment (1000 Volts Maximum)
- **Product Electrical Safety** – The DMS and all associated equipment and enclosures must be listed by the Underwriters Laboratories (UL) and will bear the UL mark on the outside of the DMS enclosure. DMS will be listed as conformant to UL 48 Standard for Electric Signs and UL 50 Enclosures for Electrical Equipment. Control equipment and enclosures shall be listed as conformant to UL 1433 Standard for Control Centers for Changing Message Type Electric Signs. Failure to meet conformance will be cause for rejection.
- **Radio Frequency Emissions** – All equipment must be designed in accordance with Federal Communications Commission (FCC) Part 15, Subpart B as a “Class A” digital device.
- **Maintenance Access and Safety** – The DMS equipment provided must be compliant with all relevant OSHA requirements. The DMS must be equipped with OSHA compliant safety rails and fall arrest system at each entrance location.
- **Optical Performance** – The LED display must be designed to comply with Performance Level 1 of UK Highways Agency standard TR-2516, Issue B2, Optical Performance Functional Specification for Discontinuous Dynamic Message Signs.
- **Structural Integrity** – The DMS housing must be designed and constructed to comply with all applicable sections of AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals, latest standards, as well as the fatigue resistance requirements of NCHRP Report 412, Fatigue-Resistant Design of Cantilevered Signal, Sign, and Light Supports.
- **Communication Protocols** – The sign controller hardware/firmware and DMS control software must conform to the applicable National Transportation Communication for ITS Protocol (NTCIP) standards. Refer to the NTCIP section of this specification for detailed NTCIP requirements for this contract.

2. Product Testing Product test reports shall be submitted for the following testing:

- NEMA Standards Publication TS 4, Hardware Standards for Dynamic Message Signs (DMS), with NTCIP Requirements – Section 2, Environmental Requirements. Test report shall detail results of mechanical vibration and shock, electrical noise and immunity, temperature, and humidity.

- Underwriters Laboratories (UL), UL 48 Standard for Electric Signs, UL 50 Enclosures for Electrical Equipment, and UL 1433 Standard for Control Centers for Changing Message Type Electric Signs. The UL report number(s) for all DMS and control equipment manufactured by the DMS manufacturer shall be submitted and the products shall bear the UL mark.

The supplier must provide a record of each test performed including the results of each test. The report must include a record of the product test report and the test lab's representative that witnessed the tests, including the signature of the lab's representative. The test reports must be provided to the Engineer for review as part of the technical submittal.

3. Self Certification The DMS manufacturer must provide self-certification, including a statement of conformance and copies of test reports, indicating that the following tests have been performed and passed.

Product test reports must be submitted for testing of the following National Transportation Communication for ITS Protocol (NTCIP) standards:

- NTCIP 1201: NTCIP Global Object Definitions
- NTCIP 1203: Object Definitions for Dynamic Message Signs (including Amendment 1)
- NTCIP 2101: Point to Multi-Point Protocol Using RS-232 Subnetwork Profile.
- NTCIP 2103: Point-to-Point Protocol Over RS-232 Subnetwork Profile.

The NTCIP testing must have been completed using industry accepted test tools such as the NTCIP Exerciser, Trevilon's NTester, Intelligent Devices' Device Tester, and/or Frontline's FTS for NTCIP. The NTCIP test report(s) must include testing of sub-network communications functionality, all mandatory objects in all mandatory conformance groups, and a subset of the remaining objects.

4. DMS Sign Housing The DMS housing structural frame shall consist of aluminum extrusions made from 6061-T6 and/or 6063-T6 aluminum alloy. All sides of the DMS housing exterior, except the front, shall be covered with 0.125-inch (3.17 mm) thick aluminum sheets made from 5052-H32 aluminum alloy. This external aluminum skin shall be attached to the structural framework using a proven method of attachment.

DMS housing right, left, and rear walls shall be vertical. The top and bottom sides shall be horizontal. The front DMS wall shall be built with a permanent forward tilt angle of three (3) degrees, so that the top of the DMS housing is deeper than its bottom. LED display modules shall be mounted parallel to the front wall, so they are tilted three (3) degrees forward toward the viewing motorists and use of the legible LED viewing area is optimized.

DMS structural assembly hardware (nuts, bolts, washers, and direct tension indicators) shall be galvanized A325 high-strength steel and shall be appropriately sized for the application.

4.1. Welding

The aluminum skin shall be welded to the DMS cabinet frame. All exterior sheet seams shall be continuously seam welded to the DMS frame to form a single structure. Stitch welding shall be used on the interior of the cabinet to attach the aluminum skin sheets to the aluminum extrusion frame. The DMS housing shall be welded and inspected in accordance with the requirements of ANSI/AWS D1.2 Structural Welding Code-Aluminum. Compliance with this standard shall include, but shall not be limited to, the following:

- Welding shall be performed according to documented in-house welding procedures
- Personnel who perform welding on the DMS housing shall be certified to AWS D1.2 for all weld types required for housing fabrication
- A Certified Welding Inspector (CWI) shall inspect DMS welding on a daily basis and shall complete written reports that document welding progress, weld integrity, and any

corrective action taken. The DMS manufacturer shall archive these reports and make them available for review, upon request of the Engineer

4.2. Chemical Bonding

An alternate method of attaching the aluminum sheet to the cabinet extrusion shall be the use of a two-part chemically bonding structural adhesive. The adhesive shall be applied in a continuous bead on all cabinet extrusion surfaces that contact the aluminum sheet. The adhesive shall provide the necessary structural bond between the aluminum sheet and the cabinet extrusion as required by the contract specifications and other pertinent standards and codes. The adhesive shall ensure a watertight seal is obtained around the entire perimeter of the cabinet and where any aluminum sheets are spliced.

To ensure that appropriate procedures are followed to bond the aluminum sheet and cabinet extrusion, the structural adhesive manufacturer shall certify the DMS manufacturer. The DMS manufacturer is responsible for performing all necessary testing of the adhesive to meet all requirements of the contract specifications.

5. **Front Face Construction** The DMS front face shall be constructed with multiple rigid panels, each of which supports and protects a full-height section of the LED display matrix. The panels shall be fabricated using aluminum sheeting on the exterior and polycarbonate sheeting on the interior of the panel.

