19.4 Project Special Provisions

Appendix A to this Section 19 includes the Project Special Provisions that shall be applicable to the Project.

This Section sets forth modifications to the CDOT *Standard Specification for Road and Bridge Construction* for design-build projects. The first section contains revisions to Division 100 of the Standard Specifications. The second section contains revisions to Divisions 200 through 700 of the Standard Specifications, as well as Standard Special Provisions applicable to the Project.

These Contract Provisions are a revised version of CDOT's *Standard Specifications for Road and Bridge Construction*, and contain requirements generally applicable to the Work to be performed by the Contractor. In certain cases, provisions in Section 100 of the *Standard Specifications for Road and Bridge Construction* have been superseded by other provisions of the Contract Documents. For ease of reference, this document uses the same Section numbers as the *Standard Specifications for Road and Bridge Construction*, and identifies provisions of the Contract Documents that have replaced or modified the standard clauses.

All references to "Engineer" that are incorporated into this Section refer to the Contractor's Engineer, unless the context requires otherwise. Non-capitalized terms, such as "work" that are defined in Book 1, Exhibit A, shall have the meanings defined therein unless the context requires otherwise. References to "approve, approval or approved" shall mean "Approve, Approval or Approved" as defined in Book 1, Exhibit A, when the approval is by CDOT or a division of CDOT. If the interpretation(s) pursuant to this paragraph are not clear, CDOT shall decide, in its sole discretion, how these terms shall be interpreted.

When these specifications describe actions, Materials, means or methods that are required and that are qualified by phrases such as: "as directed by the Engineer", "when directed by the Engineer", "as determined by the Engineer", "with or without permission of the Engineer", "in the opinion of the Engineer", "unless authorized by the Engineer", "satisfactory to the Engineer", "as approved by the Engineer", or "unless another type is specified or is permitted with approval of the engineer", such phrases shall be disregarded. If it is not clear whether a phrase should be disregarded, CDOT will make that decision in its sole discretion.

When these specifications refer to " Department", "Resident Engineer", "Agricultural Engineer", "Bridge, Construction or Maintenance Engineer", "TMC system inspector", "Concrete Engineer", "Project Engineer", "Materials Engineer", "Commissioner", "Structural Metals Engineer", "Department's Lighting Engineer", "Geotechnical Engineer" or any other specific CDOT special engineer, such reference shall mean the CDOT Project Director.

When these specifications use the term engineer relating to the approval of any activities involving the use of explosives, such term shall mean the CDOT Project Director.

When an approval or authorization of the Engineer or CDOT is required in these specifications for the use of alternative or substituted processes or components, the Engineer shall mean CDOT. If it is not clear whether a phrase involves the use of alternative or substituted processes, CDOT will make that determination in its sole discretion.

If these specifications refer to an approval of any correction or repair that deviates from the Contract requirements, the approval must be by CDOT. If it is not clear whether a specification involves a correction or repair that deviates from the Contract requirements, CDOT will make that determination in its sole discretion.

When these specifications provide that reports, records or other documents shall be submitted to CDOT or to the Engineer, such reports shall be made available to CDOT and do not have to be submitted unless either they are otherwise listed in the deliverables in the Contract Documents, or are required shop drawings, warranties, parts lists, instruction sheets or manufacturer's drawings or specifications. Such documents shall be submitted to CDOT as required by the specifications.

When these specifications require actions, Materials, means or methods that are "either as indicated in the Plans or as designated by the Engineer," the Contractor shall disregard the phrase "or as designated by the Engineer."

When these specifications refer to the "Engineer" ordering work beyond the scope of work in the Contract, "Engineer" shall mean CDOT. Whenever in these specifications the Engineer may order work that results in additional costs to CDOT, the "Engineer" shall mean CDOT.

Any acceptances on behalf of CDOT or the State shall be performed by CDOT.

Any references to other standards, codes, or criteria, or to the latest version of other standards, codes, or criteria in Book 2 of the Contract Documents shall mean the latest version at the Proposal Due Date.

Appendix 19-A

PROJECT SPECIAL PROVISIONS FOR ITS ELEMENTS

The CDOT 2011 *Standard Specifications for Road and Bridge Construction* controls construction of this Project. The following special provisions supplement or modify the *Standard Specifications* and take precedence over the *Standard Specifications* and plans.

Revision of Section 604 – Manhole (Traffic Management System)
Revision of Section 613 – Electrical Conductor Identification
Revision of Section 613 – Electrical Conduit
Revision of Section 613 – Pull Box
Revision of Section 614 – Closed Circuit Television Pole
Revision of Section 614 – Closed Circuit Television
Revision of Section 614 – Communications Cabinet
Revision of Section 614 – Fiber Optic Cable (Single Mode)
Revision of Section 614 – Fiber Optic Splice Closure
Revision of Section 614 – Fiber Optic Pre-Connectorized Cables
Revision of Section 614 – Fiber Fan Out Kit
Revision of Section 614 – Fiber Optic Termination Panel
Revision of Section 614 – Intelligent Transportation System Pole
Revision of Section 614 – Traffic Loops at Automatic Traffic Recorder (DTD ATR) Sites
Revision of Section 614 – Microwave Vehicle Radar Detection (MVRD)
Revision of Section 614 – Optical Transceiver
Revision of Section 614 - Course Wave Division Multiplexing SFP
Revision of Section 614 – Ethernet Switch
Revision of Section 614 – Ethernet Router
Revision of Section 614 – Telemetry (Field)
Revision of Section 614 – Telemetry (Master)
Revision of Section 614 – Small Form-Factor Pluggable – 1310nm SFP

Revision of Section 614 – GPS As Builts
Revision of Section 614 – Test Fiber Optic Cable
Revision of Section 614 – Travel Time Indicator (TTI)
Revision of Section 614 – Weather Monitoring System
Revision of Section 614 – Fold-over Tower (ITS)
Revision of Section 614 – Wireless Vehicle Detection System
Revision of Section 614 – Variable Message Sign Uninterruptable Power Supply
Revision of Section 614 – Variable Message Sign (LED)(Overhead)

REVISION OF SECTION 604
MANHOLE (TRAFFIC MANAGEMENT SYSTEM)

Section 604 of the Standard Specifications is hereby revised for this project as follows:

DESCRIPTION

The Traffic Management System (TMS) manhole shall include the installation of manholes for the Traffic Management System for locations shown on the plan sheets, or as approved by the CDOT.

MATERIALS

Manhole (TMS) shall consist of a pre-cast concrete, 4-foot square vault with a base and cast iron frame ring and cover. The manhole shall be designed to provide a pre-cast conduit entrance depth of 3 foot. Each manhole, frame and cover shall conform to AASHTO HS20-44. Each Manhole shall be equipment with a removable ladder that is engineered to support 300 pounds. The ladder support shall be permanently fixed to the manhole.

CONSTRUCTION

Pre-cast manhole shall be provided with Corbels (knockouts) to accommodate six (6) 2-inch conduits which shall remain intact unless otherwise required for conduit installation. Contractor shall install conduit in order from bottom to top. Contractor shall seal all voids surrounding conduits in knockouts with epoxy. The manhole shall have a detachable cover that has a skid-resistant surface and have the words “CDOT COMM” physically impressed, (not painted) on its top. The cover shall be attached to the manhole body by screw-in bolts.

Each Manhole shall include fiber management canister hangers and cable hooks for proposed fiber. Hangers and hooks for fiber coils and splice canisters shall be of sufficient quantity for each backbone and lateral cable. Fiber optic cable coils shall be tied to each cable hook with plastic cable ties. Caution shall be taken to coil the fiber cable per the manufacture’s recommendations. If hangers are not factory installed in the manhole, bolts for attaching hangers and hooks shall be installed in the manhole walls by means of either an epoxy compound or expansion type fitting. Conduit entering manhole shall have sweeps attached so conduit entrance is elevated.

REVISION OF SECTION 613
ELECTRICAL CONDUCTOR IDENTIFICATION

Section 613 of the Standard Specifications is hereby revised for this project as follows:

Section 613.08 shall include the following:

All electrical conductors shall be tagged as follows:

Electrical conductor cable tags shall be located below the termination in the base of the street light, in the pull box, in the pedestal and at the point of termination to existing facilities of the Local Utility Company supplying electrical service. The tags shall be attached with a cable tie. The information written on the tag shall include the direction and approximate length of cable feeds running from where to, etc.

Each incoming conductor shall be individually color coded with 1 tape mark, while outgoing conductors shall have 2 tape marks.

Example:

FEEDS TO PULL BOX
50' NORTH & 75' WEST
THEN TO HIGHWAY SIGN

FEEDS FROM XFMR
250' SOUTH & 75' EAST
200' WEST

Uniform tags are available in a Tag Kit. The Tag Kit consists of: 100 tags, 3 part yellow with 1 hole, 100 black nylon ties and 1 black sharpie pen.

Size	2-1/2" X 5"
Standard Package	Kit
Weight, Kit, Approx.	1.5 Pounds
Color	Yellow

REVISION OF SECTION 613
ELECTRICAL CONDUIT

Section 613 of the Standard Specifications is hereby revised for this project as follows:

DESCRIPTION

This work includes furnishing and installing either (HDPE) High Density Polyurethane or PVC electrical conduit. All materials furnished, assembled, fabricated and installed under this item shall be new, corrosion resistant and in strict accordance with the plan sheets and these Special Provisions.

MATERIALS

All conduits shall be 2 Inch, Schedule 80 in diameter and shall be compliant with all ASTM and Bellcore TW-NWT-000356 requirements.

All HDPE conduit shall be factory lubricated, low friction, high-density conduit constructed of virgin high-density polyethylene resin. Conduit shall be capable of being coiled on reels in continuous lengths, transported, stored outdoors, and subsequently uncoiled for installation, without affecting its properties or performance.

PVC conduit shall be certified by the manufacturer as meeting ANSI/UL 6 and 651. The manufacturer shall be ISO 9000 compliant.

CONSTRUCTION REQUIREMENTS

Electrical Conduit (Bored) shall be HDPE and installed using a trenchless technology of either jacked conduit or directional boring.

Electrical Conduit (Plastic) shall be PVC or HDPE and installed by direct burial methods such as plowing, open trenching, or other excavation methods. When PVC is used, expansion fittings shall be installed at 100’ intervals.

One conduit per bundle shall have a copper tracer wire of at least 12-gauge in a single conduit. In trenches containing multiple conduits, the tracer wire shall not be installed in the same conduit as the fiber.

Each individual conduit shall be equipped with a pull tape of 1250 pounds tensile strength and be of a design to prevent cutting or burning of conduit walls during cable installation.

The Contractor has the option of using pull tape in all conduit installations, irrespective of length.

The installation of conduit shall be performed in such a manner as to avoid unnecessary damage to streets, sidewalks, utilities, landscaping, and sprinkler systems. Excavations and conduit installation shall be performed in a continuous operation. All trenches shall be backfilled by the end of the work day. The material from trenching operations shall be placed in a location that will not cause damage or obstruction to vehicular or pedestrian traffic or interfere with surface drainage.

