MANAGEMENT SERVICES DEPARTMENT
Purchasing Division
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ADDENDUM #1
September 6, 2022

TO:	**ALL Prospective Bidders**
PROJECT NAME:	**Stadium Drive Signal Improvements**
BID REFERENCE #:	**96882-001.0**
BID DUE/OPENING DATE:	**Tuesday, September 20, 2022 at 3:00 p.m. Local Time**

The purpose of this addendum is to clarify and/or modify the Bid Items and/or Specifications for this project. All work affected is subject to all applicable terms and conditions of the Bidding and Contract Documents.

1. **See Addendum No. 1 (*Addendum #1, Attachment A*) for clarifications and changes made to the specifications and bid items provided by Wightman.**

2. **REPLACE**
   Replace Pages 8 – 9 of the original Bid Document (Section II, Bid and Award) with the attached REVISED Section II, Bid and Award (Pages 8 – 9) (Addendum #1, Attachment B). The revised pages must be used when submitting bids for this project, in order for a bid to be responsive.

The Addendum can be viewed and downloaded from the City's website at https://www.kalamazoocity.org/bidopportunities.

In order for a bid to be responsive, this addendum must be returned, signed and dated, with your bid. If you have already submitted your bid, acknowledge receipt and acceptance of this addendum by signing in the place provided and returning it to the undersigned and it shall be incorporated in your bid. Please identify your return envelope with the bid reference number and project description.

Sincerely,

Michelle Emig
Purchasing Division Manager

c: Anthony Ladd, Public Services
Dennis Randolph, Public Services
Prevailing Wage File

FIRM: _____ SIGNED: _____

NAME: _____ DATE: _____
(Type or Print)

ADDENDUM #1

Attachment A
Stadium Drive Signal Improvements
WIGHTMAN ADDENDUM NO. 1

96882-001.0

ADDENDUM NO. 1

PROJECT: Stadium Drive Signal Improvements Project

CLIENT: City of Kalamazoo

ISSUE DATE: 09/02/2022

The purpose of this addendum is to revise the Invitation for Bids (IFB) to include and specify the addition of four (4) new pay items. This Addendum shall be deemed a part of the Contract Documents, and to the extent that the provisions of the other Contract Documents are in conflict herewith, this Addendum shall control.

INVITATION FOR BIDS:

1. Page 8 and Page 9:

    a. The following items and quantities shall be added to the table:

Item #	Item	Unit	Quantity
SP	*Fiber Optic, Cable, Single Mode Fiber, 12F, Modified*	*Ft*	*5,200*
SP	*Fiber Optic, Pigtail, Modified*	*Ea*	*48*
SP	*Fiber Optic, Splice Enclosure, Rack-Mounted, Small*	*Ea*	*3*
SP	*Tracer Wire, Modified*	*Ft*	*4,450*

2. Page 24:

    a. The following shall be included after the “Lovell Street Intersection” Section:

    Additional Work Included in Addendum No. 1: Install “Fiber Optic, Cable, Single Mode Fiber, 12F, Modified” and “Tracer Wire, Modified” within existing conduit along Stadium Drive from the control cabinet at the Stadium Drive and Howard Street intersection, to the control cabinet at the Stadium Drive and Oliver Street intersection. Install “Fiber Optic, Cable, Single Mode Fiber, 12F, Modified” and “Tracer Wire, Modified” within existing conduit along Stadium Drive from the control cabinet at the Stadium Drive and Oliver Street Street intersection, to the control cabinet at the Stadium Drive and West Michigan Avenue intersection.

    Install “Fiber Optic, Splice Enclosure, Rack-Mounted, Small” and “Fiber Optic, Pigtail, Modified” in the controller cabinet at the following three intersections:

    - *Stadium Drive and Howard Street*
    - *Stadium Drive and Oliver Street*
    - *Stadium Drive and West Michigan Avenue*

3. Special Provisions:

    a. “City of Kalamazoo Special Provision for Fiber Optics”
    b. “City of Kalamazoo Special Provision for Fiber Optic, Splice Enclosure, Rack-Mounted, Small”
    c. “Michigan Department of Transportation Special Provision for System Integration and Testing”
    d. “Michigan Department of Transportation Special Provision for Traffic Signal Work – Construction Methods”

ATTACHMENTS:

1. Special Provisions:

    a. 826 – SP Fiber Optics: “City of Kalamazoo Special Provision for Fiber Optics”
    e. 826 – SP Fiber Optic Splice Enclosure Rack-Mounted Small: “City of Kalamazoo Special Provision for Fiber Optic, Splice Enclosure, Rack-Mounted, Small”
    b. 20SP-826H-01(Rev): “Michigan Department of Transportation Special Provision for System Integration and Testing”
    f. 20SP-820I-01: “Michigan Department of Transportation Special Provision for Traffic Signal Work – Construction Methods”

ADDENDUM #1

Attachment B
Stadium Drive Signal Improvements
REVISED
SECTION II
BID AND AWARD
(Pages 8 -9)
MUST BE USED WHEN SUBMITTING BIDS

96882-001.0

REVISED
SECTION II
BID AND AWARD

The undersigned having become thoroughly familiar with all of the bid/contract documents incorporated herein, the project site and the location conditions affecting the work, hereby proposes to perform everything required to be performed in strict conformity with the requirements of these documents, and to provide and furnish all the equipment, labor and materials necessary to complete, in a professional manner, the furnishing and installing of all of the following, meeting or exceeding the specifications as set forth herein for the prices as stated below.

STADIUM DRIVE SIGNAL IMPROVEMENTS

Item #	Item	Unit	Total Qty	Unit Cost	Ext. Cost
8182363	Wood Pole, Rem	Ea	1		
8182366	Serv Disconnect	Ea	1		
8182387	Wood Pole, Fit Up, TS Cable Pole , 1, 1 1/2 Inch, 1, 3 Inch	Ea	1		
8182397	Steel Pole, Fit Up, TS Cable Pole , 1, 1 1/2 Inch,	Ea	1		
8190285	Light Std Shaft, 30 foot or less	Ea	2		
8200020	Case Sign, Rem	Ea	2		
8200030	Controller and Cabinet, Rem	Ea	3		
8200039	Case Sign, Salv	Ea	2		
8200128	Pushbutton Station and Sign	Ea	2		
8200150	Strain Pole Fdn, Cased	Ft	42		
8200155	Strain Pole, Steel, Anchor Base, 30 foot	Ea	1		
8200182	TS, Span Wire Mtd, Rem	Ea	4		
8200215	TS, 4th Level, LTGA (LED)	Ea	2		
8200275	TS, Wireless Link, 5.8 Gigahertz, Remote	Ea	6		
8200313	TS, One Way Span Wire Mtd (LED)	Ea	2		
8200322	TS, Two Way Span Wire Mtd (LED)	Ea	6		
8200345	TS, Pedestrian, One Way Pedestal Mtd (LED) Countdown	Ea	2		
8200376	Bracket, Truss, With 12 Foot Arm (Wood Pole)	Ea	1		

Item #	Item	Unit	Total Qty	Unit Cost	Ext. Cost
8200378	Bracket, Truss, With 18 Foot Arm (Steel Pole)	Ea	10		
8200378	Bracket, Truss, With 18 Foot Arm (Wood Pole)	Ea	9		
8260160	System Integration and Testing (Max $5,000)	Lsum	1		
SP	Video Traf Detection Camera	Ea	20		
SP	Controller Cabinet, Modified	Ea	3		
SP	Ethernet Switch With SFPs	Ea	1		
SP	PTZ Camera	Ea	2		
SP	Fiber Optic, Cable, Single Mode Fiber, 12F, Modified	Ft	5200		
SP	Fiber Optic, Pigtail, Modified	Ea	48		
SP	Fiber Optic, Splice Enclosure, Rack-Mounted, Small	Ea	3		
SP	Tracer Wire, Modified	Ft	4450		

TOTAL PROJECT COST _____

* Quantities per intersection are detailed in ***Appendix C*** and plan drawings (***Appendix D***)

Bidder shall provide all of the information as requested herein with their bid. Failure to do so and/or failure to provide post-bid requested information may be cause for rejecting the bid as non-responsive.

After receipt by Contractor of Notice to Proceed, work shall start no later than 10 days, unless otherwise agreed to by the Project Manager, and shall be completed by **May 31, 2023**.

Bidder/Contractor has examined and carefully studied the bidding documents and attachments, and acknowledges receipt of the following addenda:

Addendum No:_____ _____ _____ _____

Date: _____ _____ _____ _____

By my signature below, I certify that the firm bidding on this contract, when making hiring decisions, does not use a past criminal conviction as a bar to or preclude a person with a criminal conviction from being considered for employment with the bidding firm unless otherwise precluded by federal or state law. I further certify that I have read and agree to be bound by the provisions of the City's Non-Discrimination Clause found in Appendix A as updated by City Ordinance 1856.