Front face panels shall provide a high-contrast background for the DMS display matrix. The aluminum mask of each panel shall be painted black and shall contain an opening for each pixel. Openings shall be large enough to not block any portion of the viewing cones of the LEDs.

Face panels shall be attached to each other using stainless steel hardware. Seams that separate adjacent panels shall be sealed. Panels shall not be welded or otherwise permanently mounted to the DMS housing. Panels shall be mounted in such a way that they are removable from the interior of the DMS housing.

Each panel shall have a single polycarbonate sheet attached securely to the inside of the aluminum panel. The polycarbonate sheet shall cover all of the pixel openings. The polycarbonate shall be sealed to prevent water and other elements from entering the DMS. The polycarbonate shall contain UV inhibitors that protect the LED display matrix from the effects of ultraviolet light exposure and prevent premature aging of the polycarbonate itself. The use of a plastic lens system will not meet the requirements and will be cause for rejection. Polycarbonate sheets shall have the following characteristics:

- Tensile Strength, Ultimate: 10,000 PSI
- Tensile Strength, Yield: 9,300 PSI
- Tensile Strain at Break: 125%
- Tensile Modulus: 330,000 PSI
- Flexural Modulus: 330,000 PSI
- Impact Strength, Izod (1/8", notched): 17 ft-lbs/inch of notch
- Rockwell Hardness: M75, R118
- Heat Deflection Temperature Under Load: 264 PSI at 270F and 66 PSI at 288F
- Coefficient of Thermal Expansion: 3.9×10^{-5} in/in/F
- Specific Heat: 0.30 BTU/lb/F
- Initial Light Transmittance: 85% minimum
- Change in Light Transmittance, 3 years exposure in a Southern latitude: 3%
- Change in Yellowness Index, 3 years exposure in a Southern latitude: less than 5%

LED display modules shall mount to the inside of the DMS front face panels. No tools shall be needed for removal and replacement of LED display modules.

DMS front face borders (top, bottom, left side, and right side), which surround the front face panels and LED display matrix, shall be painted black to maximize display contrast and legibility. The surrounding borders shall be a minimum of 12" in accordance with NEMA TS4 Hardware Standards for Dynamic Message Sign with NTCIP requirements.

In the presence of wind, the DMS front face shall not distort in a manner that adversely affects LED message legibility.

6. Service Access The DMS housing shall provide safe and convenient access to all modular assemblies, components, wiring, and subsystems located within the DMS housing. All of those internal components shall be removable and replaceable by a single technician. The DMS front face panels shall also be removable and replaceable from inside the DMS cabinet.

One (1) vertically hinged door shall be located on each end (left and right side) of the DMS housing. Each access door shall be mounted to an integral doorframe, which bolts to the DMS housing using stainless steel hardware. A continuous vertical stainless steel hinge shall support each door, and all doors shall open outward. In the closed position, each door shall latch to its frame with a three-point draw-roller mechanism. The latching mechanism shall include an internal handle and release lever. Door release levers shall be located so that a person with no key and no tools cannot become trapped inside the housing.

Access doors, when open at a 90-degree angle from the DMS housing end wall, shall not extend more than 38-inches (965 mm) from the housing. The bottom edge of each door shall be at least 3.5-inches (89mm) from the bottom edge of the DMS housing. This will provide clearance for the doors to swing open over external access platform.

Doorframes shall be double flanged on all sides to shed water. Each door shall close around its flanged frame and compress against a closed-cell foam gasket, which adheres to the door. All doors shall contain a stop that retains the door in a 90-degree open position. When a door is open, the door and its stop shall not be damaged by a 40 mph (64 km/h) wind.

Each door shall be furnished with a lock that is keyed to a Cobin #2 lock.

The DMS must be equipped with an OSHA compliant safety rail assembly, which prevents service personnel from falling out of the DMS when closed across an open access door. A rail assembly must be provided for each door in the display. The safety rail shall consist of a top rail that extends 42-inches (1,067 mm) above the interior walkway, and a mid rail that extends 21-inches (533 mm) above the interior walkway. The rail assembly shall require no tools to open and close.

The DMS cabinet shall be equipped with an OSHA compliant anchor point at each entrance location for the connection of a personal fall arrest system. These anchorages must be strong enough to withstand a force of 5,000 pounds (22.2 kilonewtons) as required by OSHA. The anchorages must be located such that they will not allow a person to free-fall for more than 6 feet when a 6 foot lifeline is used. The anchorages must be located just inside each access door within easy reach from the outside.

7. Interior Work Area Minimum headroom of 72-inches (1,829mm) shall be provided. This free space shall be maintained across the entire width of the DMS housing, with the exception of structural frame members. Structural members shall be designed not to obstruct the free movement of maintenance personnel throughout the DMS interior.

A level aluminum walkway shall be installed in the bottom of the DMS housing. The walkway shall be a minimum of 24-inches (610 mm) wide, and it shall run the entire length of the housing, from access door to access door. The walkway's top surface shall be non-slip and shall be free of obstructions that could trip service personnel. The walkway shall support a load of 300 pounds (136 kg) per linear foot, and it shall be constructed of multiple aluminum removable panels.

8. Environmental Monitoring Systems The DMS shall include sensors that monitor and report ambient (external) light level and temperature, as well as the internal temperature and humidity.

8.1. Ambient Light Measurement

Sensors that measure the outdoor ambient light level and the outdoor ambient temperature at the DMS site shall be mounted in-line with the DMS housing walls. This ambient light and temperature measurement system shall consist of three (3) electronic light sensors.

Two of the light sensors shall be placed such that they measure the ambient light levels striking the front and rear of the DMS. The third light sensor shall be mounted to the floor of the DMS housing and shall face the ground. The DMS sign controller shall continuously monitor the light sensors and adjust the LED display matrix intensity to a level that creates a legible message on the DMS face.

8.2. Ambient Temperature Measurement

A minimum of one (1) ambient temperature sensor shall be mounted to the rear wall of the DMS housing. The sensor shall be placed such that it is never in direct contact with sunlight. The external temperature sensor reading shall be continuously monitored by the DMS sign controller and shall be reported to the DMS control software upon request.