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REVISION OF SECTION 613
ELECTRICAL CONDUIT

The Contractor shall take all necessary precautions to avoid heaving any existing asphalt/concrete mat or over-excavating a trench, whether caused by equipment directly or by dislodging rocks and boulders. Any such heaving or over-excavation shall be repaired or replaced at the Contractor's expense. The Contractor shall bear the cost of backfilling all over-excavated areas with the appropriate backfill material as approved by the Engineer.

The Contractor shall restore all surface materials to their preconstruction condition, including but not limited to pavement, sidewalks, sprinkler systems, landscaping, shrubs, sod, or native vegetation that is disturbed by the conduit installation operation. All repairs shall be included in the cost of the conduit.

Any coupling technology shall allow the conduit to be connected without the need for special tools, and shall form a watertight, airtight seal. Breaking force between segments shall exceed 250 pounds of force. No metal fittings shall be allowed. No elevation difference between the conduit run and the splice location will be allowed. Conduit splices shall be kept to a minimum and all locations shall be approved by the Engineer. Additional pull boxes shall not be substituted for splices.

Conduit plugs shall be supplied and installed in all conduit ends as soon as the conduit is installed. Conduit shall be plugged at all termination points such as pull boxes, manholes, controller cabinets, and regen building. Conduits containing cable shall be plugged with durable and reusable split type plugs, fabricated without metallic parts, and allow easy removal and reinstallation around in-place cables. Split type plugs shall provide a water and air-tight seal of at least 50 psi and shall be installable by hand without using special tools and without damaging the cable. All plugs shall be correctly sized to fit the conduit being plugged. Empty conduits shall be sealed with removable type duct plugs that provide a watertight barrier.

All conduits shall use sweeps to elevate the buried conduits to within 4 inches of the bottom of the pull box or manhole, as shown in project details. The sweeps shall be terminated within the pull boxes and manholes to allow for easy installation and removal of the conduit plugs. The sweeps shall be set above the ground surface within the pull box at a height that does not interfere with the coiling of the fiber optic cable.

All conduit runs containing fiber optic cable shall have a limited number of bends. The sum of the individual conduit bends on a single conduit run between two pull boxes shall not exceed 360°. The preferred limit is 270°. No individual bend shall be greater than 90°. All conduit bends shall have a minimum acceptable radius. The minimum radius for 90° bends is 48 inches, and the minimum radius for all other bends is 24 inches.

If new conduits are installed in existing pull boxes, manholes or cabinet bases the Contractor shall carefully excavate around the pull box or manhole and install the new conduit as shown in the plans. The Contractor shall not damage the existing pull box, manhole or their contents. If the existing pull box, lid, or the concrete collars are cracked or damaged during conduit installation, the Contractor shall restore the damaged section to preconstruction condition at no additional cost.

REVISION OF SECTION 613
PULL BOXES

Section 613 of the Standard Specifications is hereby revised for this project as follows:

DESCRIPTION

Contractor shall furnish and install fiberglass reinforced, polymer concrete pull boxes.

MATERIALS

Pull boxes installed in dirt or landscaped areas shall have a concrete apron with 3 sides, 12 inches wide by 6 inches deep and a top side of 18 inches wide by six inches deep for marker installation. Pull boxes shall not be installed above the grade of the apron. Concrete apron shall have a 1% slope away from the top of pull box. All concrete aprons shall be Class B and shall be in accordance with Section 601. Pull boxes 24 inches and wider shall have split lids with a removable support brace. Each pull box shall have a locator disk manufactured into the lid that operates at the frequency of 101.4 kHz for communication line locating. The locator disk shall be compatible with a Dynatel cable locator.

Pull boxes shall have a detachable cover with a skid-resistant surface and have the words "CDOT COMM" cast into the surface. Painting of words shall not be accepted. The cover shall be attached to the pull box body by means of 3/8 x 7 inch lag head stainless steel hex head bolts and shall have two (2) lift slots to aid in the removal of the lid.

Wire mesh shall be installed in a manor to completely surround the box. The wire mesh shall meet the material standard ANSI/ASTM A555-79 and made of T-304 stainless steel, 0.025 inch wire diameter minimum and shall have a spacing of 12 mesh per inch.

Pull boxes shall be verified by a 3rd Party Nationally Recognized Independent Testing Laboratory as meeting all test provisions of ANSI/SCTE 77 2007 Specification for Underground Enclosure Integrity, Tier 22 rating. Pull boxes shall be UL listed. Certification documents shall be submitted with material submittals.

CONSTRUCTION

A minimum of 12 inches of ¾ inch granite-gravel shall be installed as a base for the pull box to aide in drainage. The ¾ inch granite-gravel shall be free of dirt and debris and spread evenly to facilitate a level base for the pull box. The Contractor shall ensure that sufficient compacting is made prior to the installation of ¾ inch granite-gravel to help alleviate future settling.

Wire mesh shall be installed in a manor to completely surround the box. The wire mesh shall be installed prior to the installation of the pull box above the bed of 3/4" granite-gravel and extending one foot past the outer edges of the concrete apron. The wire mesh shall be gently cut to allow only the entrance of the conduit at the bottom of the box. Any openings cut in the wire mesh larger than the diameter of the conduit shall be remedied by the installation of additional wire mesh to obtain a completely sealed pull box enclosure.

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REVISION OF SECTION 613
PULL BOXES

Pull Box (Surface Mounted) shall be aluminum type with a hinged front door and have at least a NEMA 3R rating. The hinged door shall be provided with both a weather tight seal and an aluminum hasp. Surface mounted pull boxes shall be of the dimensions shown in the plans, and shall be mounted on or embedded into hard surfaces such as bridge decks, concrete barriers, retaining walls, or buildings, as shown on the plans. Surface mounted pull boxes shall be attached using ⅜-inch epoxy anchors or other methods, as approved by the Engineer. Surface mounted pull boxes shall not be used for ground installations.

REVISION OF SECTION 614
CLOSED CIRCUIT TELEVISION POLE WITH LOWERING DEVICE

DESCRIPTION

This work consists of furnishing and installing closed circuit television poles for the mounting of various Intelligent Transportation Systems (ITS) devices and communications cabinets. This work shall be done in accordance with these specifications, the latest AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals, 5th Edition, with current interims (Sign Code), and in conformity with the details shown on the plans.

This work includes the installation of a single tapered tubular steel post, a lowering system for a closed circuit television (CCTV) camera, and a concrete caisson foundation at the location shown on the plans. Lowering device shall allow closed circuit television cameras to be lowered to five feet above ground for maintenance purposes without interfering with any other pole-mounted devices or cabinets. Lowering device cables shall be contained inside the pole.
MATERIALS

(a) Poles. Tapered tubular steel posts shall conform to the requirements of ASTM A595 Grade A or ASTM A572 Grade 55. Bars and plates shall conform to AASHTO M-270. Anchor bolts shall conform to ASTM F1554 Grade 55. All steel shall be galvanized in accordance with AASHTO M-111 (ASTM A123), except fasteners shall be galvanized in accordance with AASHTO M-232 (ASTM A153). Shop drawings shall be submitted in accordance with Section 105.02.

(b) Lowering device. The camera lowering system shall be designed to support and lower a standard CDOT closed circuit television camera (as described in the Contract), lens, housing, Pan-Tilt-Zoom mechanism, cabling, connectors and other supporting field components without damage or causing degradation of camera operations. The Contractor shall ensure that the camera lowering system device and the pole are compatible. The lowering system shall consist of a pole, suspension contact unit, divided support arm, a pole adapter for attachment to a pole one foot from the top, pole top junction box conduit mount adapter, camera connection box and shall lock into place to prevent shaking of the camera. The divided support arm and receiver brackets shall be designed to self-align the contact unit with the pole center line during installation and insure the contact unit cannot twist under high wind conditions. Square support arms are not acceptable. The camera-lowering device components and arm shall be designed in accordance with the Sign Code for 110 mph wind velocity (3-Second Gust). The lowering device manufacturer shall be able to identify a minimum of three previous projects where the purposed system has been installed successfully.

The suspension contact unit shall have a load capacity 600 pounds with a 4 to 1 safety factor. There shall be a locking mechanism between the fixed and moveable components of the lowering device. The movable assembly shall have a minimum of two latches. This latching mechanism shall securely hold the device and its mounted equipment. The latching mechanism shall operate by alternately raising and lowering the assembly using the winch and lowering cable. When latched, all weight shall be removed from the lowering cable. The fixed unit shall have a heavy duty cast tracking guide and means to allow latching in the same position each time. The contact unit housing shall be weatherproof with a gasket provided to seal the interior from dust and moisture.

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REVISION OF SECTION 614
CLOSED CIRCUIT TELEVISION POLE WITH LOWERING DEVICE

The prefabricated components of the lift unit support system shall be designed to preclude the lifting cable from contacting the power or video cabling. The lowering device manufacturer shall provide a conduit mount adapter for housing the lowering cable. This adapter shall have an interface to allow the connection of a Contractor provided 1.50 inch PVC conduit and be located just below the cable stop block at the back of the lowering device. The Contractor shall supply internal conduit in the pole as directed by the Lowering Device provider. The only cable permitted to move within the pole or lowering device during lowering or rising shall be the stainless steel lowering cable. All other cables must remain stable and secure during lowering and raising operations.

The female and male socket contact halves of the connector block shall be made of materials rated for outdoor use and extreme temperature ranges. The female socket contacts and the male pin contacts shall be copper plated with nickel and gold.

The current carrying male contacts shall be 12 gauge (1/10 inch in diameter). There shall be four alignment contacts that are longer than the rest which will mate first and break last providing optimum grounding performance. The number of contacts shall be 16 and the camera mounted thereto, shall be capable of performing all of its necessary functions on 16 contacts or less.

The current carrying female socket contacts shall be 12 gauge (1/10 inch in diameter). The female socket contacts shall be spring-loaded to provide positive mating.

A composite cable (video, data and power) will be potted and sealed into each half of the connector block.

The composite cable will be a continuous run of cable from the top of the pole to the field cabinet or other junction box. No pole top splices will be allowed. The composite cable from the bottom connector will feed into the camera junction box or directly to the camera. The coaxial cable will be provided with BNC connectors.

All pulleys for the camera lowering device and portable lowering tool shall have sealed, self-lubricated bearings, oil tight bronze bearings, or sintered- oil impregnated, bronze bushings. The lowering cable shall be a minimum 1/8-inch diameter stainless steel aircraft cable with a minimum breaking strength of 1740 pounds with seven strands of 19 wires each.

All electrical and video coaxial connections between the fixed and lower able portion of the contact block shall be protected from exposure to the weather by a waterproof seal to prevent degradation of the electrical contacts. The electrical connections between the fixed and movable lowering device components shall be designed to conduct high frequency data bits and 1 volt peak-to-peak video signals as well as the power requirements for operation of dome environmental controls.

The interface and locking components shall be made of stainless steel and or aluminum. All external components of the lowering device shall be made of corrosion resistant materials,

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REVISION OF SECTION 614
CLOSED CIRCUIT TELEVISION POLE WITH LOWERING DEVICE

powder coated, galvanized, or otherwise protected from the environment by industry-accepted coatings to withstand exposure to a corrosive environment.