Signed: _____ Name: _____

Title: _____

ADDENDUM #1

Attachment C
Stadium Drive Signal Improvements
SPECIAL PROVISIONS

- *City of Kalamazoo Special Provision for Fiber Optics*
- *City of Kalamazoo Special Provision for Fiber Optic, Splice Enclosure, Rack-Mounted, Small*
- *Michigan Department of Transportation Special Provision for System Integration and Testing*
- *Michigan Department of Transportation Special Provision for Traffic Signal Work – Construction Methods*

96882-001.0

CITY OF KALAMAZOO

SPECIAL PROVISION

FOR

FIBER OPTICS

a. Description. This work consists of furnishing, installing, splicing, and testing single mode fiber optic cable and fiber optic communications hardware.

b. Materials.

1. Fiber Optic, Cable - Outside Plant (OSP).

A. Provide cable listed in the latest edition of the Rural Development Utilities Program (RDUP, formerly RUS) List of Materials Acceptable for Use on Telecommunications Systems.

B. Provide single mode, loose tube, gel free, non-armored fiber optic cable.

C. Provide cable constructed with 12 fibers per buffer tube.

D. Provide cable meeting the following environmental conditions:

(1) Storage. -40 degrees Fahrenheit (F) to +158 degrees F;

(2) Installation. -20 degrees F to +140 degrees F;

(3) Operation. -40 degrees F to +158 degrees F.

E. Provide cable with maximum attenuation of 0.35 decibels per kilometer (dB/km) maximum at a wavelength of 1310 nanometers (nm) and attenuation of 0.25 dB/km maximum at a wavelength of 1550 nm.

F. Show the date of manufacturer and the manufacturer's name as a permanent marking on the outer jacket. Mark a numerical sequence on the jacket at intervals no greater than 3 feet to facilitate determination of length of cable and amount of cable remaining on the reel. Ensure the height of the marking is a minimum of 0.08 inch nominal. In addition, the cable must have permanent markings as indicated on the plans or in the contract.

G. Ensure the cable designated for "Partner Agency Cable," if required, is color coded as shown on the plans.

Deliver the cable on reels without splices. Ensure both ends of the cable are sealed to prevent moisture ingress.

2. *Fiber Optic, Marker, Above Ground, Modified.*

Ensure the above-ground portion of the marker is made entirely of Polypropylene or high-density polyethylene (HDPE) and is protected against damage from ultraviolet (UV) light. Ensure the marker is hollow, white, and 6 feet long. Ensure its diameter is at least 3.5 inches and its wall thickness is at least 0.125 inches. Ensure the top of the marker is covered with an orange outer tube that has a domed top, nominally 16 inches in height. Ensure the marker has a physical mechanism made of HDPE or galvanized steel to anchor the marker to the ground and prevent uplift.

Ensure that black lettering is printed on, or molded into, both sides of the top of the marker saying "MDOT FIBER OPTIC CABLE ROUTE"; decals are prohibited. Guarantee this lettering not to fade for the life of the marker. Ensure the lettering is approximately 1 inch high, with a 0.2 inch stroke width. In smaller letters, the printing must say "BEFORE DIGGING, CALL MDOT." Ensure the proposed size and layout of all text is submitted to the Engineer for approval as part of the catalog cut sheet for this item.

3. *Fiber Optic, Cable, Indoor*.

Provide indoor-rated fiber optic cable and all hardware required for splicing indoor/outdoor cables and to facilitate cable installation. Ensure fiber capacity is as indicated on the plans.

A. Provide Plenum-rated, flame resistant single mode fiber optic cable.

B. Ensure the cable has 12 fibers per buffer tube.

C. Provide non-armored cable.

D. Ensure the indoor single mode cable has a maximum attenuation of 0.35 dB/km at 1310 nm wavelength and 0.25 dB/km at 1550 nm wavelength.

E. Provide cable that meets the following environmental conditions:

(1) Storage. -40 degrees F to +158 degrees F;

(2) Installation. +32 degrees F to +140 degrees F;

(3) Operation. +32 degrees F to +158 degrees F.

4. *Fiber Optic Connectors*.

Provide type LC fiber optic connectors for pigtails and type LC-to-LC connectors for jumper cables. Ensure connectors are comprised of a ceramic ferrule with a nickel plated zinc or composite connector body. Ensure the average loss is 0.3 decibel (dB) or less.

5. *Fiber Optic, Pigtail, Modified*.

A. Ensure pigtails are factory-made, buffered, and strengthened with aramid yarn to reduce the possibility that accidental mishandling will damage the fiber or connection.

B. Ensure pigtails are yellow

C. Ensure they use the type of connector specified in subsection b.4 of this special provision and are factory terminated.

D. Ensure each pigtail contains one or two fibers (simplex or duplex). Provide lengths sufficient to provide 2 feet of slack after installation.

6. Fiber Optic, Jumper, Modified.

A. Ensure jumpers meet the requirements for pigtails and have a connector on each end of the appropriate type.

B. Provide lengths that ensure sufficient slack after installation to avoid undue force on connectors and to facilitate the ease of maintenance work.

7. *Fiber Optic, Hardware Assembly, Small, Modified*.

Provide a small (up to 48 fibers) rack- mounted interconnect center with built-in patch panel, splice enclosure, splice trays, and all splicing hardware.

A. An interconnect center is defined herein as a splice and termination enclosure, that houses the internal patch panel for fiber termination via fiber optic pigtail. Ensure the interconnect center is capable of housing the splice trays for fiber optic splicing.

B. Ensure the interconnect center enclosure has brackets and all other hardware required for rack mounting in an Electronic Industries Alliance (EIA) standard 19-inch equipment rack. Ensure it takes up no more than one rack unit (RU) (1% inch) in the cabinet. Ensure it has front and rear doors. Ensure it is made of powder-coated aluminum or 16-guage steel.

C. Provide enough trays for all splices made in the interconnect center. Ensure the interconnect center enclosure's patch panel has at least 24 positions, compatible with the connectors specified in subsection b.4 of this special provision. Ensure it has provisions for cable strain relief and for connector labeling.

D. Hold the spliced fibers in splice trays, with each fiber neatly secured to the tray. Ensure the splice trays are compatible with the fiber optic splices specified herein and meets the following minimum requirements:

(1) Ensure the tray can accommodate loose tube buffers;

(2) Ensure slack fiber within the tray is placed neatly in an oval shape along an inside wall of the tray;

(3) Provide splice trays made of power-coated aluminum or high density plastic. Ensure the trays are designed for outdoor use.

8. *Fiber Optic, Hardware Assembly, Medium, Modified*.

Provide a medium (up to 96 fibers) rackmounted interconnect center per requirements in subsection b.8 of this special provision. Ensure it takes up no more than two rack units in the cabinet.

9. *Fiber Optic, Hardware Assembly, Large, Modified.*

Provide a large (up to 288 fibers) rackmounted interconnect center per requirements in subsection b.8 of this special provision. Ensure it takes up no more than four RU in the cabinet.

10. Fiber Optic, Storage Cabinet, Wall-Mounted, Modified.

A. Provide a wall-mounted fiber optic storage cabinet for storage of fiber optic slack cable during initial installation and future cable management.

B. Ensure the storage cabinet has at least four cable entry holes.

C. Size the storage cabinet to accommodate at minimum 500 feet of fiber optic cable slack.

D. Design the storage cabinet for indoor use. Ensure the cabinet has a powder-coat finish and is made of aluminum.

11. *Fiber Optic, Splice Cabinet, Modified.*

Provide splice cabinets at locations shown on the plans.

A. Provide a fiber optic splice cabinet that meets NEMA 3R requirements with minimum dimensions of 46 inches high by 24 inches wide by 20 inches deep. Ensure the cabinet is furnished with an EIA standard 19-inch equipment rack and is fully compatible with the rack-mounted interconnect centers.

B. Design the fiber optic splice cabinet to be mounted on a pedestal as shown on the plans.

C. Ensure the foundation and pedestal for the splice cabinet conforms to the requirements for traffic signal pedestals in sections 820 and 921 of the Standard Specifications for Construction

D. Construct all cabinets from 1/8 inch 5052 aluminum. Provide a cabinet with a white polyester powder coat finish.

E. Provide an engraved plaque on the front door, displaying the cabinet ID indicated on the plans. Ensure characters are at least 4 inches high with a minimum stroke width of 0.4 inches unless smaller characters are required to fit the ID on one line. Provide a plaque made of multilayered plastic with a black surface over a white interior; the engraving will reveal the white interior.