8.3. Internal Temperature Measurement and Heater

The DMS shall contain a minimum of one (1) temperature sensor and (1) heater. The temperature sensor(s) shall measure the temperature of the air in the cabinet over a minimum range of -40°F to +176°F (-40°C to +80°C). The internal temperature sensor output shall be continuously monitored by the DMS sign controller and shall be reported to the DMS control software upon request. The heater shall be thermostatically controlled with a set temperature of -10°F.

8.4. Internal Humidity Measurement

The DMS shall contain one (1) sensor that measures the relative humidity of the air inside the DMS cabinet. The sensor shall monitor the humidity from 0 to 100%. The humidity sensor output shall be continuously monitored by the DMS sign controller and shall be reported to the DMS control software upon request.

9. Wiring and Power Distribution

9.1. Power and Signal Entrances

Two threaded conduit hubs shall be located on the rear wall of the DMS housing. One hub shall be for incoming AC power and the other shall be for incoming DMS signal cabling or a communications line.

9.2. Panel Board

The DMS shall contain a power panel board and circuit breakers that meet the following minimum requirements:

- Service entrance-rated
- Minimum of 20 circuit breaker mounting positions
- Short circuit ratings of 22,000 amps and 10,000 amps for the main and branch circuits, respectively
- UL listed panel board and circuit breakers

9.3. Internal Wiring

Wiring for LED display module control, environmental control circuits, and other internal DMS components shall be installed in the DMS housing in a neat and professional manner. Wiring shall not impede the removal of display modules, power supplies, environmental control equipment, and other sign components. Wires shall not make contact with or bend around sharp metal edges. All wiring shall conform to the National Electrical Code.

9.4. Earth Grounding

The DMS manufacturer shall provide one earth ground lug that is electrically bonded to the DMS housing. The lug shall be installed near the power entrance location on the DMS housing's rear wall. The DMS installation contractor shall provide the balance of materials and services needed to properly earth ground the DMS. All earth grounding shall conform to the National Electrical Code.

10. Transient Protection The DMS and sign controller signal and power inputs shall be protected from electrical spikes and transients as follows:

10.1. Sign AC Power

The AC power feed for all equipment in the sign cabinet shall be protected at the panel board by a parallel-connection surge suppresser rated for a minimum surge of 40 kA. This device shall conform to the following requirements:

- Withstand a peak 80,000-ampere surge current, 40kA L-N, 40kA L-G
- Designed, manufactured, & tested consistent with: IEEE C6.41.1-2002, C62.41.2- 2002, C2.45-2002, ANSI/IEEE C62.41-1991, C62.45-1992, NEMA LS-1, and NEC 285.6
- Less than 0.5 nanosecond response time
- Temperature range of -40°F to +140°F (-40°C to +60°C)
- Approximate dimensions of 3-inches (76 mm) wide by 8-inches (203 mm) long by 3- inches (76 mm) high
- 5000 Category (C3 High) impulses with <10% drift, short circuit current rating of 200,000 rms symmetrical amperes (UL Listed)
- UL listed to: UL 1449 200kA SCCR, UL 1283 4th Edition, and Canadian safety standards

10.2. Control Equipment AC Power

A series-connected surge suppressor capable of passing 15 amps of current shall protect the sign controller and other control and communication equipment. This device shall conform to the following requirements:

- Withstand a peak 50,000 ampere surge current for an 8x20 microsecond wave form
- Maximum continuous operating current of 15 amps at 120 VAC, 60 Hz
- Series inductance of 200 micro henrys (nominal)
- Temperature range of -40°F to +158°F (-40°C to +70°C)
- Approximate dimensions of 3-inches wide by 5-inches long by 2-inches high (76 mm by 127 mm by 50 mm)
- The device shall be UL-1449 recognized
- UL 1449 surge rating of 400 V or less

10.3. Communication Signals

Transient voltage surge suppressors shall protect all communication signals connecting to the control equipment from off-site sources using copper cables.

Transient voltage surge suppressors shall protect all copper communication lines used to pass data between the sign controller and sign.

10.3.1. Series inductance of 200 micro henrys (nominal)

10.3.2. Temperature range of -40°F to +158°F (-40°C to +70°C)

SPECIAL PROVISIONS

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Richardson Highway Dynamic

Messaging Sign (CMAQ)

10.3.3. Approximate dimensions of 3-inches wide by 5-inches long by 2-inches high (76 mm by 127 mm by 50 mm)

10.3.4. The device shall be UL-1449 recognized

10.3.5. UL 1449 surge rating of 400 V or less

Add the following subsection:

740-2.25 DMS CONTROLLER ASSEMBLY. This subsection describes the minimum specifications for the dynamic message sign (DMS) controllers and auxiliary control panels to be provided with this contract. Each DMS shall include a sign controller, auxiliary control panel, and associated equipment. The contractor shall provide all the materials, software, and services necessary to install DMS controllers, auxiliary control panels, and associated equipment that fully comply with the functional requirements specified herein, including incidental items that may have been inadvertently omitted.

1. General Each DMS shall be controlled and monitored by its own sign controller. The sign controller shall be a stand-alone microprocessor-based system, which does not require continuous communication with DMS control software in order to perform most DMS control functions.

The sign controller shall meet the following operational requirements:

- Communicate using embedded NTCIP protocol
- Contain memory for storing changeable and permanent messages, schedules, and other necessary files for controller operation
- Include a front panel user interface with graphical LCD and keypad for direct operation and diagnostics as described herein
- Contain a minimum of three (3) NTCIP-compliant RS232 communication ports
- Contain a minimum of one (1) NTCIP-compliant RS422 communication port with RJ45 connector
- Have the ability to play volatile messages
- Contain a minimum of one (1) NTCIP-compliant Ethernet port with RJ45 connector
- Contain a built-in Hayes-compatible modem with standard RJ11 connector
- Contain DMS-specific control firmware (embedded software) that shall monitor all external and internal sensors and communication inputs and control the display modules as directed by external control software and the front panel interface

NTCIP shall be natively supported in the DMS controller. External protocol converter or translator devices shall not be allowed.

2. Pole-Mounted Controller Cabinet The pole-mounted control equipment cabinet shall be a 336S-type cabinet. It shall be provided with two (2) mounting brackets suitable for use with pole-mount straps. The cabinet shall enclose the sign controller, panel board, 120 VAC electrical outlets, and remote communication devices, such as a modem.