(c) Foundation. Concrete for caisson foundations shall Class BZ and shall conform to the requirements of Section 601. Reinforcing steel shall conform to the requirements of Section 602.

CONSTRUCTION

The lowering device manufacturer shall furnish the Contractor an on-site factory trained representative. The manufacturer shall furnish the CDOT engineer documentation certifying that the electrical contractor has been instructed on the installation, operation and safety features of the lowering device. The manufacturer shall provide CDOT personnel with the same on-site 6 hour training session on the use of the lowering device.

The Contractor shall ensure that the camera will provide weights and /or counterweights as necessary to assure that the alignment of pins and connectors are proper for the camera support to be raised into position without binding. The lowering unit will have sufficient weight to disengage the camera and its control components in order that it can be lowered properly.

The Contractor shall ensure that the camera will provide the power and signal connectors for attachment to the bare leads in the pole top and/or camera junction boxes.

Caisson foundations shall be installed in accordance with Section 503.

All costs associated with arranging for the manufacturer's representative to be on-site will not be measured and paid for separately, but shall be included in the work.

All costs for the caisson will be measured and paid for separately in accordance with Section 503 under pay item 503- Drilled Caisson.

All costs for the camera, traffic detectors and cabinet will be measured and paid for separately in 614- CCTV and 614-Comm Cabinet.

REVISION OF SECTION 614
CLOSED CIRCUIT TELEVISION

Section 614 of the Standard Specifications is hereby revised for this project to include the following:

DESCRIPTION

This work consists of furnishing and installing an Internet Protocol (IP) Closed Circuit Television (CCTV) camera at the locations shown on the Plans.

MATERIALS

The CCTV camera shall include the camera with weatherproof dome housing, pole mount adapter, Power over Ethernet (PoE) midspan module, manufacturer supplied management software, Cat-6 Ethernet cables, and all attachment hardware to complete installation.

Camera Specifications –
The pan-tilt-zoom camera shall be of dome type construction and shall be enclosed in a sealed, heated environmental video dome housing to operate in 93% humidity at a minimum operating temperature of -40° to 122°F carrying both IP66 and NEMA 4x ratings. The camera shall utilize Ethernet protocol for native communications and be capable of sending multiple individually configurable video streams in H.264 and MJPEG format up to 30fps and capable of gathering a minimum of 50 preset color video still frame images with a minimum 176x120 resolution and maximum 704x480. The camera shall have an internal web interface for configuration with security functionality allowing multiple user access levels with password protection. The camera shall support Ipv4/v6, HTTP, HTTPS, SSL/TSL, QOS Layer 3 DiffServ, FTP, SMTP, SNMP v1/2/3, UpnP, DNS, DynDNS, NTP, RTSP, TCP, UDP, IGMP, RTCP, ARP, SOCKS.

Technical specifications for the camera shall be as follows:

- The lens shall be f=3.4 to 119mm, F1.4 to 4.2, autofocus; focus range of 35 mm (wide) to 800 mm (telephoto) to infinity. The angle of view shall be 2.8°- 48° horizontal with minimum zoom capability of 35x optical and 12x digital
- Minimum illumination color 0.5 lux at 30 IRE and B/W 0.005 lux at 30 IRE
- The camera shall provide dual mode, day (color) and night (monochrome) video down to 0.008 lux
- Shutter speed shall be variable from 1/30000 to 0.5 seconds at 60Hz.
- The pan function shall provide 360° of continuous rotation at 0.05 – 450°/s and a 220° tilt range allowing for 20° view above the horizon at 0.05 – 450°/s

Pole mount adapter arm and bracket -
The adapter shall have a minimum 33 lb load rating and have provisions that allow mounting directly to the weatherproof dome housing without modification to the housing. The adapter bracket shall have slots for a minimum of 2 straps or banding material for mounting to the poles from 3 inches to 6 inches in diameter. The bracket shall have cable strain relief in at least two locations on the reverse side, (between the bracket and the pole).

PoE midspan module-
Power for the camera shall be by means of a high power over Ethernet midspan module with a pass through port for all Ethernet communications. The module shall meet IEEE 802.3at and 802.3af standards and operate at temperatures from -40°F to +122°F. The PoE module shall

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REVISION OF SECTION 614
CLOSED CIRCUIT TELEVISION

allow 100-240 VAC input and 55 VDC output at 60W and operate at temperatures from -40°F to +122°F.

Manufacturer's supplied management software-
Management software shall give the user access to discover and configure the camera using standard network protocols. Software shall allow for network setup and firmware updates.

Cat6 Ethernet cable-
Cable shall be a UTP cable, Category 6 rated and constructed of 24 AWG stranded copper wires. The outer jacket shall be UV resistant PVC insulation. The Ethernet cable shall be terminated with male 8P8C connectors as a 'straight through' cable using the Telecommunications Industry Association / Electronic Industries Alliance (TIA/EIA) T- 568B pin/pair assignments.

CONSTRUCTION REQUIREMENTS

The CCTV camera shall be installed in accordance with these specifications, the details shown in the Plans, and in accordance with manufacturer's recommendations. The Contractor shall make all arrangements for a qualified manufacturer's representative to be on-site to ensure proper installation of the CCTV camera.

The weatherproof dome housing shall be attached to the pole mount adapter using the materials supplied from the manufacturer.

For the attachment of the adapter bracket to the pole, a ¾ inch type 201 stainless steel strap used in conjunction with type 201 stainless steel buckles at a mounting height shown on the Plans. The attachment shall be banded to the pole at an orientation to achieve the optimal view of both the main roadway and crossroad or as directed by the Engineer.

A maximum 1 inch hole shall be drilled in the mounting pole to allow passage of the Ethernet cable. The hole shall be free of burs and sharp edges prior to the installation of the Ethernet cable. The Ethernet cable shall be attached to the reverse side of the mounting bracket to ensure proper strain relief or damage caused to the camera or housing. The Ethernet cable shall run down the interior of the pole and exit through non-metallic flexible conduit to the communication cabinet. The non-metallic flexible conduit shall be weather sealed on each end to eliminate exterior liquid entry. The Contractor shall also provide a weather seal for the adapter bracket at the 1 inch hole at the top of the pole per the manufacturer's recommendations.

The PoE midspan module shall be securely mounted in the communication cabinet and plugged

~~REVISION OF SECTION 614~~
~~COMMUNICATIONS CABINET~~

~~Section 614 of the Standard specifications is hereby revised for this project as follows:~~

~~Subsection 614.01 shall include the following:~~

~~Communications cabinet shall be furnished and installed at designated Intelligent Transportation System (ITS) field device sites to house and protect electrical power components, DIN rails, field equipment, serial servers, communications telemetry equipment and fiber optic termination panels.~~

~~Subsection 614.08 (c) shall be deleted and replaced with the following:~~

~~Communications cabinets shall be UL 508A *Industrial Control Panels* listed and conform to a NEMA Type 4X[1] rating. Communications cabinets shall be constructed of 0.125 inch Type 5052 H-32 aluminum conforming to the requirements of ASTM B209 *Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate*. The dimensions shall be as shown in Table 1 below.~~

~~Table 1 - Communications Cabinet Types~~

~~Communications Cabinet~~	~~Dimensions~~	~~Maximum Weight (w/o back panel)~~
~~Type 2~~	~~36" (h) × 24" (w) × 12" (d)~~	~~35 lb~~

~~All fabricated materials and added components must be free from burrs and sharp edges. Exterior seams of the cabinet shall be continuously welded with edges ground smooth to a 0.03 inch radius. All welding shall be done with gas tungsten arc welds that comply with AWS B2.1-22-015 *Standard Welding Procedure Specification for Gas Tungsten Arc Welding of Aluminum* and C5.6 *Recommended Practices for Gas Metal Arc Welding*. All welds shall be neatly formed and free of blisters, blowholes, cracks and other irregularities. All bolts, clamps, fasteners, hinges, latches, nuts and screws shall be stainless steel, unless an alternative corrosion proof material is approved in writing by the Department.~~

~~The cabinet door opening shall be designed to prevent dust and moisture intrusion in conformance to NEMA 4X requirements. All flange joints shall be welded or continuously formed. The door shall have an adequately sized, oil-resistant gasket that provides a uniform seal with the door frame surface in conformance with NEMA 4X requirements and shall be permanently bonded to the door. The door shall utilize a continuous stainless steel hinge that allow for door removal from the hinge side. Hinges shall be mounted such that the cabinet door opens out to the left, unless otherwise specified on the Plans, Project Details or as specified by~~

[1] ~~Enclosures constructed for either indoor or outdoor use to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (windblown dust); to provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (rain, sleet, snow, splashing water, and hose directed water); that provides an additional level of protection against corrosion; and that will be undamaged by the external formation of ice on the enclosure.~~

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~~**REVISION OF SECTION 614**~~
~~**COMMUNICATIONS CABINET**~~

~~the Department. Hinges shall be mounted with appropriately sized stainless steel hardware. The door shall be equipped with a hasp and staple for padlocking and Corbin #2 key lock be utilized in place of the hasp and staple if the NEMA 4X rating can be maintained. A document holder constructed of high-impact thermoplastic shall be provided for each communications cabinet and permanently mounted to the lower portion of the inside door. The Contractor shall insert a copy of the communications cabinet Bill of Materials (BOM), individual communications cabinet component specification sheets and an as built electrical/low-voltage wiring diagram of the communications cabinet in the document holder.~~

~~Each communications cabinet, designated for mounting on a pole, shall include a pole mounting kit suitable for pole diameters ranging from 7-12 inches. Each pole mounting kit shall include channel bars (for attachment to factory mounting holes on the back of the communications cabinet), pole shims (to prevent cabinet movement against pole), stainless steel straps and all other associated mounting and sealing hardware. The channel bars, pole shims and associated mounting hardware shall be manufactured from either galvanized steel or stainless steel. Mounting holes on the back of the communications cabinet shall be installed at the factory (communications cabinet Manufacturer) to assure NEMA 4X integrity along with all factory-recommended mounting and sealing hardware. Field installation or modification of mounting holes shall be prohibited.~~

~~Each communications cabinet shall have tapped pads to provide for the mounting of a back panel as specified herein.~~

~~Two conduit access holes shall be made on the bottom of the communications cabinet for electrical wiring, specific field device low-voltage control cabling, waveguides and fiber optic cabling, as applicable for each communications cabinet application. The conduit access holes shall be sized and positioned at locations shown in the Project Details to ensure the proper, safe routing of cabling entering the cabinet. The holes shall be free of burrs and sharp edges prior to the installation of LFMC, fittings and nipples. Conduit access holes and appropriate sealing strategies to maintain a NEMA 4X integrity shall be performed at the factory and no field installation or modification of the conduit access holes shall be permitted.~~

~~Back Panels~~
~~Back panels shall be constructed of 0.10 inch Type 5052-H32 aluminum alloy, unless otherwise specified by the Department. One back panel and associated mounting hardware shall be included with each communications cabinet and be rated for use in NEMA 4X cabinets. The back panel shall be not less than 27 inches (h) × 21 inches (h) and protected on one side with a plastic film. The back panel shall be mounted within the communications cabinet with a minimum of four screws.~~