F. Provide continuous gas tungsten arc (TIG) welding for all external welds. Use the gas metal arc (MIG) or TIG welding method for all internal welds.

G. Provide two removable lifting eyes, each rated to 1,000 pounds, on either side of the top of the cabinet. Ensure each eye has a minimum internal diameter of 3/4 inch.

H. Doors.

(1) Ensure front and rear access doors are of same metal grade and finish as the cabinet body.

(2) Hinges are to be approximately 1/8 inch stainless steel piano hinge or continuous door length stainless steel hinges to provide a rigid and strong door construction.

(3) Ensure hinge pin stops are welded on top and bottom to prevent tampering.

(4) Mount hinges on internal side of door, so that hinges cannot be removed without first opening the door.

(5) Ensure the two-position door stop allows the door to remain open at the 90 degree position and at the 120 or 180 degree positions.

(6) Mount the door stop to the top or bottom of the door.

(7) Ensure each door has a 3-point locking/latching mechanism.

(a) Provide three latch points - center, top, and bottom of each door.

(b) Ensure that the latch points do not move until the cabinet door is unlocked.

(c) Use stainless steel locking bars for the top and bottom latch points capable of resisting manual prying.

(d) Provide nylon rollers on the top and bottom locking bar ends.

(e) Provide an industrial standard pin tumbler lock (Corbin lock), keyed #2, with two keys per locking mechanism.

(f) Door handle and locking mechanism may be separate.

(g) Provide locking eyes on handle and door, for each door such that a padlock may be installed.

I. Provide a louvered vent near the bottom of each door capable of deflecting water and directing incoming air downward towards the bottom of the cabinet. Provide a reusable-washable filter that will be placed inside the door vents.

J. Provide R-4 insulation on interior sides, top, and both doors.

12. *Tracer Wire, Modified*.

A. Provide fiber optic tracer wire at locations as indicated on the plans and as directed by the Engineer.

B. Ensure the tracer wire is a single conductor solid copper, American Wire Gauge (AWG) 14/1, gauge size 14, underground, UL Rated.

C. Insulate the tracer wire using High Molecular Weight Polyethylene (HMWPE) meeting ASTM D 1248 or High-Density Polyethylene (HDPE) as approved by the Engineer and be an orange jacket color.

D. Ensure wire connectors are 3M DBR, IDEAL UnderGround, or approved equal,

E. and are watertight to provide electrical continuity.

F. Ensure the tracer wire is accessed/connectorized from each handhole.

G. Install minimum 6 feet tracer wire slack at each head end of tracer wire.

c. Construction.

1. *Cable Pulling*.

A. Install the cable such that the optical and mechanical characteristics of the fiber are not degraded.

B. Do not violate the minimum bend radius or the maximum tension, both during and after installation. Corner rollers (wheels), if used, must not have radii less than the minimum installation bending radius of the cable. A series array of smaller wheels can be used for accomplishing the bend if the cable manufacturer specifically approves the array.

C. Use a clutch device to ensure the allowable pulling tension is not exceeded, if the cable is pulled by mechanical means. Also, attach a strain gauge to the pulling line at the cable exit location, and at a sufficient distance from the take-up device such that the strain gauge can be read throughout the entire cable pulling operation.

D. Do not leave the let-off reel unattended during a pull to minimize the chance of applying excess force, center pull, or back feeding.

E. Use entry guide chutes to guide the cable into the pull-box conduit ports.

F. Only lubricants approved by the cable manufacturer are permitted. Wipe the exposed cable in a pull box, junction box, or cabinet clean of cable lubricant with a cloth, after the cable has been installed.

G. Use separate grooved rollers for each cable, when simultaneously pulling fiber optic cable with other cables.

H. Seal the fiber optic cable ends to prevent the entry of water.

I. Install above ground fiber optic markers every 500 feet and also where the cable changes direction.

J. Install fiber optic tracer wire at locations as indicated on the plans.

2. *Cable Slack Requirements*.

Throughout the cable plant, pull and store excess cable slack at designated intervals. These intervals must occur at each handhole. The following lengths of slack cable are minimums:

A. HH, Round, 3 foot diameter (36 inches) 50 feet

B. HH, Type D 100 feet

3. *Optical Splicing Requirements*.

   A. Use a fusion splicer that automatically positions the fibers using the Light Injection and Detection (LID) system when making splices.

   B. Package each spliced fiber in a heat-shrinkable splice protection sleeve with strength member. Cover the splice and any bare fiber stripped of its coating with the protective sleeve. Completely re-coat bare fibers with a protective gel or similar substance, prior to application of the sleeve or housing to protect the fiber from scoring, dirt, or microbending. The use of Room Temperature Vulcanizing (RTV) or silicone sealants is strictly prohibited.

   C. Do not splice fibers from a given buffer tube in multiple splice trays.

   D. Furnish and install a fiber optic splice cabinet for end-to-end fusion splicing and at other locations shown on the plans. End-to-end splicing at locations not shown on the plans is permitted only when cable distance exceeds maximum reel length and must be approved by the Engineer. Pull cables into splice cabinet such that the bending radius of the fiber is not compromised.

   E. No splice is acceptable with an attenuation of greater than 0.06 dB. Test all fibers spliced, end-to-end once all fibers have been terminated, unless otherwise indicated on the plans. If a splice is measured to exceed 0.06 dB during the splicing process, it must be remade until its loss falls below 0.06 dB, unless otherwise approved by the Engineer. Record each attempt for purposes of acceptance.

   F. Terminate fibers by splicing them to factory-made pigtails or matching fibers as shown on the plans. Cap all connectors that are not connected to a mating connector.

4. *Fiber Acceptance Testing*.

   A. The basis of fiber acceptance is testing using an optical loss test set (OLTS).

   B. Test the fiber after installation, including all splicing and termination, is complete. Note, however, that this test procedure involves measuring the optical loss of any fiber installed by others, prior to splicing to it.

   C. For each fiber optic link, including spare fibers, determine whether the optical loss is within the limits permitted by this special provision. A link is defined as a continuous segment of fiber between one connector and another connector.

   D. When testing links that do not have connectors on both ends, use a mechanical splice to attach a pigtail to the unterminated fiber for the duration of the test. Mechanical splices will not be measured for separate payment.

   E. For each fiber link, follow this procedure:

      (1) If the link includes fiber installed by others, measure and record the optical loss over that portion of the link before it is spliced to new fiber.

      (2) Calculate the maximum allowable loss for the completed link, both at 1310 nm and 1550 nm. Use the following formula:

MAL = MLL + OFL + FSL + MSL + CL

Where:

MAL = Maximum Allowable Loss (calculate at both 1310 nm and 1550

nm) MLL = Maximum Link Loss for cable portions installed by others

OFL = Outdoor Fiber Length in km times (0.35 dB for 1310 nm and 0.25 dB for 1550 nm)

FSL = Number of fusion splices times 0.06 dB

MSL = Number of mechanical splices times 0.3

dB CL = Number of Connections times 0.3 dB

Provide this calculation to the Engineer along with the test results.

(3) Calibrate an OLTS and provide evidence satisfactory to the Engineer that the set produces accurate results at both wavelengths. This can be a demonstration that the set correctly measures the loss of a test fiber whose loss is known.

(4) Use the OLTS to measure the loss of the link under test. Record the results at both 1310 nm and 1550 nm, and submit a summary to the Engineer in a tabulated format.

(5) If the measured loss exceeds the calculated maximum, use an Optical Time Domain Reflectometer (OTDR) and other test equipment to troubleshoot the link. Take whatever corrective action is required, including cable replacement, to achieve a loss less than the calculated maximum.

F. Fiber Optic Tracer Wire Testing.

(1) Perform a continuity test on all tracer wire. If the tracer wire is found to be not continuous after testing, repair or replace the failed segment of the wire.

(2) Perform the test using a transmitter and tracer provided by MDOT, or approved equal. Arrange for the test to be witnessed by the Engineer.

5. *Documentation*.

Prepare a diagram showing all the links tested in this project. For the portions installed in this project, show the equipment cabinets, splices, and pigtails. On each line representing a link, show the maximum allowable loss and the actual loss. Ensure the actual loss is the one measured after all corrective actions have been taken. If required by the plans, provide an OTDR trace for all fibers to document the location of the sources of optical loss in the cable.

6. *Warranty.*

   Provide all fiber optic equipment covered by this special provision with a standard manufacturer's warranty, transferable to MDOT. All the fiber optic equipment covered by this special provision must carry a warranty (parts and labor) of 1 year from the date of shipment. Furnish warranty and other applicable documents from the manufacturer, and a copy of the invoice showing the date of shipment, to the Engineer prior to final acceptance.

d. Measurement and Payment.