The pole-mounted controller cabinet shall be 46" (1,168 mm) +/- 1" (25.4 mm) high by 24" (610 mm) +/- 0.5" (12.7 mm) wide by 20.25" (514 mm) +/- 0.5" (12.7 mm) deep. The front-to-back cabinet dimensions shall not exceed 26" (660 mm) at its widest point, including the door handles, louvers and roof overhang.

The controller cabinet weight shall not exceed 200 pounds (45.5 kg) when the cabinet is empty.

2.1. Cabinet Construction

The controller cabinet shall be constructed to have a neat, professional appearance. The cabinet shall protect all internal components from rain, ice, dust and corrosion in accordance with NEMA

enclosure Type 3R standards, as described in NEMA Standards Publication 250, Enclosures for Electrical Equipment (1000 Volts Maximum).

Internal component hardware (nuts, bolts, screws, standoffs, rivets, fasteners, etc.) shall be fabricated from hot dipped galvanized steel, stainless steel, aluminum, nylon or other durable corrosion-resistant materials suitable for roadway signage applications.

The DMS controller cabinet shall be constructed using 0.125-inch thick aluminum alloy 5052- H32. The exterior of the controller cabinet shall be natural mill-finish aluminum.

2.2. Serviceability

The controller cabinet shall provide safe and convenient access to all modular assemblies, components, wiring and other materials located within the cabinet. All internal components shall be removable and replaceable by a single technician.

Two (2) vertically hinged doors shall be mounted on the cabinet for interior access. One door shall be located on the front face and one door shall be located on the rear face of the cabinet. Each of the door openings shall not be less than 36" (914 mm) high by 21" (533 mm) wide. Each opening shall be sealed with a 0.5" x 2" closed cell foam gasket.

Each door shall be attached to the cabinet by a full-length stainless steel hinge and mounting hardware. Both doors shall open outward. In the closed position, each door shall latch to a double-flanged door opening with a three-point draw-roller mechanism. The door handle shall be stainless steel. Each door shall have a doorstop to hold the door in the open position. The doors shall each be equipped with a Corbin #2 lock.

A fluorescent lamp shall be located at the top of the controller cabinet to illuminate the cabinet interior. A switch mounted near the front and rear doors shall automatically turn on the light when the door is opened.

2.3. Equipment Rack

The cabinet shall contain a full-height standard EIA 19-inch rack. The rack shall be secured within the cabinet by mounts at the top and bottom.

The rack shall contain a minimum of one (1) pullout drawer. The drawer shall be suitable for storing manuals and small tools, such as screwdrivers. The drawer shall be able to latch in the out position to function as a laptop/utility shelf.

2.4. Electrical Systems

The cabinet shall contain a power panel board and circuit breakers that meet the following minimum requirements:

- Service entrance-rated
- Minimum of 12 circuit breaker mounting positions
- Short circuit ratings of 22,000 amps and 10,000 amps for the main and branch circuits, respectively
- UL listed

The panel board shall be mounted in the equipment rack.

The cabinet shall contain a utility outlet circuit consisting of a minimum of two (2) 15-A NEMA 15-R, 120 VAC duplex outlets, with a minimum of one (1) ground-fault circuit interrupters. The outlets shall be mounted inside the cabinet and located near the panel board.

The cabinet shall include one (1) earth ground lug that is electrically bonded to the cabinet. The lug shall be installed near the power entrance. The installation contractor shall provide the balance of materials and services needed to properly connect to earth ground. All earth grounding shall conform to the National Electrical Code.

2.5. Environmental Systems

One (1) thermostatically controlled 100 cfm exhaust fan shall be mounted near the top of the control cabinet.

One (1) thermostatically controlled heater shall be mounted near the bottom of the control cabinet.

Filtered air intake ports shall be located on the bottom third of each access door. The fan and air filters shall be removable and replaceable from inside the cabinet.

3. DMS Controllers Unit

3.1. Mechanical and Electrical

The sign controller shall meet the following electrical and mechanical requirements:

- Mount in a standard EIA 19-inch (480 mm) equipment rack with a maximum 4U space requirement
- Weigh no more than 10 pounds, including its enclosure
- Consume no more than 30 watts of power
- Powered by an internal regulated DC power supply capable of operating on 120VAC or 240VAC at both 50Hz and 60Hz

3.2. Operational Requirements

Front Panel User Interface

The sign controller's front panel shall include a menu driven architecture, 16-button keypad, and a 64x240 graphical LCD screen. These devices shall be used to perform the following functions with the sign controller and DMS:

- Monitor the current status of the sign controller, including the status of all sensors and a monochromatic what-you-see-is-what-you-get (WYSIWYG) representation of the message visible on the display face including the use of graphical messages.
- Perform all diagnostics testing of various system components including pixels, power systems, sensors, and more
- Activate, create, preview, and delete messages stored in memory
- Blank the sign
- Start and stop the schedule
- Configure display parameters, including display size and color technology
- Configure date and time
- Configure communications port settings and NTCIP options
- Configurable level of password protection per user
- Select automatic or manual brightness mode of operation The front panel interface shall also include:
 - Power switch to turn the controller on and off
 - LED power "on" indicator
 - "Local/remote" switch that places the controller in local mode such that it can be controlled from the front panel interface, instead of via the primary NTCIP communication channel
 - LED to indicate state of the "local/remote" mode switch
 - Reset switch to quickly restart the controller
 - LED "Active" indicator that blinks when the controller is operating correctly
 - LED to indicate when any of the NTCIP communication channels are active

3.3. Memory

The sign controller shall have non-volatile electronically changeable memory. This memory shall be formed by flash or battery-backed static RAM integrated circuits that retain the data in memory for a minimum of 30 days following a power loss. This changeable memory shall be used to store messages and schedules. The controller memory shall be capable of storing a minimum of 500 changeable messages in non-volatile RAM.

3.4. Internal Clock

The DMS sign controller shall contain a computer-readable clock that has a battery backup circuit. The battery shall keep the clock operating properly for at least 3 years without external power, and the clock shall automatically adjust for daylight savings time and leap year using hardware, software, or a combination of both. The clock shall be set electronically by the sign controller microprocessor and shall be accurate to within one (1) minute per month.

4. Communications

All remote communication ports shall be NTCIP-compatible as defined in the "Requirements for NTCIP Compatibility" section of these Specifications.