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~~REVISION OF SECTION 614 COMMUNICATIONS CABINET~~

~~Outlet Box~~

~~Each communications cabinet shall contain a 4 inch square junction box attached to the back panel as shown in the Project Details. Each junction box shall be constructed of drawn or welded steel and have a minimum depth of 1.25 inches. Each junction box shall include knockouts and clamps for conduit and cables, as appropriate. Steel box covers shall be provided with each junction box as appropriate for the specific communications cabinet application, e.g., duplex receptacles and/or duplex GFCI receptacles.~~

~~Duplex NEMA 5-15R receptacles shall be provided within the outlet box as specified in the Project Details. NEMA 5-15R receptacles shall be rated for 125 VAC, 0.5 HP and 15 A. It shall be of commercial grade quality and be manufactured from high strength nylon. NEMA 5-15 receptacles shall have two poles, three wires and include a self grounding strap to insure ground contact.~~

~~Duplex NEMA 5-15R GFCI receptacles shall be provided within the outlet box as specified in the Project Details. NEMA 5-15R GFCI receptacles shall be rated for 125 VAC, 0.5 HP and 15 A. It shall be of commercial grade quality and manufactured from high strength nylon. NEMA 5-15R GFCI receptacles shall have two poles, three wires, a manual reset button and a self-test button.~~

~~Both duplex NEMA 5-15R and duplex NEMA 5-15R GFCI receptacles shall be UL listed.~~

~~Power Strip~~

~~Furnish and install one back panel mounted power strip with six front facing NEMA Type 5-15R outlets. Mounting location shall be as shown in the Project Details. The power strip shall be rated for 15 A at 120 VAC. It shall have an energy rating of 630 Joules, clamping voltage of 500 V and EMI/RFI noise filter of 150 KHz to 100 MHz at up to 43 dB. The power strip shall have a recessed power switch and a power cord of not less than 2.5 feet.~~

~~Power Conditioner~~

~~The power conditioner shall be designed for outdoor use, support an operating temperature range of -40°F to +165°F, be operational in humidity levels of 0% to 95% (non-condensing) and operate at an altitude ranging from sea level to two miles above sea level. It shall utilize an input voltage of 120 VAC, 40 to 70 Hz and an output voltage of 120 VAC (± 3%), user selectable 50 to 60 Hz (± 0.25%). The power conditioner shall support an output current of 4.8 A (400 W/570 VA). It shall have a total harmonic distortion not exceeding 3.0%. The power conditioner shall utilize input and output electrical connectors conforming to the IEC 60320-1 *Appliance Couplers for Household and Similar General Purposes* specification. Its dimensions shall not exceed 1.7 inches (h) × 11 inches (w) × 8.5 inches depth and its weight shall not exceed 5 lbs. One power conditioner shall be provided with each communications cabinet.~~

~~DIN Rails~~

~~Each communications cabinet shall utilize standard 1.38 inch DIN rails. The DIN rails shall be of steel construction with a coating for corrosion resistance. The DIN rails shall utilize 0.25 inch~~

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~~**REVISION OF SECTION 614**~~
~~**COMMUNICATIONS CABINET**~~

~~× 0.71 inch slots for fastening to the back panel located in each communications cabinet. The spacing of the DIN rail slots shall be 0.98 inch center-to-center. DIN rails and associated~~

~~mounting hardware for attachment to the back panel shall be provided with each communications cabinet in the lengths and quantities specified in the Project Details.~~

~~**12 VDC Power Supply**~~
~~The 12 VDC power supply shall support an input voltage range of 85-264 VAC and frequency range of 47-63 Hz. It shall have a typical efficiency of at least 76% and typical AC current of 1.6 A at 115 VAC. The 12 VDC power supply shall provide an output voltage of 12 VDC and have a current rating of 6.3 A. It shall support an output current range of 0 to 6.3 A and have a rated power of 75 W. The 12 VDC power supply shall have overload protection of 105-150% for its rated output power and overvoltage protection for voltages of 15-16.5 VDC. It shall be designed for an operating temperature of +14°F to +140°F and humidity levels of 20% to 90% (non-condensing). The 12 VDC power supply shall conform to the following standards: IEC 60068-2-6 *Environmental Testing (Vibration)* and UL 508 *Industrial Control Equipment*. It shall be DIN rail mountable, have dimensions not exceeding 5 inches (h) × 2.25 inches (w) × 4 inches (d) and a weight of not more than 1.5 lb. One 12 VDC power supply shall be provided with each communications cabinet.~~

~~**Warranty**~~
~~The communications cabinet manufacturer shall affix a permanent label on the inside of the door that identifies the cabinet type, date of manufacture, warranty expiration date and manufacturer's name. The warranty expiration date shall be expressed in the (mm/dd/yyyy) format. The warranty shall cover all communication cabinet materials and workmanship, including pole mounting kits, for two (2) years after delivery of each communication cabinet.~~

REVISION OF SECTION 614
COMMUNICATIONS CABINET

Section 614 of the Standard specifications is hereby revised for this project as follows:

Subsection 614.01 shall include the following:

Communications Cabinet shall be a Caltran 336S furnished and installed at designated Intelligent Transportation System (ITS) field device sites to house and protect electrical power components, DIN rails, field equipment, serial servers, communications telemetry equipment and fiber optic termination panels. All ITS Communication Cabinets shall include a raised polymer concrete or poured concrete base.

Subsection 614.08 (c) shall be deleted and replaced with the following:

Communications cabinets shall be UL 508A *Industrial Control Panels* listed and conform to a NEMA Type 3R[2] rating. Communications cabinets shall be H-32 aluminum conforming to the requirements of ASTM B209 *Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate*.

All fabricated materials and added components must be free from burrs and sharp edges. Exterior seams of the cabinet shall be continuously welded with edges ground smooth to a 0.03 inch radius. All welding shall be done with gas tungsten arc welds that comply with AWS B2.1-22-015 *Standard Welding Procedure Specification for Gas Tungsten Arc Welding of Aluminum* and C5.6 *Recommended Practices for Gas Metal Arc Welding*. All welds shall be neatly formed and free of blisters, blowholes, cracks and other irregularities. All bolts, clamps, fasteners, hinges, latches, nuts and screws shall be stainless steel, unless an alternative corrosion proof material is approved in writing by the Department.

The cabinet door openings shall be designed to prevent dust and moisture intrusion in conformance to NEMA 3R requirements. All flange joints shall be welded or continuously formed. The doors shall have an adequately sized, oil-resistant gasket that provides a uniform seal with the door frame surface in conformance with NEMA 3R requirements and shall be permanently bonded to the door. The door shall utilize a continuous stainless steel hinge that allow for door removal from the hinge side. Hinges shall be mounted such that the cabinet door opens out to the left, unless otherwise specified on the Plans, Project Details or as specified by the Department. Hinges shall be mounted with appropriately sized stainless steel hardware. The door shall be equipped with a hasp and staple for padlocking and Corbin #2 key lock be utilized in place of the hasp and staple if the NEMA 3R rating can be maintained. A document holder constructed of high-impact thermoplastic shall be provided for each communications cabinet and permanently mounted to the lower portion of the inside door. The Contractor shall insert a copy of the communications cabinet Bill of Materials (BOM), individual communications cabinet component specification sheets and an as built electrical/low-voltage wiring diagram of the communications cabinet in the document holder.

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REVISION OF SECTION 614
COMMUNICATIONS CABINET

Each communications cabinet shall have tapped pads to provide for the mounting of a back panel as specified herein.

Conduit accesses into the cabinet for electrical wiring, specific field device low-voltage control cabling, waveguides and fiber optic cabling, shall be plugged with a manual plug (no foam sealant is allowed). The cabinet base shall be filled with ¾" gravel or poured as a concrete base.

[2] Enclosures constructed for either indoor or outdoor use to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (falling dirt); to provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (rain, sleet, snow); and that will be undamaged by the external formation of ice on the enclosure.

Cabinet layout
Each Communications Cabinet shall be physically divided into two (2) sides by an aluminum back panel that is adjustable in the cabinet depth. Side "A" will house the power and fiber resources, such as: 120V main power feeding the cabinet, the Clary power conditioner, 6-oulet power strip, equipment power supplies, the fiber termination panel and slack fiber. Side "B" will house a duplex GFI convenience outlet, all associated ITS electronics and communication device hardware.

Back Panels (Side A and B)
Back panels shall be constructed of 0.10 inch Type 5052-H32 aluminum alloy, unless otherwise specified by the Department. Two back panels and associated mounting hardware shall be included with each communications cabinet and be rated for use in NEMA 3R cabinets. The back panel shall be approximately 1-inch less than the inside dimensions. The back panel shall be mounted within the communications cabinet with a minimum of four screws on an adjustable sliding channel.

Outlet Box (Side A and B)
The communications cabinet shall contain a 4 inch square junction box attached to the back panel of Side A and near the door opposing the external service disconnect on side B. Each junction box shall be constructed of drawn or welded steel and have a minimum depth of 1.25 inches. Each junction box shall include knockouts and clamps for conduit and cables, as appropriate. Steel box covers shall be provided with each junction box as appropriate for the specific communications cabinet application, e.g., duplex receptacles and/or duplex GFCI receptacles.

A duplex NEMA 5-15R receptacle shall be provided within the outlet box opposing the external service disconnect. NEMA 5-15R receptacles shall be rated for 125 VAC, 0.5 HP and 15 A. It shall be of commercial grade quality and be manufactured from high strength nylon. NEMA 5-15 receptacles shall have two poles, three wires and include a self-grounding strap to insure ground contact.

Duplex NEMA 5-15R GFCI receptacles shall be provided within the outlet box mounted to the backplane of side A. NEMA 5-15R GFCI receptacles shall be rated for 125 VAC, 0.5 HP and 15 A. It shall be of commercial grade quality and manufactured from high strength nylon.

Both duplex NEMA 5-15R and duplex NEMA 5-15R GFCI receptacles shall be UL listed.

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REVISION OF SECTION 614
COMMUNICATIONS CABINET

Power Conditioner (Side A)
The power conditioner shall be a Clary SP400U Universal Power Conditioner. The power conditioner shall be designed for outdoor use, support an operating temperature range of -40°F to +165°F, be operational in humidity levels of 0% to 95% (non-condensing) and operate at an altitude ranging from sea level to two miles above sea level. It shall utilize an input voltage of 120 VAC, 40 to 70 Hz and an output voltage of 120 VAC (± 3%), user selectable 50 to 60 Hz (±

0.25%). The power conditioner shall support an output current of 4.8 A (400 W/570 VA). It shall have a total harmonic distortion not exceeding 3.0%. The power conditioner shall utilize input and output electrical connectors conforming to the IEC 60320-1 *Appliance Couplers for Household and Similar General Purposes* specification. Its dimensions shall not exceed 1.7 inches (h) × 11 inches (w) × 8.5 inches depth and its weight shall not exceed 5 lbs. One power conditioner shall be provided with each communications cabinet.