The completed work, as described, will be measured and paid for at the contract unit price using the following pay items:

Pay Item Pay Unit

Fiber Optic, Cable, Single Mode Fiber, __F, Modified..... Foot
Fiber Optic, Cable, Indoor, Single Mode Fiber, __F, Modified ..... Foot
Fiber Optic, Splice Cabinet, Modified..... Each
Fiber Optic, Pigtail, Modified..... Each
Fiber Optic, Jumper, Modified..... Each
Fiber Optic, Hardware Assembly, (size), Modified..... Each
Fiber Optic, Storage Cabinet, Wall-Mounted, Modified..... Each
Fiber Optic, Marker, Above Ground, Modified..... Each
Tracer Wire, Modified..... Foot

1. **Fiber Optic, Cable, Single Mode Fiber, __F, Modified** includes furnishing and installing outdoor-rated fiber optic cable and all fusion splicing as shown on the plans. Number of fibers will be as indicated on the plans.

2. **Fiber Optic, Cable, Indoor, Single Mode Fiber, __F, Modified** includes furnishing and installing plenum- rated indoor fiber optic cable, fusion splicing, and all hardware required for splicing indoor/outdoor cables and to facilitate cable installation. Number of fibers will be as indicated on the plans.

3. **Fiber Optic, Splice Cabinet, Modified** includes furnishing and installing a pedestal mounted cabinet, pedestal, and pedestal foundation at locations as indicated on the plans.

4. **Fiber Optic, Pigtail, Modified** includes furnishing and installing a single mode fiber pigtail and includes the associated fusion splicing.

5. **Fiber Optic, Jumper, Modified** includes furnishing and installing a single mode fiber optic jumper.

6. **Fiber Optic, Hardware Assembly, Small, Modified** includes furnishing and installing a small (up to 48 fibers) rack-mounted interconnect center (includes built in patch panel, splice enclosure, and splice trays).

7. **Fiber Optic, Hardware Assembly, Medium, Modified** includes furnishing and installing a medium (up to 96 fibers) rack-mounted interconnect center (includes built in patch panel, splice enclosure, and splice trays).

8. **Fiber Optic, Hardware Assembly, Large, Modified** includes furnishing and installing a large (up to 288 fibers) rack-mounted interconnect center (includes built in patch panel, splice enclosure, and splice trays).

9. **Fiber Optic, Storage Cabinet, Wall-Mounted, Modified** includes furnishing and installing a plain storage cabinet for the fiber optic cable slack.

10. **Fiber Optic, Marker, Above Ground, Modified** includes furnishing and installing markers at intervals and locations as described in this special provision and on the plans.

11. **Tracer Wire, Modified** includes furnishing, installing, and testing tracer wire at locations as described and/or shown on the plans.

CITY OF KALAMAZOO

SPECIAL PROVISION

FOR

FIBER OPTIC, SPLICE ENCLOSURE, RACK-MOUNTED, SMALL

KZOO/JH 1 of 1 11-24-2015

a. Description. This work consists of furnishing and installing fiber optic communications hardware.

b. Materials.

1. Rack-Mounted Splice Enclosure, Small.

A. Provide a small splice enclosure made for rack mounting that meets the following requirements:

(1) Approximately 17 inches wide by 1.75 inches high by 15.92 inches deep;

(2) Made of powder-coated steel;

(3) Has a slide out master panel;

(4) Designed to be hung from rack;

(5) Designed to hold two splice trays, with 36 fusion splices per tray.

B. Provide two 36-splice trays with each enclosure.

C. Provide means for anchoring two incoming cables and the outgoing pigtails. The pigtails may be anchored to the splice trays.

c. Construction.

1. Place in cabinet and attach to existing cabinet as designed to do.

2. Warranty. Provide all fiber optic equipment covered by this special provision with a standard manufacturer's warranty, transferable to MDOT. All the fiber optic equipment covered by this special provision must carry a warranty (parts and labor) of 1 year from the date of shipment. Furnish warranty and other applicable documents from the manufacturer, and a copy of the invoice showing the date of shipment, to the Engineer prior to final acceptance.

d. Measurement and Payment. The completed work, as described, will be measured and paid for at the contract unit price using the following pay items:

Pay Item Pay Unit

Fiber Optic, Splice Enclosure, Rack-Mounted, Small ..... Each

1. **Fiber Optic, Splice Enclosure, Rack-Mounted, Small** includes furnishing and installing a small (up to 72 fibers) rack-mounted interconnect center (splice enclosure, and splice trays).

MICHIGAN
DEPARTMENT OF TRANSPORTATION

SPECIAL PROVISION
FOR
SYSTEM INTEGRATION AND TESTING

a. Description. This work consists of conducting system integration and acceptance testing work in accordance with the standard specifications, except as modified herein.

1. General. System integration and testing includes network integration of ITS devices into the communication network and testing to prove functionality and operation for local, subsystem and final system. This may include trunk and distribution fiber networks. This special provision contains testing requirements for all ITS devices and networks; however, all of these devices may not be included in this project. Disregard testing requirements for devices that are not part of this project.

2. Location. The integration services include all necessary configuration and programming work at communication aggregations points, subsystem locations, and the transportation operations center (TOC). All individual field device integration and equipment configurations are paid for under the individual device special provisions pay item.

3. Existing Systems. This project may include integration with existing ITS devices, systems, or networks. See applicable sections regarding network migration and network pre/post testing.

b. Materials. None specified.

c. Construction.

1. Prior to construction, in addition to the requirements outlined in equipment specific special provisions and the Special Provision for Basic Methods and Materials for Intelligent Transportation System Work, the Contractor must provide the following:

A. Equipment Integration Plan (EIP). After all equipment shop drawings have been approved, and 14 days prior to any ITS device field installation, submit a complete EIP to the Engineer for review and approval. The EIP must follow the procedures and integration requirements described in the Special Provision for Project Overview. Ensure any deviations from these specifications are noted in the EIP and are not executed in the field without the approval of the Engineer. Field installation and integration must not begin before approval of the EIP. The EIP includes, but is not limited to, the following:

(1) Revised ITS field device location plan in response to any device relocation or layout adjustment.

(2) Revised ITS field device interconnection and wiring layout plans in response to any construction field changes.

(3) Detailed step-by-step integration procedures for each local and TOC integration. Typical site integrations can be grouped in one integration procedure by approval of the Engineer.

(4) Typical devices interconnect diagrams for local, Hub/Node, and TOC locations. Ensure all device interconnect diagrams are generated in Visio, CAD, or Microstation and clearly identify equipment model numbers and cable types.

(5) Network Integration details, including but not limited to the following:

(a) Overall system network diagram, including full logical network and Internet Protocol (IP) configuration details for all devices in a system diagram and tabulated formats.

(b) Bandwidth and traffic flow analysis for all network layers links including anticipated typical traffic flows.

(c) Network segmentation and virtual local area network (VLAN) configuration.

(d) Port assignments for all network and ITS devices.

(e) Provide proposed routing protocol and scheme including details of the method of operations and failover criteria, failover settings and routing costs. Include at a minimum:

(i) IP Unicast Routing;

(ii) IP Multicasting Routing;

(iii) Internet Group Management Protocol (IGMP); and

(iv) Constraint methods for multicast packet flooding.

(f) Provide a planned method of testing performance. Include at a minimum:

(i) Performance criteria description, proposed measurements, and methods of measurement;

(ii) Acceptance threshold and references for the values;

(iii) Network loading, 20, 50 and 90 percent full capacity at access, distribution and trunk layer; and

(iv) Measurement tools.

(g) Proposed configurations of Managed Field Ethernet Switches.

(h) Proposed coordination steps with the ITS Maintenance Contractor to have field switches integrated into MDOT’s Network Monitoring System (NMS).

(6) Equipment programming/configurations for each ITS device type included in the Bill of Materials (BOM) and as specified in the Special Provision for Basic Methods and Materials for ITS Work.

(7) Advanced Traffic Management System (ATMS) Software Integration plan and proposed procedures.

(a) Procure material compatible with the MDOT Statewide ATMS Software.

(b) Confirmation testing and software integration into the ATMS will be paid for under the Special Provision for Integration, Advanced Traffic Management System Software.

(8) Fiber Network Integration plan. The fiber network integration portion of the EIP must include, but is not limited to, the following:

(a) Plan to test fiber optic cable prior to the connection into the Node switches and provide comparison between the calculated and anticipated measured optical link budgets, including adjustments for optical sensitivity.

(b) Proposed coordination steps with the ITS Maintenance Contractor for network integration into existing or proposed switches at Hub/Node and TOC locations including:

(i) Back-end network configurations;

(ii) Installation of fiber optic transceivers;

(iii) Network termination and end-to-end connectivity establishment; and

(iv) Port configuration including open shortest path first routing.