4.1. Communication Modes

The DMS sign controller shall be able to receive instructions from and provide information to a computer containing DMS control software using the following communication modes:

- Remotely via direct or dial-up communications with a remotely located computer. The system communications backbone, as well as all field modems or signal converters, shall provide the DMS sign controller with an RS232 signal.
- Locally via direct connection with a laptop computer that is connected directly to the sign controller using an RS232 null modem connection.

4.2. Serial Communication Ports

The DMS sign controller shall contain a minimum of three (3) NTCIP-compatible RS232 communication ports. These ports shall support multiple communication interfaces, including, but not limited to, direct null-modem (for local laptop control), dial-up and leased-line modems, radio systems, cellular modems, and fiber optic modems. The RS232 ports shall all have standard DB9M connectors.

The baud rate, connection type, and NTCIP communication protocol shall be configurable. Each port must support all typical serial baud rates ranging from 1200 to 115,200 baud. All three ports shall be capable of supporting either of the following sub network profiles: NTCIP 2101 (PMPP) or NTCIP 2103 (PPP). They shall also be capable of supporting either NTCIP 2201 (Null) or NTCIP 2202 (Internet) transport profiles. Only one each of the transport and sub network profiles shall be active at any time on each port.

4.3. Ethernet Port

The DMS sign controller shall contain a minimum of one (1) 10/100Base-T Ethernet communication port. This port shall be available for optional use for communicating from the central control system to the DMS sign controller when an Ethernet network is available. The Ethernet port shall have a standard RJ45 connector.

Communications on the Ethernet port shall be NTCIP-compatible using the NTCIP 2202 Internet transport profile and the NTCIP 2104 Ethernet sub network profile. This shall permit the controller to be operated on any typical Ethernet network using the TCP/IP and UDP/IP protocols.

5. Messaging

The DMS controller shall have the ability to display messages on the DMS display face as required herein.

Message Presentation on the DMS Display Matrix

The sign controller shall control the LED drivers in a manner that causes the desired message to display on the DMS sign. At a minimum, the sign controller shall support the following features as described in the DMS specification:

- Display of alpha numeric characters, including letters, numbers, and punctuation
- Selection of particular character fonts style
- Horizontal alignment of text on the display, including left, center, and right justification
- Vertical alignment of text on the display, including top, middle, and bottom justification
- Adjusting the spacing horizontally between characters or vertically between lines of text
- Alternating between pages of a multiple-page message
- Display of graphic bitmaps of various sizes ranging to very small to the size of the entire DMS matrix

5.1. Message Effects

The DMS shall be able to display messages using the following types of effects:

- Static Message – The selected message is displayed continuously on the sign face until the sign controller blanks the sign or causes the display of another message
- Flashing Message – All or part of a message is displayed and blanked alternately at rates between 0.1 seconds and 9.9 seconds. The flash rate is user programmable in increments of 0.1 seconds
- Scrolling Message – The message moves across the display face from one side to the other. The direction of travel is user selectable as either left-to-right or right-to-left
- Multiple-Page Message – A message contains up to six different pages of information, with each page filling the entire pixel matrix. Each page's display time is user programmable from 0.1 seconds to 25.5 seconds, and adjustable in increments of 0.1 seconds.

5.2. Message Activation

Messages shall be activated on a DMS in three ways:

- Manual – An operator using the front panel LCD/keypad interface or NTCIP-compatible control software manually instructs a particular message to be activated.
- Schedule – The internal time-based scheduler in the DMS may be configured to activate messages at programmable times and dates. Prior to activation, these messages and their activation times and dates shall be configured using the control software.
- Events – Certain events, like a power loss, may trigger the activation of pre-configured messages when they occur. These events must be configured using the control software.

A displayed message shall remain on the sign until one of the following occurs:

- The message's duration timeout expires
- The controller receives a command to change the message
- The controller receives a command to blank the sign

- The schedule stored in the controller's memory indicates that it is time to activate a different message
- A special event, such as a loss of communication, occurs that is linked to message activation

It shall be possible to confer a "priority" status onto any message, and a command to display a priority message shall cause any non-priority message to be overridden.

Schedule Activation

The DMS sign controller shall support the activation of messages based on a time/date-based schedule. The format and operation of the message scheduler shall be per the NTCIP 1201 and NTCIP 1203 standards.

5.3. Display of Alphanumeric Text

The DMS sign controller shall support the storage and use of a minimum of twelve (12) font sets with which messages can be formatted and displayed. Each font shall support up to 255 characters. All text font files shall include the following characters:

- The letters "A" through "Z", in both upper and lower case
- Decimal digits "0" through "9"
- A blank space
- Eight (8) directional arrows
- Punctuation marks, such as: . , ! ? - ' ' " " ;
- Special characters, such as: # & * + / () [] < > @

The DMS supplier shall provide the DMS controller with the following fonts preinstalled. The controller shall support changing or replacing these fonts from the central software using NTCIP.

5.4. Display of Graphic Images

The DMS control software shall support the inclusion of graphics in messages. If the NTCIP 1203 v2 standard has not reached a "recommended" or "approved" state by the time of contract award, the vendor shall support graphics using manufacturer-specific objects and MULTI tags.

If a manufacturer-specific means of supporting graphics is used, the vendor shall commit to provide NTCIP 1203 v2 firmware updates at no cost to the customer. These updates will include all current requirements of these Specifications and also standard graphics support. The vendor shall install the updates no later than six months after the NTCIP 1203 v2 standard reaches the "approved" state.

6. Acceptance Testing

The vendor will provide certification of NTCIP-compliance as part of the vendor's pre-build submittal documentation. This certification shall be in the form of a comprehensive test plan and completed test report as performed by either the vendor or a third-party testing agency. The testing shall have been completed using industry accepted test tools such as the NTCIP Exerciser, Trevilon's NTester, Intelligent Devices' Device Tester, and/or Frontline's FTS for NTCIP. Data capture files from the FTS software during the performance of the above testing shall be furnished upon request of the Engineer.

The Engineer can elect to perform additional NTCIP testing if desired. This testing shall be conducted on a production DMS in the vendor's facility during the factory acceptance test. The vendor shall provide a written NTCIP test procedure to the Engineer a minimum of 30 days prior to the NTCIP testing.