An integral component of the power conditioner shall be a factory-installed power strip. The power strip shall have six front facing NEMA Type 5-15R outlets. The power strip shall be rated for 15 A at 120 VAC. It shall have an energy rating of 630 Joules, clamping voltage of 500 V and EMI/RFI noise filter of 150 KHz to 100 MHz at up to 43 dB. The power strip shall have a recessed power switch and a power cord of not less than 2.5 feet. The dimensions of the power strip shall be 10 inches (L) × 1.63 inches (W).

DIN Rails (Side A and B)

Each communications cabinet shall utilize standard 1.38 inch DIN rails. The DIN rails shall be of steel construction with a coating for corrosion resistance. The DIN rails shall utilize 0.25 inch × 0.71 inch slots for fastening to the back panel located in each communications cabinet. The spacing of the DIN rail slots shall be 0.98 inch center-to-center. DIN rails and associated mounting hardware for attachment to the back panel shall be provided with each communications cabinet in the lengths and quantities specified in the Project Details.

12 VDC Power Supply (Side A)

The 12 VDC power supply shall support an input voltage range of 85-264 VAC and frequency range of 47-63 Hz. It shall have a typical efficiency of at least 76% and typical AC current of 1.6 A at 115 VAC. The 12 VDC power supply shall provide an output voltage of 12 VDC and have a current rating of 6.3 A. It shall support an output current range of 0 to 6.3 A and have a rated power of 75 W. The 12 VDC power supply shall have overload protection of 105-150% for its rated output power and overvoltage protection for voltages of 15-16.5 VDC. It shall be designed for an operating temperature of +14°F to +140°F and humidity levels of 20% to 90% (non-condensing). The 12 VDC power supply shall conform to the following standards: IEC 60068-2-6 *Environmental Testing (Vibration)* and UL 508 *Industrial Control Equipment*. It shall be DIN rail mountable, have dimensions not exceeding 5 inches (h) × 2.25 inches (w) × 4 inches (d) and a weight of not more than 1.5 lb. One 12 VDC power supply shall be provided with each communications cabinet.

Service Disconnect

Each service disconnect shall be readily accessible and installed on the exterior of the cabinet close to the door so that the center of the grip of the operating handle of

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REVISION OF SECTION 614
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the circuit breaker, when in its highest position, is not more than 6 feet 7 inches above the ground or as required per Article 240.24 of the NEC. The neutral from the power source or service enclosure shall be connected to the ground bar in the service disconnect. The ground bar shall be connected to the service disconnect using a bonding strap. The ground bar shall

be connected to a grounding electrode using grounding conductors conforming to the requirements of Article 250.122 of the NEC. The grounding electrode shall conform to the requirements of Articles 250.52 through 250.70 of the NEC. The service disconnect shall feed a duplex NEMA 5-15R mounted on the inside of the cabinet.

Warranty
The communications cabinet manufacturer shall affix a permanent label on the inside of the door that identifies the cabinet type, date of manufacture, warranty expiration date and manufacturer's name. The warranty expiration date shall be expressed in the (mm/dd/yyyy) format. The warranty shall cover all communication cabinet materials and workmanship, including pole mounting kits, for two (2) years after delivery of each communication cabinet.

REVISION OF SECTION 614
FIBER OPTIC CABLE (SINGLE MODE)

Section 614 of the Standard Specifications is hereby revised for this project to include the following:

DESCRIPTION

This work consists of furnishing and installing single mode fiber optic cable for CDOT communications in conduit.

The main backbone cable shall be terminated in a Communications Node or Regeneration Building. Lateral fiber cables shall be terminated using fan-out kits in a termination patch panel in the field equipment cabinet.

All fiber optic cables shall be suitable for outdoor conduit installation.

MATERIALS

All fiber optic cable shall have compatible chrematistics with proposed and existing cables.

All optical cables furnished on this project shall meet the following fiber optic industry standards:

a) Electronic Industries Alliance (EIA) Telecommunications Industry Association (TIA)
b) International Organization for Standardization (ISO)

c) International Electronics Commission (IEC)
d) Telecommunication industry Association (TIA)
e) International Telecommunications Union (ITU)
f) Insulated Cable Engineers Association (ICEA)

All cables shall be new and unused non-armored outdoor cable consisting of dispersion-unshifted, low water peak single-mode fiber strands free of surface imperfections and inclusions. Each single mode fiber shall consist of a doped silica core surrounded by a concentric silica cladding. The fiber shall be of matched clad design.

(a) Fiber Strands

a) Typical core diameter of 8.3µmer
b) Cladding Diameter of 125.0µm
c) Core-to-Cladding Offset: ≤ 0.5 µm
d) Cladding Non-Circularity: ≤ 1 %
e) Coating Diameter (Colored): 245 ± 10 µm.
f) Maximum Attenuation (Loose Tube): 0.35 dB//km at 1310 nm wavelength and 0.22 dB/km at 1550 nm wavelength
g) Mode-Field Diameter: 9.20 ± 0.30 µm at 1310 nm wavelength and 10.40 ± 0.50 µm at 1550 nm wavelength
h) Attenuation at the Water Peak: 0.32 to 0.34 dB/km at 1383 ± 3 nm wavelength
i) Cutoff Wavelength: ≤ 1260 nm.
j) Zero Dispersion Wavelength: 1300nm to 1322 nm

k) Zero Dispersion Slope: 0.090 ps / (nm^2 • km)
l) Polarization Mode Dispersion: 0.06 ps/ $\sqrt{}_{km}$
m) Maximum Fiber Dispersion: 3.5 ps/(nm • km) for 1285 nm through 1330 nm and shall be < 18 ps/(nm • km) at 1550 nm.
n) Fiber Curl: ≥ 4.0 m

All optical fibers shall be proof tested by the manufacturer to a minimum load of 0.7 GN/m^2 (100 ksi).

The fibers shall not adhere to the inside of the buffer tube.

The coating shall be a dual layered, UV cured acrylate applied by the fiber manufacturer. The coating shall be capable of being mechanically stripped with a force of 0.3 – 2.0 lbf (1.3 – 8.0 N).

Each single mode fiber strand shall be color coded with distinct and recognizable colors in accordance with the most recent version of EIA/TIA-598, Optical Fiber Cable Color, as shown in the plans.

(b) Buffer Tubes

Each buffer tube shall contain 6 or 12 fibers as appropriate for the respective size cable.

Optical fibers shall be placed inside a loose buffer tube. The nominal outer diameter of the buffer tube shall be 3.0 mm

Each buffer tube shall be color coded with distinct and recognizable colors in accordance with the most recent version of EIA/TIA-598, Optical Fiber Cable Color, as shown in the plans.

In buffer tubes containing multiple fibers, the coloring shall be stable during temperature cycling as stated under “Fiber Specification Parameters” and shall not be subjected to fading or smearing onto each other or into the buffer tube gel filling material. Colorings shall not cause fibers to stick together.

Buffer tubes shall be of a dual-layer construction with the inner layer made of polycarbonate and the outer layer made of polyester.

Each buffer tube shall be filled with a non-hygroscopic, non-nutritive to fungus, electrically non-conductive, homogenous gel. The gel shall be free from dirt and foreign matter. The gel shall be readily removable with conventional nontoxic solvents.

Buffer tubes shall be stranded around a central member of the cable using a reverse oscillation stranding process.

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REVISION OF SECTION 614
FIBER OPTIC CABLE (SINGLE MODE)

The buffer tubes shall be resistant to external forces and shall meet the buffer tube cold bend and shrink requirements of EIA/TIA standards.

(c) Fiber Cable

Fillers may be included in the cable core to lend symmetry to the cable cross-section where needed.

The central anti-buckling member of the cable shall consist of a glass reinforced plastic rod. The purpose of the central member shall be to prevent buckling.

For single layer cables, a water blocking tape shall be applied longitudinally around the outside of the strand tubes/fillers. The tape shall be held in place by a single polyester binder yarn. The water blocking tape shall be non-nutritive to fungus, electrically non-conductive homogenous. It shall also be free from dirt and foreign matter. Gel filled water-blocking compound shall not be allowed in the cable core interstices in either the backbone cable or the lateral cables.

Binders shall be applied with sufficient tension to secure the buffer tubes to the central member without crushing the buffer tubes. The binders shall be non-hygroscopic, non-wicking (or rendered so by the flooding compound), and dielectric with low shrinkage.

The cable shall contain at least one ripcord under the sheath for easy sheath removal.

Tensile strength shall be provided by high tensile strength dielectric yarns and shall be helically stranded evenly around the cable core.

Outer cable jacket shall have a consistent thickness throughout the entire cable length and shall be sheathed with medium density polyethylene, (MDPE). The minimum nominal jacket thickness shall be 1.4 mm. Jacketing material shall be applied directly over the tensile strength members and water blocking tape. The MDPE shall contain carbon black to provide ultraviolet light protection and shall not promote the growth of fungus.

The cable jacket shall be free of holes, splits and blisters.

Cable jackets shall be marked with sequential foot markings, year of manufacture and a telecommunication handset symbol, as required by Section 350G of the National Electrical Safety Code (NESC). The actual length of the cable shall be within 0 to 1% of the length markings. The marking shall be in contrasting color to the cable jacket. The height of the marking shall be easily readable.

(d) Environmental Parameters

a) Shipping, storage and operating temperature range of the cable as defined by Bellcore GR-12 shall be;
-40°C to +75°C (-40°F to +167°F)

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REVISION OF SECTION 614
FIBER OPTIC CABLE (SINGLE MODE)

b) Operating temperature range of the cable as defined by Bellcore GR-12 shall be; -40°C to +70°C (-40°F to 158°F)
c) Installation temperature range of the cable as defined by Bellcore GR-12 shall be; -30°C to +60°C (-22°F to +140°F)

(e) Quality Assurance

a) All optical fibers shall be 100% attenuation tested. The attenuation of each fiber shall be provided with each cable reel.
b) The cable manufacturer shall be ISO 9001 registered.

(f) Packaging

a) The complete cable shall be packaged for shipment on non-returnable wooden reels.
b) Top and bottom ends of the cable shall be available for testing.
c) Both ends of the cable shall be sealed to prevent the ingress of moisture.
d) Each reel shall have a weatherproof reel tag attached identifying the reel and cable.
e) Each cable shall be accompanied by a cable data sheet that contains significant information on the cable.

The Contractor shall provide the CDOT with two copies of the cable manufacturer's installation instructions for all fiber optic cable. All installations shall be in accordance with the manufacturer's recommendations except as otherwise directed by CDOT. All additional costs including fiber optic cable associated to damages caused by the Contractor's neglect of recommended procedures shall be the Contractor's responsibility.

The Contractor shall submit a Method Statement to the CDOT indicating cable routing, splice points and cable end splicing locations. Installation of the cable will not be permitted until the schematic diagram has been approved by CDOT.

Fiber optic cable including both backbone cables and lateral cables shall be installed in continuous runs. Under no conditions shall fiber optic cable be cut or spliced at intermediate points without express written direction from CDOT.