(c) Proposed termination of the distribution network into patch panels at local ITS cabinets as shown on the plans.

(d) Proposed configuration of new field switches in ITS cabinets that are logically nearest to the Node. Configuration for the ITS site next in the network architecture can only continue if previous link communications chain has been integrated and communications verified.

(9) Include a Network Migration Plan as part of the EIP if called for in the Special Provision for Project Overview. Submit a Network Migration Plan identifying the intended process for transitioning communications from the existing network architecture to the proposed network architecture including, but not limited to:

(a) A detailed action plan identifying each step in the installation and migration activities including testing.

(i) Pre-Migration Testing. Test existing network and ITS device availability before network and device migration. Work with the ITS Maintenance Contractor for pre-testing. Ensure the results are used to compare pretesting

to post test results. Propose expected changes in results in the Acceptance Test Plan.

(ii) Post Migration Testing. Ensure testing is completed in accordance with the Acceptance Test Plan requirements.

(b) A list of certified personnel performing the work at each location;

(c) Contact information for the main point of contact during regular business hours and emergencies;

(d) Switch installation and configuration details;

(e) A list of equipment to be removed;

(f) A contingency plan for each activity identifying recovery process from each situation outlined in the migration plan;

(g) An outline of downtime and risk mitigation strategies; and

(h) Coordination for reintegrating existing devices into ATMS if the proposed network configuration utilizes a new addressing scheme.

B. Acceptance Test Plan (ATP).

(1) General Requirements.

(a) If a system mock up is required, submit a complete ATP to the Engineer at least 14 days prior to beginning the mock up. If a system mock up is not required, submit a complete ATP to the Engineer 14 days prior to installing any electronic devices in the field.

(b) The ATP must include individual test cases clearly showing passing criteria for all ITS devices as applicable per project.

(c) The ATP must include local, subsystem, and final system testing for all ITS devices to be integrated on this project.

(d) Ensure failures during testing are included in a report that documents the defective unit or setting and the corrective action taken. Minor failures may be addressed and retested at the Engineer's discretion. Major failures, which would require additional work to multiple units and sites, may cause the Engineer to stop testing until the issue has been resolved. No extension of time or additional payments will be given or made due to delays caused by failed acceptance testing.

(e) The ATP forms as well as any supplemental documentation completed during the testing are to be delivered to the Engineer upon system acceptance. Ensure the forms are signed by the Contractor as well as the Engineer or representative.

(2) ITS Local Device Assembly Test (LDAT). Before ITS sub-system tests (SST),

conduct stand-alone tests of the equipment installed at each field site as approved by the Engineer. The test must, at a minimum, exercise all stand-alone (non-network) functional operations of the field equipment with all of the equipment installed per the plans or as directed by the Engineer.

(3) ITS Sub-System Test (SST). Conduct SST to verify a section of the overall ITS system is functioning properly. Ensure SST testing is conducted at logical nodes or aggregation points to verify both communications and device functionality.

(4) ITS Final System Test (FST). FST is the last step in the ATP and serves as the basis for system acceptance. Ensure the FST is performed at the TOC following completion of the SST. After the successful completion of the FST, the burn-in period begins.

(5) Testing Requirements. Ensure the list of ITS devices and testing requirements identified in Table 1 are included in the ATP. Submit test procedures required for Fiber Optic and Licensed Wireless Link Backhaul as part of their own special provision requirements.

Table 1: List of ITS Devices Required for ATP

ITS Devices	Test Procedures Required
ITS Cabinet	LDAT, SST, FST
Surveillance System Assembly	LDAT, SST, FST
Dynamic Message Sign (DMS)	LDAT, SST, FST
Microwave Vehicle Detection System (MVDS)	LDAT, SST, FST
Managed Field Ethernet Switches (MFES)	LDAT
Uninterruptible Power Supply (UPS)	LDAT, SST, FST
Unlicensed Wireless Radios	LDAT
Cellular Modems/Cable Modems	LDAT, FST
Environmental Sensor Station (ESS) Equipment	LDAT, FST
IP Power Distribution Unit	LDAT, FST
Infrared Illumination Device	LDAT
Lane Control System (LCS)	LDAT, SST, FST
Dynamic Message Panel (DMP)	LDAT, SST, FST
Fiber Optic Hardware Assembly	LDAT

For each ITS device type, ensure there is a test case developed with pass/fail criteria. All functional requirements in the test case must pass during the witness testing to grant final acceptance. The sections below list all functional requirements per device to be included in each test case. During the review of the ATP report, the Engineer has the right to add or remove test case requirements, as applicable, to the project and within the functional requirements shown in the special provisions.

(a) ITS Cabinet.

(i) LDAT.

1) Visual inspection to check workmanship, confirm equipment has been installed in accordance with approved layout drawings and equipment shop drawings, and verify the cabinet field wiring matches the cabinet wiring diagram and interconnect drawings are stored in the cabinet.

2) Verify proper operation of the Ground Fault Interrupter (GFI) outlet.

3) Verify proper operation of the lights and vent fans.

4) Verify all ITS devices are labeled as required with the device name and IP address.

5) Verify accuracy of the temperature and humidity reported by the cabinet monitoring system.

6) Test door alarms locally.

7) Set and verify network settings (i.e., IP address, subnet mask, and gateway).

8) Configure the cabinet monitor to issue Simple Network Management Protocol (SNMP) traps to a central computer when a cabinet door is open and when the temperature in the cabinet exceeds 120 degrees.

a. Demonstrate the cabinet monitor system can successfully use a SNMP trap for door opening/closing.

(ii) SST. Verify communications to the SNMP card of the cabinet monitoring system.

(iii) FST.

1) Test Alarm Conditions. Demonstrate the cabinet monitoring system can successfully use SNMP traps to alert a computer at the TOC about an open door and a high temperature.

2) Verify the ability of users in the TOC to determine the temperature, humidity, and door status using a web browser.

(b) Surveillance System Assembly.

(i) LDAT. Ensure the following local field operational tests are performed at the camera assembly field site on each closed-circuit television (CCTV) camera. Provide a laptop computer testing the video and camera control through software that supports National Transportation Communications for ITS Protocol (NTCIP). Notify the Engineer at least 14 working days in advance of the proposed date for the camera local device assembly test. After the camera assembly, including the camera hardware, DVE, power supply, and connecting cables, has been installed:

1) Camera Assembly (local control). Perform the following local field operational tests at the camera assembly field site in accordance with the test plans. After the camera assembly, including the camera hardware, power supply and connecting cables, has been installed:

a) Verify physical construction has been completed as detailed in the contract, on the plans and herein.

b) Inspect the quality and tightness of ground and surge protector connections, patch cords and jumpers.

c) Verify proper voltage of all the power supplies.

d) Verify installation of specified cables and connections between the camera, PTU and camera control receiver.

e) Set and verify the camera control address and network/IP settings.

f) Verify the presence and quality of the video image via a video streaming client on the laptop computer.

g) Demonstrate camera sensitivity at low light levels meets the specification.

h) Verify title block information is correct.

i) Exercise the pan, tilt, zoom (PTZ), focus - auto and manual, iris opening, and manual iris control selection; and the operation, low-pressure alarm (if present), preset positioning, and power on/off functions.

j) Demonstrate pan/tilt speed and extent of movement meets the specifications, and verify latency of PTZ does not exceed 250 milliseconds

2) Camera Cable. Furnish all equipment, appliances and labor necessary to test the installed camera cable between the camera assembly and the network communication device.

a) Perform tests on the camera Ethernet cable per the *ANSI/TIA/EIA-568-B.1* using a meter designed for Ethernet cable testing.

b) Perform all Ethernet cable testing after final termination and cable installation, but prior to the connection of any electronics or field devices.

c) Replace any cable that fails to meet these parameters, or if any testing reveals defects in the cable, and test the new cable as specified above.

3) Configure and test the CCTV camera using settings that were approved at equipment mock up (if required) per the Special Provision for Project Overview or as approved by the Engineer to ensure interoperability and security.

4) Coordinate all configuration settings with the Engineer and provide any exportable electronic configuration files for each camera. The file will contain the location of the camera, its serial number, final accepted configuration and will be named to clearly indicate the device location from which it was obtained.

(ii) SST. Verify communications to the surveillance system or DVE.

(iii) FST. Ensure the following remote operational tests are conducted at the TOC using NTCIP software.

1) Verify the camera IP address and system name.

2) Verify the presence and quality of the video image.

3) Exercise the PTZ, focus, iris opening, and manual iris control selection; and the operation, low-pressure alarm (if present), preset positioning, and power on/off functions.

(c) DMS. Integrate the DMS into the communications network within 14 calendar days of installation and successful post-delivery testing. DMS may be used by MDOT as soon as integration is complete through final acceptance testing.