APPENDIX A

NOT USED

APPENDIX B
MATERIALS CERTIFICATION LIST (MCL)

HIGHWAY MATERIALS CERTIFICATION LIST, EXCEPT SECTION 660/661/740

Project Name RICHARDSON HIGHWAY DYNAMIC MESSAGING SIGN (CMAQ)

Project Number 0002479/NFHWHY00554

Project Engineer Signature _____

Unshaded boxes indicate who approves the manufacturer's certificate of compliance or materials submittals. If two boxes aren't shaded, either approving authority may be used.

Materials Item	Specification 2020 or Std. Mod./Special Provisions, if noted	Construction		Design			Statewide Materials		Manufacturer/ Remarks	Certificate Location e.g. Binder#
		Project Engineer	Regional Materials or QA Engineer	Design Engineer of Record	State Bridge Engineer	Regional Traffic Engineer	*Qualified Products List (QPL)	State Materials or QA Engineer		
401 HOT MIX ASPHALT PAVEMENT										
Mix Design	401-2.09								CR Special Provision	
Asphalt Binder	401-2.01								CR Special Provision	
Joint Adhesive	401-2.03/702-2.05								CR Special Provision	
Joint Sealant	401-2.04, 702-2.06								CR Special Provision	
Warm Mix Asphalt	401-2.05/702-2.05								CR Special Provision	
Asphalt Release Agent	401-2.06/702-2.08								CR Special Provision	
501 CONCRETE FOR STRUCTURES										
Concrete Mix Design	501-2.02									
	701-2.03, 501-2.01.5, 712-2.19									
Grout & Epoxy Concrete Anchor Bolts and Inserts	712-2.20									
Asphalt Felt	501-2.01.4									
Curing Materials	711-2.01									
Utiliduct, HDPE	706-2.08									
Utiliduct, Steel	716									
Structural Steel	716									
503 REINFORCING STEEL										

*Unshaded boxes under QPL do not indicate that the materials are currently on that list. They indicate materials with potential for being on the QPL once qualified. See Section 106-1.05 for submittal requirements.

Unshaded boxes indicate who approves the manufacturer's certificate of compliance or materials submittals. If two boxes aren't shaded, either approving authority may be used.

Materials Item	Specification 2020 or Std. Mod./Special Provisions, if noted	Construction		Design			Statewide Materials		Manufacturer/ Remarks	Certificate Location e.g. Binder #
		Project Engineer	Regional Materials or QA Engineer	Design Engineer of Record	State Bridge Engineer	Regional Traffic Engineer	*Qualified Products List (QPL)	State Materials or QA Engineer		
Reinforcing Steel Bars	709-2.01.1									
Epoxy-Coated Reinforcing Steel Bars	709-2.01.3									
Headed Reinforcing Steel Bars	709-2.01.2									
Epoxy-Coating Patch Material	709-2.01.7									
Bar Supports	709-2.03									
Epoxy for Bonding Dowels	712.2.21									
504 STEEL STRUCTURES										
<u>Paint</u>										
Prime Coat	708-2.01.1									
Intermediate Coat	708-2.01.2									
Top Coat	708-2.01.3									
<u>Structural Steel</u>										
Rolled Steel Plates, Shapes, Sheet Piling and Bars	716-2.02.1									
Structural Steel	716-2.02.2									
Filler Metal for Applicable Arc-Welding Electrodes	716-2.02.3									
Stud Shear Connectors	716-2.02.4									
Raised Pattern Plate	716-2.02.5									
Arc Welding Electrodes	AWS Standards									
<u>Fasteners</u>										
High Strength Bolts	716-2.03.1									
Nuts	716-2.03.2									

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Materials Item	Specification 2020 or Std. Mod./Special Provisions, if noted	Construction		Design			Statewide Materials		Manufacturer/ Remarks	Certificate Location e.g. Binder #
		Project Engineer	Regional Materials or QA Engineer	Design Engineer of Record	State Bridge Engineer	Regional Traffic Engineer	*Qualified Products List (QPL)	State Materials or QA Engineer		
Hardened Steel Washers	716-2.03.3									
Zinc Coated Load Indicating Washers	716-2.03.4									
Machine Bolts	716-2.05									
Steel Grid Floors	716-2.04									
Steel Pipe	716-2.06									
Galvanizing	716-2.07									
<u>Steel Forgings</u>										
Alloy Steel Forgings	718-2.02									
Carbon Steel Forgings	718-2.02									
<u>Pins and Rollers</u>										
More than 7" in Diameter	718-2.02.3.a									
7" or less in Diameter	718-2.02.3.b									
Threads for Pins	718-2.02.4									
<u>Castings</u>										
Carbon Steel Castings	719-2.02									
Chromium Alloy Steel Castings	719-2.02									
Gray-Iron Castings	719-2.02									
Malleable-Iron Castings	719-2.02									
Elastomeric Bearing Pads	720-2.01									
Epoxy Adhesive	720-2.02									

513 FIELD PAINTING OF STEEL STRUCTURES

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		Project Engineer	Regional Materials or QA Engineer	Design Engineer of Record	State Bridge Engineer	Regional Traffic Engineer	*Qualified Products List (QPL)	State Materials or QA Engineer		
<u>Paint</u>										
Prime Coat	708-2.01.1									
Intermediate Coat	708-2.01.2									
Top Coat	708-2.01.3									
<u>Abrasives</u>										
Non-Steel Abrasives	513-2.01.2.a/ 513-2.02									
Steel Abrasives	513-2.01.2.b/ 513-2.02									
515 DRILLED SHAFTS										
<u>Concrete</u>										
DS Concrete Mix Design	501-2.02									
DS Grout	701-2.07									
<u>Reinforcing Steel</u>										
Reinforcing Steel Bars	709-2.01.1									
Epoxy-Coated Reinforcing Steel Bars	709-2.01.3									
Headed Reinforcing Steel Bars	709-2.01.2									
Epoxy-Coating Patch Material	709-2.01.7									
Bar Supports	709-2.03									
Epoxy for Bonding Dowels	712.2.21									
Steel for Casing	515-2.01									
CSL Tubes	515-2.01									
606 GUARDRAIL										