Blowing cable is an acceptable alternative to pulling cable. If the Contractor chooses to use this method, submittals for cable installation shall be submitted along with complete information on fiber installation equipment.

The maximum pulling tension shall be 2700 N (600 lbs) during installation (short term) and 890 N (200 lbs) long term installed.

All cables shall have a minimum bending radius based on the diameter of the cable and shall meet the following;

a) Pulled under tension, (Short Term) – 20 (Twenty times the cable diameter)

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REVISION OF SECTION 614
FIBER OPTIC CABLE (SINGLE MODE)

b) Pulled not under tension, (Long Term) – 10 (Ten times the cable diameter)

The fiber optic cable shall be installed in the conduit with a split-mesh cable grip to provide a firm hold on the exterior covering of the cable.

The manufacturer's recommended limits for cable pull lengths shall not be exceeded. The Contractor shall use a pulley system with a numerical readout indicating the cable tension. The pulley system shall be capable of alerting the installer when the cable pulling tension approaches the manufacturer's maximum allowable tension. The Contractor may supplement this procedure with a breakaway tension limiter set below the lowest recommended tensile limit of the cables being pulled. Intermediate pulleys shall be used at all pull boxes or manholes along the installation run to prevent cable damage.

If cable installation limits are met and the entire length cannot be installed completely from the shipping reel, installation shall be continued from the mid-point of the run. The Contractor shall first pull one-half of the cable from the reel at the mid-point through the conduit to one end of the run. The other half of the cable shall be removed from the reel and carefully placed on the ground in a figure eight pattern with a minimum loop diameter of 10 feet. While installing the remaining cable, care shall be taken to avoid any dragging against the ground resulting in

damage or excess bending of the cable. The Contractor shall not kink, twist or bend the cable during installation coiling or uncoiling.

The cable shall be continuously lubricated as it enters the conduit. The Contractor shall only use pulling lubricants recommended by the cable manufacturer. Liquid detergent shall not be used.

If the Contractor must install new cable in conduits which contain existing fiber or electrical wiring, the Contractor shall be responsible for any damage to the existing cables or wires. After this installation the Contractor shall perform a functional test of all the equipment connected by the existing fiber cables or electrical wiring to ensure proper working conditions.

Contractor shall perform a functional test of all the equipment connected by the existing fiber cables or electrical wiring to ensure proper working conditions.

If an existing fiber optic cable is damaged during construction, it shall be removed from both points of termination and replaced, at no cost to the project. In no case shall the fill of any new conduit exceed the requirements of the National Electrical Code. The Contractor shall provide documentation to CDOT supporting the conduit fill. All costs associated with equipment testing and repairs shall be included in the cost of the Fiber Optic Cable.

Lateral cables shall be installed in continuous runs from the backbone splice location to the field equipment cabinet. Odd length cables and reel ends are acceptable for lateral cables provided they are pre-tested and free of defects and are of sufficient lengths to archive continuous runs.

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REVISION OF SECTION 614
FIBER OPTIC CABLE (SINGLE MODE)

Lateral cables shall have slack and include a maximum of three locations of appropriate strain relief within all field equipment cabinets.

All fiber optic cables shall include identification labels attached to the cable in each pull box, manhole or field equipment cabinet. The label shall be provided with information as shown on the Project Detail Sheet.

The Contractor shall splice fiber cables at locations shown on the plans. All splices shall be enclosed within a splice closure as approved by CDOT. Following successful splicing, the splice closure shall be placed inside the pull box or manhole. The Contractor shall use tools and hardware recommended by the cable manufacturer.

Only proposed active (lit) fibers shall be spliced in the closure and terminated in the field communications cabinet. All unused (dark) fibers of both the backbone and lateral cables shall remain uncut and be neatly coiled in the splice tray within the closure. All unused buffer tubes shall remain uncut and neatly coiled along with the buffer tubes used for splicing in appropriate location in the splice closure.

Backbone and lateral buffer tubes and fiber strands shall be labeled on the splice tray prior to sealing of the closure as shown on the Project Detail Sheet.

The Contractor shall coil 100 feet of backbone cable in the manholes. The Contractor shall coil 50 feet of backbone cable in pull boxes.

The Contractor shall coil 50 feet of lateral cable in the manholes. The Contractor shall coil 25 feet of lateral cable in pull boxes.

The Contractor shall ensure that all cable coils and splice canisters are attached to the cable management hardware in all pull boxes and manholes.

The Contractor shall terminate the lateral cable at the field equipment cabinet using a buffer tube fan-out kit. Fanned-out fiber strands shall be terminated in a termination block with ST connectors.

The Contractor shall submit a final documentation package to CDOT. The final documentation package shall include the cable manufacturer's installation procedures, technical support documentation and material documentation. These documents shall match the original submittals provided to CDOT.

REVISION OF SECTION 614
FIBER OPTIC SPLICE CLOSURE

DESCRIPTION

Fiber optic splice closures shall be used to enclose spliced fiber optic cable from both backbone and lateral cables at locations shown in the plans. The splice closures shall be provided for underground installations.

At field Ethernet switch locations, two splice canisters shall be required. One full size canister shall be required for splicing of the backbone cable to a single lateral cable. A second smaller canister shall be required for splicing of course wavelength division multiplexing modules.

MATERIALS

The fiber optic splice closures shall be furnished and installed by the Contractor.

The splice closures shall be a stand-alone closure that does not require an outer closure and shall meet the following minimum requirements:

(a) The closure shall seal, anchor and protect fiber optic cable splices.
(b) The closure shall provide for a minimum of two (2) additional spare entries in addition to the required number of cables being spliced. Larger sized canisters shall have up to a maximum of six (6) total cable entries while the smaller canisters shall have up to a maximum of 4 (4) total cable entries..
(c) The closures shall be suitable for underground applications and shall be watertight and airtight.
(d) The closures shall be of clamshell design, no dome type closures will be allowed.

The closures shall be sized to provide the capacity equal to the total number of strands for all cables entering the closure. All fiber optic cables shall be secured per the manufacture's recommendations. All remaining access holes not utilized shall be plugged to prevent water from entering closure.

The smaller canister shall have capacity for splicing of two (2) lateral twelve (12) strand fiber cables in addition to the single wavelength ODAM.

CONSTUCTION REQUIEMENTS

All splices shall be performed using the fusion splicing method. The fusion splicer shall be calibrated and certified within one year previous to splicing on this project. All certification documentation shall be presented to the Project Engineer prior to start of splicing.

The only fibers to be cut are those shown to be spliced on the splicing schematic plan sheet. All unused buffer tubes and fiber strands shall remain uncut. After splicing is complete, the fiber strands shall be cleaned of all homogeneous gel, and then coiled in splice tray. All remaining uncut strands from the buffer tube shall also be cleaned of all homogenous gel, and then coiled in the tray. Remaining buffer tubes shall be neatly coiled and secured within the closure per the manufacturer's recommendations. Buffer tubes shall be secured to the splice tray in foam

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REVISION OF SECTION 614
FIBER OPTIC SPLICE CLOSURE

splice holders per manufacturer's recommendations. Fiber strands shall not be taped to the splice tray.

At field Ethernet switch splice locations, two (2) canisters shall be required. One canister shall be used for spicing of the backbone cable to one lateral cable. A second, smaller canister shall be required for splicing of two (2) lateral cables to a single wavelength optical add / drop multiplexor (ODAM). The canister required for the single wavelength ODAM shall be sized to accept two (2) 12 strand fiber optic cables and one single wavelength ODAM, a full size canister is not required for this splice.

If the closure requires reentry, it shall be conducted per the manufacturer's recommendation for re-entry and resealing. The Contractor shall use caution not to damage the fiber strands or buffer tubes existing inside.

The Contractor shall ensure that the fiber optic splice enclosure and associated fiber cable coils fit adequately within the pull box specified on the plans. No additional payment shall be made for replacement of pull boxes, and no pull box modifications shall be allowed.

The optical fibers shall be fusion spliced and shall meet the following minimum requirements:

(a) Splice loss <0.15 dB
(b) Reflection <50 dB
(c) Completed splice shall be stable from -40º F to +185º F (-40ºC to +85ºC)

The Contractor shall label each individual splice and buffer tube in all splice trays per the Project Detail Sheet included in the plans.

The Contractor shall inform the Project Engineer the day before and the morning of proposed splicing locations for that day. While the splicing procedures are occurring and within four (4) hours prior to sealing the closure and installation in the pull box, the Contractor shall again contact the Project Engineer for inspection. In the event that the Project Engineer cannot be on site, a minimum of eight (8) digital pictures shall be taken at varying angles of the interior of the splice closure showing all completed work as stated in this specification and shown on the Project Detail Sheet. These pictures shall include exposed fiber stands, (both spliced and uncut) in all splice trays, fiber tray labeling and remaining buffer tubes showing appropriate coiling. One picture shall also include the complete re-assembly of all interior parts prior to final sealing. Once the closure and fiber coils are installed in the pull box or manhole, two (2) pictures shall be taken showing the final installation of both the closure and the coiled fiber cable attached to the fiber management hardware.

Fiber Optic Splice Closure will not be measured or paid for separately but will be considered subsidiary to the Fiber Optic Cable (Single Mode) pay item. This item shall include all labor, materials and equipment required to complete the work.

REVISION OF SECTION 614
FIBER OPTIC PRE-CONNECTORIZED CABLE

DESCRIPTION

This work consists of the installation of fiber optic pre-connectorized patch cables in traffic signal cabinets, ramp metering cabinets and automated traffic recorder station cabinets for connection of optical devices from the termination panel to the optical device. Patch cables for these devices shall also be installed in the Colorado Transportation Management Center.

At the Ethernet switch locations, course wavelength division multiplexor (CWDM) shall be used and shall require bend intensive fiber optic pre-connectorized patch cables. Bend intensive (optimized) pre-connectorized patch cable shall also be required for CWDM optical connections at the Colorado Transportation Management Center Ethernet switch location.

MATERIALS

The pre-connectorized cables for traffic signal cabinets, ramp metering cabinets and automated traffic recorder stations shall be jacketed for extra protection and shall be provided with pre-connectorized connectors on both ends to match the optical connectors to which they connect. Connectors shall be pre-terminated by the manufacturer with a convex physical contact (PC) polish on the ferrule end to reduce reflection.

The measured attenuation of the connector (inclusive of coupler and mated test connector) shall not exceed an average of 0.3 dB for all connectors provided. Any connector found in excess of 0.5 dB shall be rejected. Reflectance shall be less than -40 dB from 14º F to 140º F (-10ºC to +60ºC). The manufacturer shall have a program that periodically tests connectors to ensure than after 1000 re-matings, the attenuation will not change more than 0.2 dB.

The connector shall be able to withstand an axial pull of 25 lbs. with no physical damage to the connector and no permanent optical degradation more than 0.3 dB.

The pre-connectorized cables for CWDM optics modules shall be jacketed for extra protection and shall be provided with pre-connectorized connectors on both ends to match the optical connectors to which they connect. Connectors shall be pre-terminated by the manufacturer. Duplex patch cables shall be installed in all field cabinets for connection from the patch panel to the CWDM optic. In the Colorado Transportation Management Center Data Center, simplex patch cables shall be installed for connection from the 10~~8~~-Channel Course Wavelength Division Multiplexing ~~LGX~~ Module port to the ~~CISCO~~CIENA Ethernet switch optics. The bend intensive (optimized) cable shall be used to enable tight bend radii and routing to help alleviate data loss.