(i) LDAT. Ensure DMS LDAT is conducted at each field location after the DMS has been installed and integrated into the system. The test cases, at minimum, must include inspection of the sign housing, power supply, and electrical distribution; DMS controller; DMS Auxiliary Control Panel (ACP); Light-Emitting Diode (LED) display modules; temperature and light control; and sign failure conditions.

1) DMS Controller.

a) Verify a “local/remote” switch with an LED indicator that places the controller in local mode such that it can be controlled from the front panel interface instead of via the primary communication channel.

b) Verify the reset switch to quickly restart the controller.

c) LED “Active” indicator blinks when the controller is operating.

d) Verify system status Liquid Crystal Display (LCD) displays time and date.

2) DMS ACP.

a) Verify a “local/remote” switch with an LED indicator that places the controller in local mode such that it can be controlled from the front panel interface instead of via the primary communication channel.

b) Reset switch to quickly restart the controller.

c) LED “Active” indicator blinks when the controller is operating.

d) Verify system status LCD displays time and date.

3) LED Display Module.

a) On command from either a remote computer or local laptop running the central control software, the sign controller must test the operation of all LED pixels and determine whether their functional status is “normal” or “stuck-off.”

- Run a diagnostic test to verify all the LED driver cards, power supply diagnostic cards, temperature sensor cards, fan sensor card, and photo sensor are functioning properly.

- Verify Real-time DMS message posting.

- Verify static test message display.

- Verify flashing test message display.

- Verify a multipage test message display.

- Verify manual blanking of the display.

4) Light Control (DMS Intensity Control).

a) Verify from the DMS controller the option of selecting from a minimum of 100 LED intensity levels. Ensure LED intensity levels are available in a range of 1 percent to 100 percent of the maximum display intensity, and in increments of 1 percent.

b) Not cause any flickering of the LED display matrix.

c) Verify manual and automatic intensity control modes to be user selectable using the DMS control software, although the typical control mode must be “automatic.”

d) Verify manual intensity control from both local and remote locations.

5) Sign Failure Conditions.

a) Verify that in the event of communication error between the DMS sign controller and the system control computer; the DMS

controller automatically blanks the sign.

b) Verify that in the event of a power failure, the DMS controller automatically blanks the sign.

c) Ensure all testing work, activity, and results are documented and reported with their details to the Engineer.

(ii) SST. Verify communications to the DMS controller.

(iii) FST. Ensure the DMS FST is conducted from the TOC using the ATMS software. In the event the ATMS software is not capable of testing some required functional specifications of the DMS, then the DMS specific manufacturer's software can be used. Test the following requirements remotely:

1) LED display module as described in the LDAT.

2) DMS intensity control as described in the LDAT.

3) Sign failure conditions as described in the LDAT.

(d) MVDS.

(i) LDAT.

1) Verify physical construction has been completed as specified in the contract and herein.

2) Verify network settings.

3) Inspect the quality and tightness of ground connections.

4) Verify lanes match actual field conditions using the MVDS vendor-supplied test software.

5) Verify speed, volume, and occupancy are within the requirements of the MVDS special provision. The use of a calibrated Lidar gun is required for the speed test. Follow manufacturer recommended procedures for calibration of the Lidar gun.

6) Each installed MVDS's volume counts and speed measurements are to be verified utilizing the MVDS vendor-supplied test software running on a laptop connected locally to the detector communication port. Compare the counts from the detector to visual counts or counts from permanent or temporary traffic detection devices of known accuracy. Compare the speed measured by the detector to the speeds measured by the Lidar gun.

7) Ensure all testing work, activity, and results are documented and reported with their details to the Engineer.

(ii) SST. Verify communications to the MVDS.

(iii) FST.

1) Verify network interface device is receiving and transmitting data from the remote site to across the ITS network.

2) Conduct FST from the head end ATMS software.

(e) MFES.

(i) LDAT.

1) Verify physical connections are performed as specified in the contract.

2) Verify all LED indicators for link, activity, and power are functioning.

3) Configure and test the MFES using settings that were approved at equipment mock up (if required) per the Special Provision for Project Overview or as approved by the Engineer to ensure interoperability and security. Coordinate all configuration settings with the Engineer and provide backup configuration files electronically. Configuration settings include system name, location, IP address, subnet mask, and default gateway.

4) Verify all active ports have been configured per the Special Provision for Project Overview. Check the speed, duplex, and Virtual Local Area Network (VLAN) settings.

5) Disable any ports not in use.

6) If any MFES installed in the project is connected to equipment that originates a multicast stream, develop an IP multicasting plan, including multicast addressing and quality of service parameters, using protocol independent multicast sparse mode (PIM-SM). Revise the plan until it is satisfactory to the Engineer and then configure the MFESs and other devices accordingly.

7) On Layer 3 MFESs, configure gateway IP addresses for all subnets that connect to that MFES. Configure open shortest path first (OSPF) routing and confirm that routes to those subnets are being advertised to adjacent MFESs. Configure access control lists (ACLs). Work with the Engineer to determine IP ranges, ports, and other settings to be used in configuring the ACLs.

8) On Layer 2 MFESs, configure VLANs as shown on the plans. Configure trunking ports between MFESs and access ports between MFESs and equipment. Set VLAN Trunk Protocol (VTP) to transparent mode on all MFESs. Configure port security to only allow the media access

control (MAC) addresses of equipment connected to the MFES to pass traffic. Configure Rapid Spanning Tree Protocol (RSTP) to prevent bridging loops and provide redundant paths.

(f) UPS.

(i) LDAT.

1) Verify electrical connections have been completed as detailed in the contract and herein.

2) Provision UPS with IP address and network settings provided by the Engineer. Configure the UPS using settings that were approved at equipment mock up (if required) per the Special Provision for Project Overview or as approved by the Engineer.

3) Alarms.

a) Disable all audible alarms associated with the UPS.

b) Ensure that the communication module of the UPS reports alarm conditions to the TOC using SNMP over the Ethernet communication system.

4) Verify the UPS can run off battery backup. Test utility power loss feature, automatic low-battery, and high temperature shutdown features. Verify the UPS returns to normal operations without a manual reset.

5) Demonstrate the UPS can successfully use a SNMP trap for utility power loss and return to normal operations.

(ii) SST. Verify remote communications to the SNMP card of the UPS.

(iii) FST. Test Alarm conditions. Demonstrate the UPS can successfully use SNMP traps to alert a computer at the TOC about a power loss, low-battery, and high temperature shutdown.

(g) Unlicensed Wireless Radios.

(i) LDAT.

1) Furnish all test equipment required to test the wireless link. The furnishing of test equipment is an appurtenance of the system integration and testing pay item.

2) Testing based on the Contractor supplied Test Plan must begin 30 days prior to the date of acceptance notification to the Engineer that the wireless link meets all requirements of the specifications and complies with all appropriate standards listed in the contract and is ready for final inspection.

3) Verify physical construction has been completed per the contract.

4) Inspect the quality and tightness of ground connections.

5) Set and verify the radio has been configured with the proper site name, IP address, subnet mask, gateway, and VLAN settings.

6) Verify actual throughput meets requirements using two laptops with Iperf, Jperf, or similar approved software for each site.

7) Record the throughput, Signal-to-Noise Ratio (SNR), Received Signal Strength (RSS), Received Signal Strength Indication (RSSI) and noise level for each site.

8) The Contractor is responsible for meeting the throughput and other requirements for wireless links. Ensure wireless links that do not meet the performance requirements during acceptance testing are upgraded or replaced at no additional cost to the Department.

(h) Cellular Modem/Cable Modem.

(i) LDAT.

1) Verify physical construction has been completed per the contract.

2) Verify cable, connections, and antenna (as applicable) are properly installed.

3) Integrate and test to meet MDOT specifications for integration and as shown on the plans.

4) Set and verify VPN settings, local IP address, port forwarding, Network Address Translation (NAT), and IP-based filtering.

5) Conduct an upload throughput test of the cellular modem using Iperf, Jperf, or similar approved software.

6) Test the data throughput between the MFES inside the ITS cabinet through the cable modem and to an internet connected computer using a standard software application designed for this purpose. The throughput test will be witnessed by the Engineer and System Manager, recorded, and signed off by both the Contractor and MDOT as adequate for the design intent. The expected value for data throughput will be provided by the Engineer upon coordination with the Cable Internet Provider.

(ii) FST. Verify remote connectivity to the cell/cable modem. Ensure the modem is able to be monitored and configured remotely.

(i) ESS Equipment. Integrate and calibrate the sensors with the remote processing unit (RPU) located in the field cabinet as designated on the plans.

(i) LDAT.

1) After each ESS field location is fully installed and integrated, ensure the following tests are conducted for all environmental sensors and remote processing unit (RPU).