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		Project Engineer	Regional Materials or QA Engineer	Design Engineer of Record	State Bridge Engineer	Regional Traffic Engineer	*Qualified Products List (QPL)	State Materials or QA Engineer		
Concrete Mix Design	501-2.02									
Wire Cable	709-2.02									
Metal Beam Rail	710-2.04								CR Special Provision	
<u>Guardrail Posts and Blocks</u>										
Wood Posts and Blockouts	710-2.06.1									
Timber treatment	714									
Steel Posts and Blockouts	710-2.06.2									
Synthetic Blockouts	710-2.06.3									
Guardrail Hardware	710-2.07									
Short Radius Guardrail	AK Std. Plan G-26									
<u>Terminals</u>										
Parallel Terminals	710-2.11.1									
Terminal Markers (Flexible)	730-2.05								CR Special Provision	
Guardrail Reflector Assembly Brackets	606-2.01								CR Special Provision	
Retroreflective Sheeting Type IX or XI	606-2.01								CR Special Provision	
<u>Bollards</u>										
Shapes, Plates and Bars	606-2.01								CR Special Provision	
Bollard Pipe	716-2.06									
Bollard Tube	606-2.01								CR Special Provision	
Galvanizing	716-2.07									
Galvanizing Repair	606-2.01								CR Special Provision	

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		Project Engineer	Regional Materials or QA Engineer	Design Engineer of Record	State Bridge Engineer	Regional Traffic Engineer	*Qualified Products List (QPL)	State Materials or QA Engineer		
Paint	708-2.01/2.02									
Bollard Post	713-2.01									
Preservatives for Timber	714.2.01									
Retroreflective Bands	606-2.01								CR Special Provision	
618 SEEDING										
Seed	724									
Fertilizer	618-2.01/725								CR Special Provision	
Soil Stabilization Material	727								CR Special Provision	
641 EROSION, SEDIMENT AND POLLUTION CONTROL										
Materials	641-2.05								CR Special Provision - 641 Control and Stabilization Materials identified and documented in SWPPP and approved on project.	
643 TRAFFIC MAINTENANCE										
Traffic Control Devices	643-3.04								CR Special Provision - 643 Materials approved on project with TCP conforming to Alaska Traffic Manual (ATM).	

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Project Name
 Project Number
 Project Engineer Signature

RICHARDSON HIGHWAY DYNAMIC MESSAGING SIGN (CMAQ)

0002479/NFHWHY00554

Unshaded boxes indicate who approves the manufacturer's certificate of compliance or materials submittals. If two boxes are unshaded, either approving authority may be used.

SECTION 660/661/740 MATERIALS CERTIFICATION LIST

Item	2020 Specifications	Third Party Listing or Labeling Required? (Y/N)	Acceptance By:						Remarks
			Construction		Design			Statewide	
			Project Engr	QA/ Matls Engr	Design Engr	Bridge Engr	Traffic Engr	State Materials Engineer	
660 SIGNALS AND LIGHTING									
DMS SYSTEMS									
PCC SIGNAL POLE FOUNDATIONS: Cast									
In Drilled Hole									
Concrete Mix Design	660-3.02	N							
Reinforcing Steel	Std. Plans 709-2.01	N							
Anchor Bolts	Std. Plans 709-2.01	N							
Corrugated Steel Pipe	Std. Plans 660-3.02	N							
JUNCTION BOXES: (from Manufacturers on APL)									
Type I / IA, II, III	See Detail in Plans 660-2.01 660-3.04 709-2.01 711-2.01	N							
JUNCTION BOXES: (from Manufacturers NOT on APL)									
Type I / IA, II, III	See Detail in Plans 660-2.01 660-3.04	N							
Electronic ball marker/Locator bauble	660-3.04	N							
Concrete Mix Design	660-2.01 501-3.01	N							
Curing Materials	711-2.01	N							
Reinforcing Steel	709-2.01	N							
Junction Box Cover	See Detail in Plans 660-3.04	N							
STEEL POLES AND POSTS:									
Galvanizing	Std. Plans 740-2.02	N							
Shop Drawings	Std. Plans 660-3.01 740-2.02	N							
Computations, Wind Stress Certification	Std. Plans 740-2.02	N							

SECTION 660/661/740 MATERIALS CERTIFICATION LIST

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			Construction			Design				Statewide
			Project Engr		QA/ Matis Engr	Design Engr	Bridge Engr	Traffic Engr		State Materials Engineer
				QPL						
Welding Quality Control Plan	Std. Plans 660-3.01 740-2.02	N								
Mill Certifications for Steel Products	Std. Plans 740-2.02	N								
CONDUIT / LOOPS:										
Galvanized Rigid Metal Conduit	740-2.06	Y								
High Density Polyethylene Conduit (HDPE)	740-2.06	Y							Central Region	
High Density Polyethylene Couplings	660-3.03 740-2.06	Y							Central Region	
RMC to HDPE Electrofusion Coupler	660-3.03	N								
Galvanized Couplings	740-2.06	Y								
Galvanized Split Couplings	740-2.06	Y								
Galvanized Elbows	740-2.06	Y								
Bore Casing	660-3.03	N								
Galvanized Nipples	740-2.06	Y								
Underground Marker Tape	660-3.03	N								
Pull Rope	660-3.03	N								
Watertight Caps (for unused conduit)	See Detail in Plans	N								
Watertight sealing bushing (for used conduits above ground)	See Detail in Plans	N								
Duct Sealing Compound (for conduits through Controller Foundation slab)	660-3.03	Y								
Galvanized Myers Hub (for connection to enclosures)	740-2.06	Y							Central Region	
Schedule 80 PVC Conduit (for loops)	See Detail in Plans 740-2.06	Y								
PVC Fittings & Adapters (Loops)	See Detail in Plans 740-2.06	Y								
Type "X" Conduit Bodies with Covers, Gaskets & Plugs (Loops)	See Detail in Plans 740-2.06	Y								
BONDING & GROUNDING:										
Copper Ground Rod	See Detail in Plans 660-3.06	Y								
Grounding Bushings	See Detail in Plans 740-2.06	Y								
Ground Rod Clamps	660-3.01 660-3.06	Y								
Bare Copper Grounding Wire	See Detail in Plans 660-3.06	N								
Braided Copper J-Box Lid Bonding Wire	See Detail in Plans 740-2.06 660-3.06	Y								
Irreversible Compression Type Connectors	See Details in Plans 660-3.02 660-3.06	Y								
Air Terminal	See Details in Plans	N								
CONDUCTORS / CABLES:										