Single mode fiber optic cables for installation in field cabinets shall be made with bend insensitive fiber satisfying International Telecommunication Union (ITU) G.657 category A1 recommendations. The cable shall have a ‘tactical’ polyurethane jacket to resist bending.

The bend intensive (optimized) patch cable shall have the following requirements for simplex cables;

- Yellow PVC Jacket Material

- Nominal Dimension: 2.95 mm

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REVISION OF SECTION 614
FIBER OPTIC PRE-CONNECTORIZED CABLE

- Weight: 16 Lbs./KM
- Pull Load (N): 1332 (Install) / 1066 (Operate)
- Bend Radius: 10mm (1 Turn)
- Core Size: 9/125
- Attenuation: 0.50 dB/Km at 1550nm (Maximun)
- Link Lengths at 1550nm: 10,000 Mtr (For 1GB/s) – 5,000 Mtr (For 10 GB/s)

The bend intensive (optimized) patch cable shall have the following requirements for duplex cables;

- Yellow PVC Jacket Material
- Noninal Dimension: 2.95 mm x 5.8 mm
- Weight: 32 Lbs./KM
- Pull Load (N): 2664 (Install) / 2132 (Operate)
- Bend Radius: 10mm (1 Turn)
- Core Size: 9/125
- Attenuation: 0.50 dB/Km at 1550nm (Maximun)
- Link Lengths at 1550nm: 10,000 Mtr (For 1GB/s) – 5,000 Mtr (For 10 GB/s)

The bend intensive (optimized) pre-connectorized patch cable shall meet the following specifications:

Patch Cable Connectors
EIA, TIA-55 (FOCIS)
UL94 V-O
GR-326, Issue 3 Specifications

Cable
Telcordia GR-409

All connectors shall have ceramic ferrules.

The cables shall contain the exact number of loose tube fibers and connectors to connect the optical equipment. If the optical equipment transmits and receives data on a single fiber, the pre-connectorized cable shall contain only a single fiber, (simplex). When the optical device transmits and received data on two or four fibers, a pre-connectorized cable shall be provided with 2 (two) fibers per cable, (duplex), for each bulkhead pair, (transmit and receive).

Single mode fiber optic cables for installation in field cabinets shall be made with bend insensitive fiber satisfying International Telecommunication Union (ITU) G.657 category A1 recommendations. The cable shall have a 'tactical' polyurethane jacket to resist bending.

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REVISION OF SECTION 614
FIBER OPTIC PRE-CONNECTORIZED CABLE

Connectors shall be compatible with both the connectors on the optical devices and the termination patch panel bulkhead panels.

At the CTMC, the pre-connectorized cables shall be installed in the cable management hardware in the equipment racks. The Contractor shall provide patch cables of sufficient length to span from the fiber

patch panel to the optical network device. This length shall include a maximum of 4 feet of slack cable. Appropriate cable management shall be used while installing cables.

Prior to installation, all pre-connectorized cable bulkhead connectors shall be cleaned with lint-fee fiber wipes moistened with Isopropyl Alcohol 99% U.S.P. After cleaning with alcohol, the bulkhead shall be cleaned with an optical connector cleaner to ensure the all residue is removed from the bulkhead surface.

Any manufacturer testing reports showing db loss for both Side A and Side B of the pre-connectorized cables shall be submitted as part of the as-built documentation. Installation location shall be noted on the test report for future reference.

At the CTMC cables shall have identification labels at each end indicating patch panel number, field device and field device location.

At all field device locations, each cable shall have individual labels indicating the devices, lateral fiber color and the data transmitting description, (example: Tx or Rx).

Patch cable labeling shall be as shown on the Project Detail Sheet.

The pre-connectorized cables shall be provided in the following lengths.

Field Device Cabinets……. 3 Feet – 0 Inch maximum

CTMC …… Cable shall be of sufficient length to accommodate connection of each individual optical device to the equipment rack termination panel while allowing for appropriate slack.

REVISION OF SECTION 614
BUFFER TUBE FAN OUT KIT

DESCRIPTION

For this project, the Buffer Tube Fan Out Kit shall be furnished and installed on fiber lateral cable ends in field termination panels mounted within communication cabinets.

MATERIALS

The Contractor shall use fiber optic fan out kits on the fiber lateral cable in the communication cabinet termination panels. Fan out buffer tubes for the lateral fiber strands shall be 9mm minimum and shall be neatly coiled after installation and secured within the field termination panels. Fan out kits shall be supplied with buffer tubes matching the lateral fiber strand colors. ST type bulkhead connectors shall be terminated on the ends of the lateral cable fiber strands and installed on the back side of the termination panel bulkheads. The connectors shall have a ceramic ferrule with a nickel-plated nut and body. The connector shall be polished with a physical contact (PC) finish.

REVISION OF SECTION 614
FIBER OPTIC TERMINATION PANEL

Section 614 of the Standard Specifications is hereby revised for this project to include the following:

DESCRIPTION

This work consists of furnishing and installing modular type fiber optic termination panels in field communications cabinets for single mode fiber.

MATERIALS

The unit shall meet the design requirements of ANSI/TIA/EIA-568 and the plastics flammability requirements of UL 94 V-0.

Splice housings shall be manufactured using 16-gauge aluminum or equivalent and shall be finished with powder coat for durability. The splice housings shall provide individual tray access while minimizing disturbance to neighboring trays and fibers.

Connector housings shall be provided with ST modular connector panels that minimize space. The entire panel shall be populated with fiber connector bulkheads. The unit shall have patch cord cable guides that allow a transition and segregation point for jumpers exiting from both sides of the housing to alleviate all patch cable entry on a single side.

Fiber jumper management designed specifically for fiber optic cable shall be included. The jumper management panels shall have removable front covers to conceal and protect the jumpers when installation is complete. The jumper management panels shall be designed to maintain a 1.5” minimum bend radius.

The panels shall have a hinged door to protect the fiber patch cable connector. The panel shall be sized to accommodate the entry of the lateral fiber optic cable.

CONSTRUCTION REQUIREMENTS

All hardware shall be installed in accordance with manufacturer’s recommendations. The Contractor shall provide CDOT with documentation and all manuals. All connector housings shall have a labeling scheme that complies with ANSI/TIA/EIA-606.

REVISION OF SECTION 614
INTELLIGENT TRANSPORTATION SYSTEM POLE

Section 614 of the Standard Specification is hereby revised for this project as follows:

DESCRIPTION

Subsection 614.01 shall include the following:

ITS poles are to be used for the mounting of various Intelligent Transportation Systems devices and communications cabinets along the highway. The contractor shall furnish and install poles shall be made of composite fiberglass material and be of breakaway design. They shall be direct burial type which requires no base plate or concrete foundation. Poles shall be 30 feet in height and shall include all work for installation.

MATERIALS

Subsection 614.08 shall include the following:

(q) ITS Pole. The pre-fabricated, non conductive, non-corroding composite fiberglass poles shall be designed for installation directly into the ground including a breakaway device which meets the Federal Highway Administrations safety guidelines.

The poles shall be constructed per the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic SIGNALs standards with a 30% gust factor.

The breakaway design shall also comply with current AASHTO LTS-2 Street Lighting Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic SIGNALSs by the same manufacturer as the pole.

The poles shall not be painted. Coloring shall be by pigment in the composite fiberglass resin during the manufacturing process. The poles shall be coated with polyurethane which includes ultraviolet inhibitors to help prevent fading.

Subsection 614.10 shall include the following:

(n) ITS Pole. The pole shall be tapered round and be constructed by the filament winding process from thermosetting polyester resin and contain a minimum of 65 percent “E” type fiberglass by weight. The filament windings shall be continuously applied with uniform tension and shall be placed on the pole helically at low angles to provide axial strength. Additional windings shall be placed on the pole in a circular manner to provide compressive strength.
The resin used to make the pole shall be ultraviolet resistant and pigmented approximately the same as the final coating to be applied. The color shall be brown and uniform throughout the entire wall thickness. A weather resistant, pigmented, polyurethane coating shall be applied to the pole and have a dry film thickness of 1.5 mils.
The pole shall be flame resistant in accordance with ASTM D635. In tests, samples must cease to burn before the gauge mark of 3.9 inches is reached.

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REVISION OF SECTION 614
INTELLIGENT TRANSPORTATION SYSTEM POLE

All surface and ends shall have a smooth finish with no burs or blemishes. The top of the pole shall be supplied with a cap to match the color and diameter of the pole.
The pole surface shall be tested for a minimum of 2500 hours of accelerated testing in accordance with ASTM G53-84 (UV-B Lamp 313 NM wavelength 130º F, cycle lamp 4 hour on, 4 hours off) with no fiber exposure, no crazing, no calking and with only minor color variations.

Stabilization of the pole shall be by a two-part polymer material recommended and provided by the manufacturer. This material shall be environmentally safe to the worker and the surrounding area. The Contractor shall use care while combining the material on site so no overspill occurs. All remaining material not used in the installations of the poles shall be cleared from the site by the Contractor, and surrounding area returned to pre-installation conditions.

REVISION OF SECTION 614
TRAFFIC LOOPS AT AUTOMATED
TRAFFIC RECORDER (DTD ATR) SITES

Section 614 of the Standard Specifications is hereby revised for this project to include the following:

DESCRIPTION

This work consists of the removal and replacement of loop detector wires, or loops and for the Automatic Traffic Recorder (ATR), where the loops, piezos or both have been removed within a project site. Work shall be in accordance with this specification and as shown on the plans.

MATERIALS

Loop detector wire shall consist of specified loop wire encased in ¼ inch OD, 3/16 inch ID vinyl or polyethylene tubing. (14-1/C Loop detector cable 19 STR. PVC/Nylon/PVC Tube 600v IMSA 51-5)

Loops shall be sealed with a two-part self-curing, self-bonding weatherproof epoxy approved for sealing loops. Loops shall be 6 feet by 6 feet.

The piezo shall be class II and 6 feet in length. The piezo shall have sufficient lead in cable, so the lead in cable can be pulled in to the cabinet without splicing.

Grout or epoxy for the installation of the loops and piezos shall conform to manufacturer's recommendations.

Pull boxes shall be in accordance with Section 613.

CONSTRUCTION

(a) *General.* A minimum of five days prior to installation, the contractor shall submit a schedule of installation activities including alternative scheduling to the CDOT Project Manager and the Traffic Data Collection (TDC) Manager (Mike DelCupp 303-757-9816 robert.delcupp@dot.state.co.us). The installation instructions from the manufacturer shall also be submitted for approval. Installation of loops and piezos shall not begin until approval has been received from CDOT.

The Contractor shall install the loops and piezos as close to the locations shown on the plans as possible. Exact locations, dimensions, and configurations may vary based on site conditions, and shall be as approved by CDOT.