2) Furnish test equipment at no additional cost to the Department, that is capable of completing test procedures whose parameters are equal or better than the minimum test parameters specified by the sensor manufacturer. Provide a list of tools and test equipment (common and specialized, including any built-in testing facilities that are functionally equivalent to external test equipment) necessary to test the equipment.

3) Verify physical construction has been completed as detailed in the contract and herein.

4) Verify all cable, connectors, grounding, bonding and lightning protection.

5) Sensor Testing. Conduct all sensor measurements using manufacturer's recommended testing equipment, and compare the recorded data to the functional requirements shown in the Atmospheric sensors, Pavement Condition Sensors, and Sub-Surface Temperature Probe special provisions. Provide all test results to MDOT for review prior to final system acceptance.

6) RPU Testing.

a) Verify all sensors are connected to the RPU as shown on the plans.

b) Set and verify the IP address and network settings provided by the Engineer.

c) Verify accurate data collection and reporting from each sensor.

d) Verify the RPU displays real-time data for all sensors connected.

e) Verify the RPU displays the data for the entire system "at a glance" for analysis.

f) Verify a long-term history page is present to show historical data from any sensor connected to the RPU. A log of at least 3 days should be present.

g) Verify the RPU supports local maintenance of all devices physically connected to the RPU using a graphical user interface (GUI).

h) Verify the RPU allows remote configuration of any sensor

physically connected to the RPU using web interface.

i) Verify the presence of eight camera views in the RPU menu.

j) Verify the user is able to switch the first eight images with a second set of eight views.

(ii) FST. After each ESS field location is fully installed and integrated, ensure the following tests are conducted from the TOC using ATMS or current residing Road Weather Information System (RWIS) central management software:

1) Verify remotely from the TOC that each sensor is reporting accurate data within the ranges shown in the contract.

2) Verify each ESS location is represented on the map on the RWIS central management system.

3) Verify the presence of eight camera views on the hosted site during the day and the night. Ensure night images are easily viewed when an infrared (IR) illumination device is present.

4) Verify the IP address and site name corresponds to the ESS site location.

5) Verify remote configuration of the RPU from a web-browser.

6) Verify remote configuration of the IP camera from a web-browser.

(j) IP Power Distribution Unit (PDU).

(i) LDAT.

1) Configure the PDU for access from the MDOT Traffic Operations Center (TOC) or head-end.

2) Verify the user has the ability to reset the power to all the devices connected to the IP PDU.

3) Verify all devices recover and return to normal operation.

(ii) FST.

1) Verify the user has the ability to remotely reset the power to all the devices connected to the IP PDU.

2) Verify all devices recover and return to normal operation.

(k) IR Illumination Device.

(i) LDAT.

1) Verify physical construction has been completed per the contract.

2) Verify the camera images/video is clearly viewable at night during low ambient light conditions.

(l) LCS. Provide Parsons Transportation Group, MDOT's ATMS contractor, access to an LCS controller, either by remote access or by providing a physical unit, for development and testing of the controller driver and ATMS software within 60 days of project award. Provide all firmware updates for this LCS controller throughout construction, testing and integration.

(i) LDAT. Ensure LCS LDAT is conducted at each field location after the LCS has been installed and integrated into the system. The test cases, at minimum, must include inspection of the sign housing, power supply, and electrical distribution; LCS controller; LCS ACP; LED display modules; temperature and light control; and sign failure conditions.

1) LCS Controller.

a) Set and verify the IP address and network settings provided by the Engineer.

b) Verify a "local/remote" switch with an LED indicator that places the controller in local mode such that it can be controlled from the front panel interface instead of via the primary communication channel.

c) Verify the reset switch to quickly restart the controller.

d) LED "Active" indicator blinks when the controller is operating.

e) Verify system status LCD displays time and date.

f) Verify what you see is what you get (WYSIWYG) functionality.

2) LCS ACP.

a) Set and verify the IP address and network settings provided by the Engineer.

b) Verify a "local/remote" switch with an LED indicator that places the controller in local mode such that it can be controlled from the front panel interface instead of via the primary communication channel.

c) Reset switch to quickly restart the controller.

d) LED "Active" indicator blinks when the controller is operating.

e) Verify system status LCD displays time and date.

f) Verify what you see is what you get (WYSIWYG) functionality.

3) LED Display Module.

a) On command from either a remote computer or local laptop running the central control software, the sign controller must test the operation of all LED pixels and determine whether their functional status is “normal” or “stuck-off.”

- Run a diagnostic test to verify all the LED driver cards, power supply diagnostic cards, temperature sensor cards, fan sensor card, and photo sensor are functioning properly.

- Verify Real-time LCS message posting, including American Standard Code for Information Interchange (ASCII) text and graphics.

- Verify static test message display.

- Verify flashing test message display.

- Verify a multipage test message display.

- Verify manual blanking of the display.

- Verify posting of pre-stored graphic images

4) Light Control (LCS Intensity Control).

a) Verify from the LCS controller the option of selecting from a minimum of 100 LED intensity levels. Ensure LED intensity levels are available in a range of 1 percent to 100 percent of the maximum display intensity, and in increments of 1 percent.

b) Verify that intensity control does not cause any flickering of the LED display matrix.

c) Verify manual and automatic intensity control modes to be user selectable using the LCS control software, although the typical control mode must be “automatic.”

d) Verify manual intensity control from both local and remote locations.

5) Sign Failure Conditions.

a) Verify that in the event of communication error between the LCS sign controller and the system control computer; the LCS controller automatically blanks the sign.

b) Verify that in the event of a power failure, the LCS controller automatically blanks the sign when power is restored.

c) Verify that in the event of a power failure, all data in the LCS controller non-volatile memory is retained.

d) Ensure all testing work, activity, and results are documented and reported with their details to the Engineer.

(ii) SST. Verify communications to the LCS controller.

(iii) FST. Ensure the LCS FST is conducted from the TOC using the ATMS software. In the event the ATMS software is not capable of testing some required functional specifications of the LCS, then the LCS specific manufacturer's software can be used. Test the following requirements remotely:

1) LED display module as described in the LDAT.

2) LCS intensity control as described in the LDAT.

3) Sign failure conditions as described in the LDAT.

(m) DMP. Integrate the DMP system into the communications network.

(i) LDAT. Ensure DMP LDAT is conducted at each field location after the DMP has been installed and integrated into the system. The test cases, at minimum, must include inspection of the sign housing, power supply, and electrical distribution; DMP controller; LED display modules; temperature and light control; and sign failure conditions.

1) DMP Controller.

a) Verify a "local/remote" switch with an LED indicator that places the controller in local mode such that it can be controlled from the front panel interface instead of via the primary communication channel.

b) Set and verify the IP address and network settings provided by the Engineer.

c) Verify the reset switch to quickly restart the controller.

d) LED "Active" indicator blinks when the controller is operating.

e) Verify system status LCD displays time and date.

f) Verify what you see is what you get (WYSIWYG) functionality.

2) DMP ACP.

a) Verify a "local/remote" switch with an LED indicator that places the controller in local mode such that it can be controlled from the front panel interface instead of via the primary communication channel.

b) Set and verify the IP address and network settings provided by the Engineer.

c) Reset switch to quickly restart the controller.

d) LED “Active” indicator blinks when the controller is operating.

e) Verify system status LCD displays time and date.

f) Verify what you see is what you get (WYSIWYG) functionality.

3) LED Display Module.

a) On command from either a remote computer or local laptop running the central control software, the sign controller must test the operation of all LED pixels and determine whether their functional status is “normal” or “stuck-off.”

- Run a diagnostic test to verify all the LED driver cards, power supply diagnostic cards, temperature sensor cards, fan sensor card, and photo sensor are functioning properly.

- Verify Real-time DMP message posting.

- Verify static test message display.

- Verify flashing test message display.

- Verify a multipage test message display.

- Verify manual blanking of the display.

4) Light Control (DMP Intensity Control).

a) Verify from the DMP controller the option of selecting from a minimum of 100 LED intensity levels. Ensure LED intensity levels are available in a range of 1 percent to 100 percent of the maximum display intensity, and in increments of 1 percent.

b) Not cause any flickering of the LED display matrix.

c) Verify manual and automatic intensity control modes to be user selectable using the DMP control software, although the typical control mode must be “automatic.”

d) Verify manual intensity control from both local and remote locations.

5) Sign Failure Conditions.

a) Verify that in the event of communication error between the DMS sign controller and the system control computer; the DMP controller automatically blanks the sign.

b) Verify that in the event of a power failure, the DMP controller automatically blanks the sign.

c) Verify that in the event of a power failure, all data in the DMP controller non-volatile memory is retained.

d) Ensure all testing work, activity, and results are documented and reported with their details to the Engineer.