SECTION 660/661/740 MATERIALS CERTIFICATION LIST

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			Construction		Design			Statewide	
			Project Engr	QA/ Mats Engr	Design Engr	Bridge Engr	Traffic Engr	State Materials Engineer	
			QPL						
Control Cables	740-2.05	Y							
Control Cables 4C#14		Y							
Power Cables	740-2.05	Y							
Detector Loops	See Details in Plans	Y							
Loop Lead-in (Snyder) Cable	740-2.05	Y							
a. Power & Control Tray Cable									
b. Used on all new construction, and on rehabilitation work with sufficient conduit capacity.									
Loop Lead-in (Shielded Data) Cable	740-2.05	Y							
a. Polyethylene or polypro insulation									
b. Used on Rehab jobs where Snyder Cable creates fill problems.									
3C#20 Opticom Lead-In Cable		N							
12/25PR#19 Interconnect Cable		N							
Interconnect Cable (Copper)	740-2.05	N							
Interconnect Cable (Fiber)	662-2.03	N							
Illumination Cable - PE Jacket	740-2.05	Y							
Luminaire Tap Conductors	740-2.05	Y							
Terminals		Y							
Identification Tags	660-3.05	N							
SPLICES and TERMINALS									
Terminal Blocks	660-3.05	Y							
	740-2.11 Plans								
Spade type crimp-on terminals	660-3.05	Y							
Re-enterable Splice Kits (for Loops)		N							
Heat Shrink Tubing Only	660-3.05	Y							
Wye Resin Splice Kit (Lighting)		N							
Overlap Type Crimp Connectors		N							
Loop Lead In Splice Kit (for Loops)	See Detail in Plans	N							
	660-3.05								
Heat Shrink Tubing or Electrical Tape		Y							
Fused Disconnect Kits (Lighting)		Y							
Fuses for Disconnect Kits		Y							
Inline Resin Splice Kit (Lighting) (Only for tying into existing circuits)		Y							
Power Cable Splice Kit (Lighting)	See Details in Plans	N							
	660-3.05								
Splice Connectors	See Details in Plans	N							
	660-3.05								
Electrical Tape	See Details in Plans	Y							
	660-3.05								
Double Fuse Connector Kits (Lighting)	See Detail in Plans	Y							
	740-2.07								

SECTION 660/661/740 MATERIALS CERTIFICATION LIST

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			Construction			Design				Statewide
			Project Engr	QA/ Mats Engr	Design Engr	Bridge Engr	Traffic Engr	State Materials Engineer		
			QPL							
Fuses for Double Fuse Connector Kit	See Detail in Plans 740-2.07	Y								
Interconnect Splice Kits		N								
Interconnect Splice Kits (fiber)	662-3.09	N							Central Region	
Interconnect Closures and Splice Trays	662-3.10	N								
DMS ITS Enclosure										
NEMA Type 4X	740-2.11 See Plans	Y								
Type 'M' Cabinet (Enclosure Only)		Y								
Econolite TS2 Plug N Go Cabinet		Y								
Interconnect Termination Cabinet		Y								
Size 6 Cabinet	See Detail in Plans. 740-2.11	Y								
Size 7 Cabinet	See Detail in Plans. 740-2.11	Y								
Flashing Beacon Control Cabinet	See Detail in Plans. 740-2.17	N								
DMS CONTROLLER										
Manufacturer Supplied	740-2.25 See Plans	N								
Econolite ASC/2		N								
Econolite ASC/3	740-2.10	N								
Econolite Cobalt ATC		N							Northern Region	
Econolite Cobalt	740-2.10	N								
OTHER CABINET COMPONENTS										
Surge Protection Device	740-2.11 See Plans	N								
Conflict (Malfunction) Monitoring Unit		N								
2/4 Channel Loop Detector Amplifiers		N								
NEMA TS2 Plug N Go	740-2.11	Y								
Malfunction Management Unit (MMU)	740-2.12	N								
Inductive Loop Detector Unit	740-2.13	N								
Traffic Logging System	740-2.13	N							Central Region	
Solid State Flasher	740-2.12	N							Northern Region	
3-Circuit Solid State Load Switch	740-2.12	N							Northern Region	
Flash Transfer Relay	740-2.12	N							Northern Region	
Bus Interface Units	740-2.13	N							Northern Region	
Uninterruptible Power Supply Cabinet		N							Northern Region	
Uninterruptible Power Supply Controller		N							Northern Region	
Uninterruptible Power Supply Batteries		N							Northern Region	
Hot Swap Bypass Switch		N							Northern Region	
Fail-Safe Bypass Switch		N							Northern Region	
GPS time clock		N							Northern Region	

SECTION 660/661/740 MATERIALS CERTIFICATION LIST

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			Construction			Design			Statewide	
			Project Engr	QA/ Mats Engr	Design Engr	Bridge Engr	Traffic Engr	State Materials Engineer		
			QPL							
Time Switch	740-2.17	Y								
Bypass Switch	740-2.17	N								
Patch Panel (interconnect)	662-2.4	N								
Ethernet Switch (interconnect)	See Detail in Plans 740-2.13	N								
Cable interface device (radar)	See Detail in Plans 740-2.13	N								
CABINET VENTILATION SYSTEM										
Heater	See Detail in Plans 740-2.11	Y								
Thermostat	See Detail in Plans 740-2.11	Y								
COMMUNICATION SYSTEMS										
Ethernet Extender	660-2.01 / See Plans	N								
Ethernet Switch	660-2.01 / See Plans	N								
Ethernet Cable	660-2.01 / See Plans	N								
Cellular Modem With Remote Directional Antenna	660-2.01 / See Plans	N								
Cell Extender	660-2.01 / See Plans	N								
Antenna	See Plans	N								
Antenna Cable	See Plans	N								
VIDEO DETECTION										
Fixed View Camera	660-2.01 / See Plans	N								
High Definition PTZ Camera	660-2.01 / See Plans	N								
PTZ Camera	660-2.01 / See Plans	N								
Camera Mounting Bracket	660-2.01 / See Plans	N								
POE Injector	660-2.01 / See Plans	N								
DMS Display	660-3.13 740-2.22 Plans	N								
661 ELECTRICAL LOAD CENTERS										
UNIT SUBSTATION	See Details in Plans	N								