(ii) SST. Verify communications to the DMP controller.

(iii) FST. Ensure the DMP FST is conducted from the TOC using the ATMS software. In the event the ATMS software is not capable of testing some required functional specifications of the DMP, then the DMP specific manufacturer's software can be used. Test the following requirements remotely:

1) LED display module as described in the LDAT.

2) DMP intensity control as described in the LDAT.

3) Sign failure conditions as described in the LDAT.

(n) Fiber Optic Hardware Assembly (all sizes).

(i) LDAT.

1) Visual inspection to check workmanship, confirm equipment has been installed in accordance with approved layout drawings and equipment shop drawings, and verify the cabinet field wiring matches the cabinet wiring diagram.

2) Verify all fiber optic cables, pigtails, jumpers, and patch panels are labeled as shown on the plans per the ITS cabinet labeling scheme.

3) Verify all fiber optic cables, pigtails and jumpers are properly trained inside the fiber optic hardware assembly.

2. Post-Installation Testing Phase.

A. ATP Execution Requirements.

(1) After the ATP has been accepted, submit in writing a detailed ATP schedule to MDOT for witness testing in the field. Include time and duration for each test case in the schedule.

(2) Conduct pre-testing to verify each device is performing in accordance with the

passing criteria requirements submitted with each test case, prior to scheduling formal testing with the Engineer and MDOT.

(3) Maintain an ATP progress report tracker in a tabulated format and submit to MDOT when required and at the completion of testing.

(4) Maintain signed electric and hard copies of the witness testing and submit to MDOT with the as-built documentation.

(5) Provide all required test equipment. Prior to field testing, ensure all test equipment datasheets and calibration records are submitted to MDOT for approval.

B. Burn-in Period Requirements.

(1) Begin the burn-in period at a time after FST acceptance and as approved by the Engineer. Ensure all ITS items are accepted and training requirements met prior to the start of the burn-in-period.

(2) Conduct the burn-in-period for 60 days.

(3) Maintain a failure log that records the date, time, and location of major and minor failures that occur and the corrective actions taken. Record the details of the failure and corrective action in this log. Make documentation available for inspection by the Engineer and provide to the Engineer at the end of the burn-in-period.

(4) Equipment failure reports will be generated by the Engineer and issued to the Contractor for corrective action.

(5) There may be no major failures during the burn-in-period. If one occurs, restart the 60-day period after the major failure has been corrected to the Engineer's satisfaction. The following are major failures:

(a) Less than 95 percent of entire ITS system for the project is operational at any moment.

(b) Any failure that requires more than 48 hours to correct after providing notice to the Contractor.

(c) Frequent occurrence of minor failures indicating a major system flaw, as determined by the Engineer.

(d) Any failure of routing or core network communications equipment.

(6) A minor failure is any other failure. The 60-day acceptance test period must be stopped when a minor failure occurs and restarted without resetting to zero after the minor failure is corrected to the satisfaction of the Engineer.

C. General requirements.

(1) Furnish, install and integrate all available software/firmware upgrades through final acceptance for all new devices.

d. Measurement and Payment. The completed work, as described, will be measured as a lump sum and paid for at the contract price using the following pay item.

Pay Item	**Pay Unit**
System Integration and Testing	Lump Sum

System Integration and Testing will be paid based on Table 2:

Table 2: System Integration and Testing Partial Payments

Accepted EIP and ATP	50%
FST Acceptance	85%
Final ITS Acceptance	100%

Fifty percent of the lump sum will be paid upon acceptance of the EIP and ATP by the Engineer, and completion of the mock-up if required in the Special Provision for Project Overview.

An additional 35 percent of the lump sum will be paid upon acceptance of the FST, by the Engineer. Ensure all FST's are successfully tested and satisfied per the requirements noted above. Any tests that do not pass will prevent receiving partial payment, unless otherwise approved by the Engineer.

The remaining 15 percent will be paid upon Final ITS Acceptance by the Engineer. In addition to successful completion of the burn-in test, final acceptance requires delivery of all contract deliverables, including all project documentation referenced in the Special Provision for Basic Methods and Materials for ITS work and other special provisions.

MICHIGAN
DEPARTMENT OF TRANSPORTATION

SPECIAL PROVISION
FOR
TRAFFIC SIGNAL WORK - CONSTRUCTION METHODS

SIG:EMS 1 of 2 APPR:HLO:NJB:04-29-20
FHWA:APPR:05-06-20

a. Description. This special provision is for electrical construction and/or relocation of traffic signal facilities is to be used in addition to the applicable sections of the standard specifications. In case of conflict use whichever is most restrictive.

b. Materials. Furnish new material and equipment, unless specified otherwise, and comply with sections 918 and 921 of the Standard Specifications for Construction. Materials furnished by the Department to the Contractor will be picked up by the Contractor at such site as designated by either MDOT, or the Local Agency representing MDOT, with any associated costs included in pay items as indicated on the plans and will not be paid for separately.

1. General. Provide manufacturer's certifications, in accordance with the specifications, for all wire and cable and other items or as directed by the Engineer. Do not install any wire or cable before it has been approved by the Engineer. Include statement "Materials are in accordance with the Specifications" on their material order, especially on wire and cable.

Reuse only the best of the existing material and equipment where the contract calls for reuse of existing material and equipment as directed by the Engineer. The Department will have the right to furnish the Contractor with a new part if any are found defective prior to dismantling. Any part or parts damaged by the Contractor subsequent to starting the removal are a liability of the Contractor.

Furnish the Engineer an as-built record of all underground or overhead work installed within 5 days after completion of each section of the underground conduit, cable or overhead line work. This record must include the size and length of cable and duct lines, location of the lines, handholes and manholes, and location and size of support poles. Tag and stamp all wires and cables using a brass tag indicating the source and use of the cable.

Connect the ground wire to the ground rod with a UL rated copper or bronze ground clamp.

c. Construction. All work must comply with sections 819 and 820 of the Standard Specifications for Construction, the applicable "typical" signal construction details, this special provision, and requirements of the *NEC*, *National Electrical Safety Code (NESC)*, and the Michigan Department of Licensing and Regulatory Affairs (LARA). Contact the LARA for electric service inspection and be responsible for payment of all applicable fees.

1. Maintain all existing street lighting, traffic signal, primary, transmission, communication cables, etc. circuits in an operational condition, unless otherwise noted on the plans or as directed by the Engineer.

2. In addition to subsections 104.07 and 812.03 of the Standard Specifications for

Construction, the following applies to Contractor maintenance of permanent or temporary traffic signal installations which are being worked on by the Contractor:

A. The Contractor is responsible for maintaining any portion of a traffic signal which has been worked on by the Contractor until final acceptance of that specific location.

B. If MDOT forces are required to work on an emergency traffic signal malfunction that is determined to have been caused by the work of a Contractor, the cost of the work will be the responsibility of the Contractor.

C. If vandalism occurs to equipment that is not energized, the Contractor is responsible for replacement.

3. Utility Coordination. Notify the System Operating Division of the local utility 72 hours in advance of any work on underground or overhead transmission or distribution circuits. If possible, the System Operating Division will shutdown and red tag the line by 8 a.m. for the day requested. Notify the System Operating Division when the work is complete.

Provide coordination and make arrangements, as described above, to work on traffic signal circuits.

Schedule, coordinate, install, and pay for work provided by the local utility company(s), as indicated on the plans or as directed by the Engineer. The Engineer will not authorize payment for delay caused by the Contractor's failure to properly schedule and coordinate any utility work.

4. Agency Coordination. Secure all necessary permits covering the operations, including permits from the Public Authorities having jurisdiction over the streets, or other Public Properties in which the work is located, and the improvements therein. Obtain the amount of any charges for payment, including fees or inspection charges required by such authorities, and include the cost of these fees in the bid prices.

The local traffic authority may impose restrictions regarding particular times of certain days of the week wherein the Contractor cannot perform work and may, in fact, be required to clear the area of work obstacles or construction equipment. The Contractor must take note of this and there will be no extra payment to perform the work with possible restrictions imposed. The Engineer will not authorize extra payment if the Contractor chooses to perform work during overtime status.

5. Ensure construction is performed by persons who are experienced and qualified for the work required. On-site licensed (Journeyman electrician) supervision is required for the electrical system installation (including placement of traffic loops, conduits, and/or cables in dirt, foundations, and handholes) and must be present at all times when electrical construction is in progress. Ensure the ratio of electrical journeymen or master electricians to registered apprentice electricians is on the basis of one electrical journeyman or master electrician to one registered apprentice electrician in accordance with Michigan Law section 338.883e. This ratio is to be enforced on a jobsite basis. For traffic signal work a single jobsite is defined as a single intersection or single electronic traffic control device.