All work will be inspected by the Traffic Data Collection Unit (TDC) during installation. Acceptance will be based on the testing and operation of the piezos and loops under actual traffic conditions, in which one week of actual data will be collected. The volume and vehicle class shall be within ±10 percent for the site compared to historical data for the same time period. There shall be no more than 1 percent sensor misses in any one lane for the same time period.

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REVISION OF SECTION 614
TRAFFIC LOOPS AT AUTOMATED
TRAFFIC RECORDER (DTD ATR) SITES

(b) *Installation of loops.* Loops shall be centered in the travel lane with two sides parallel to lane striping. The saw cut for the loops shall be made 3/8 inch wide and 3-½ inches deep. The saw slot shall be as straight as possible and shall not vary more than ½ inch when checked with a straightedge. No more than one set of loop lead wires shall be placed in one saw slot. Saw cuts shall be hydro-blasted with a mixture of water and air and then blown free of water and debris with compressed air, using a large capacity air compressor of at least 150 CFM. The cuts shall be dry prior to placement of loop wire.

(c) The contractor shall locate all buried utilities, which may interfere with the planned location of the ATR site. The Contractor shall contact the Utility Notification Center of Colorado (UNCC) at 811 or 1-800-922-1987 for location of member utilities at least three working days prior to any excavation, not including the day of actual notice.

The Contractor shall also locate non-member utilities, such as storm sewer and ditch. Any utility conflicts encountered with the proposed installation shall be brought to the attention of the Engineer

After the saw slot is cleaned of debris and dried, the wire shall be placed for the loop by pushing it into the slot with a blunt non-metallic object. A screwdriver or other sharp tool will not be permitted. Care shall be used to avoid abrading or damaging the insulation.

All loop corners shall be rounded using a 1-½ inch hole drilled to a minimum depth of 3-½ inches. Loop leads shall be drilled when leaving the roadway surface at a 45 degree angle 8 inches from pavement edge out through the side or bottom of roadway, the drilled hole shall be no larger than ¾ of an inch. All holes shall be spaced a minimum of three inches from one another. No more than one set of loop lead wires shall be placed in one drill hole.

One continuous length of loop wire shall be used for each loop from pull box or cabinet around the loop with 4 turns and back to the pull box or cabinet with no splices. The wires shall be seated in the bottom of the saw slot. A ½-inch backer-rod shall be installed to insure wires do not float to the surface during grouting. Backer-rod shall be installed in 4 to 6 inch pieces with 1 to 2 foot gaps in-between, to insure the sealant will come in contact with the loop wire. One continuous piece of backer-rod will not be allowed.

Prior to sealing the loop, loop lead and feeder slots, a loop continuity test will be performed. The test will be performed by the TDC representative. Loop continuity shall be no higher than 1 ohm. Loop continuity higher than 1 ohm shall be cause for replacement of the loop. Replacement shall be at the Contractor's expense.

After the loops are properly seated and tested, the slots shall be filled with a two-part self-curing, self-bonding epoxy or grout, as recommended by the manufacturer. Excess epoxy shall be removed to avoid unnecessary high spots, and level with the roadway surface.

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REVISION OF SECTION 614
TRAFFIC LOOPS AT AUTOMATED
TRAFFIC RECORDER (ATR) SITES

Loop leads shall be pulled into cabinet without splices to match original installation when applicable.

All detector loops shall measure six feet by six feet.

Installation at an ATR count or classification site shall consist of one loop or one loop set (two loops) within a single lane. The loop sets shall be separated by 10 feet, plus or minus 1 inch, resulting in a distance of sixteen feet from the leading edge of the first loop in the direction of travel to the leading edge of the second loop.

Loop and loop leads shall be installed directly into the pavement, to pavement edge, pull box or cabinet. If loops are installed during asphalt paving, the loops shall be installed before the final lift is placed.

Loop lead wires from pavement edge to pull box shall be enclosed in ¾ inch PVC conduit or ¾ inch rubber hose to protect wire from abrasion. Loop lead-in pairs from pavement edge, to pull box, shall be symmetrically twisted 5 turns per 1 foot. Pull boxes or cabinet shall contain a minimum of 3 feet of loop lead wire for splicing. All loop and loop leads shall be clearly labeled in all pull boxes and or cabinet. The Contractor shall be responsible for all trenching and digging from pavement edge to pull box.

All splices shall be made with approved waterproof pressure connector. All splices shall be capable of satisfactory operation under continuous submersion in water.

(d) *Pull Boxes* All pull boxes on the shoulder of the roadway surface shall be raised to finished grade or level with the surrounding ground. If the shoulder has been raised to the point that the conduit is below the bottom of the pull box, then the conduit shall be raised. All wiring splices for existing wiring shall be a minimum of 12 inches in length above the conduit.

All existing pull boxes that are found to be damaged shall be replaced.

(e) *Water Valves.* A minimum of two feet of slack shall be provided on the loop and piezo wires that are contained in water valves.

No splices shall be allowed in water valves.

(f) *Pull Rope.* A 1/8 inch nylon pull rope shall be installed in all new conduits and all existing conduits where a wire or cable is added or an existing wire or cable is replaced.

(g) *Conduit*. The contractor shall seal all conduits with a sealing compound where a wire or cable is added or an existing wire or cable is replaced. The sealing compound shall be UL tested and approved for use. Sealing compound shall be a permanently soft, fibrous, non-staining sealer that can be easily applied and removed by hand at all working temperatures.

Sealing compound shall be designed to seal out weather, moisture, dust rodents and atmospheric conditions both indoors and outdoors. No foam sealant will be allowed.

REVISION OF SECTION 614
MICROWAVE VEHICLE RADAR DETECTOR (MVRD)

Section 614 of the Standard Specifications is hereby revised for this project to include the following:

DESCRIPTION

This work shall consist of furnishing and installing Microwave Vehicle Radar Detectors (MVRDs) in accordance with these Special Provisions at the locations shown on the Plans.

MATERIALS

The MVRD shall be Wavetronix SmartSensor HD model WX-SS-125. The MVRD shall include the radar detection unit, sensor mount, sensor connector cable, communications cabinet, attachment hardware, and all other hardware, cables, and test equipment necessary for a complete installation.

In addition to the items listed above, the MVRD includes all associated power supplies, surge suppressors, and power and communications cabling. The Contractor shall furnish and install all other related hardware, including but not limited to double-gang electrical box, GFCI and 5-15 receptacles, mounting hardware, power strip, and data interconnection cables. Contractor shall be responsible for prefabrication of the communications cabinet before installation.

The radar detection unit shall include a non-intrusive device using frequency modulated continuous wave radar technology for the gathering of vehicle information including traffic volume, lane occupancy, individual and average speed, vehicle classification, and presence. It shall have auto configuration capabilities to simultaneously identify up to ten highway lanes with the ability to detect over center median barriers and accurately detect partially occluded vehicles. Weather shall not impact the radar detection of the unit. Wind or temperature change shall not cause the device's original field installation configuration to alter over time. The radar detection unit shall include the manufacturer's recommended power/communication cable for the length shown on the plan sheets.

The power supply shall be a DIN rail mountable AC to DC power converter. The power supply shall accept input voltage from 100 to 240 VAC at 45 to 65 Hz and provide 24 VDC output at 1A. The power supply shall have a minimum operating temperature range of -29 to 165˚F up to 95 percent relative humidity. The power supply shall provide for 100 percent power reserve for a minimum of 20 milliseconds to protect against static voltage dips, transient failures of supply voltage, or continuous phase failures. One DIN rail shall be mounted within the communications cabinet on the device pole and a second DIN rail shall be mounted within the 332 cabinet shown on the plans.

The surge suppressor shall be DIN rail mountable with hot swappable protected busses. The surge suppressor shall provide protection for RS-232, RS-485, and DC power to the radar detection unit. Wiring for the surge suppressor shall be by means of pluggable screw terminals and include unprotected RS-232 and RS-485 communications connectors. The surge suppressor shall have a minimum operating temperature range of -29 to 165˚F up to 95 percent relative humidity.

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REVISION OF SECTION 614
MICROWAVE VEHICLE RADAR DETECTOR (MVRD)

The communications cabinet shall be of aluminum construction, measure 14" x 14" x 11" (H x W x D), and have a hinged door with a police type lock and weather proof seal to prevent the ingress of wind and water. The communications cabinet shall include the installation of an internal backplane with a 10A single phase DIN rail mountable circuit breaker, 8 position surface mount terminal block, surface mounted double gang metal electrical box with one duplex NEMA 5-15R and one duplex ground-fault circuit interrupter (GFCI) receptacle, and a six outlet 5-15R power strip rated at a minimum of 500 joules. The communications cabinet shall include an internal DIN rail.

All cables shall be provided per the manufacturer's recommendations according to the length and application.

CONSTRUCTION REQUIREMENTS

The Contractor shall mount the 10A circuit breaker, power supply, surge suppressor, 8 position terminal block, double gang metal electrical box with one duplex NEMA 5-15R and one duplex (GFCI) receptacle on the communications cabinet backplane. The 10A circuit breaker shall be used to supply power to the power supply and both duplex receptacles. The duplex GFCI receptacle shall be wired such that in the event of a ground fault, both the power supply and duplex NEMA 5-15R receptacle remain energized.

One conduit access hole not to exceed 1.5 inches shall be made on the bottom of the communications cabinet for power wiring and radar detection unit power/communication cabling. The access hole shall be positioned at a location to ensure the proper, safe routing of wiring entering the cabinet. 3/4 inch Type 201 stainless steel strap used in conjunction with Type 201 stainless steel buckles shall be used to mount the communications cabinet to the structure so that the top of the cabinet is approximately 5-7 feet above surrounding grade and all shall be located by Matthew Becker with CDOT ITS at 303-435-8288. The communications cabinet shall be oriented such that anyone working in the cabinet has direct line of sight with oncoming traffic. The Contractor shall be responsible for any necessary modifications or additions needed to mount the communications cabinet to the structure.

0.75 inch Type 201 stainless steel strap used in conjunction with Type 201 stainless steel buckles shall be used to mount the radar detection unit at a height and angle determined by roadway off-set and detection distance in accordance with manufacturer's recommendations.

The manufacturer's recommended power/communication cable shall run on the interior of the mounting structure from the radar detection unit to the communications cabinet. A hole not to exceed 1.5 inches shall be made 12 inches below the radar detection unit to allow passage of the power/communications cable into the structure. The Contractor shall ensure strain relief and drip loops in the power/communication cable before the cable enters the structure in accordance with manufacture's recommendations. A hole not to exceed 1.5 inches shall be made below the communications cabinet to allow the power/communications cable and communications cabinet supply power cable to pass from the interior of the structure to the

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REVISION OF SECTION 614
MICROWAVE VEHICLE RADAR DETECTOR (MVRD)

interior of the communications cabinet. Flexible conduit shall be used to run cables from the structure to the communications cabinet.

The Contractor shall run and connect existing power from the interior of the structure to the 10A circuit breaker in the communications cabinet. The communications cabinet power shall be connected through a 10A in-line waterproof fused disconnect and shall be labeled “Radar Detector Power”. The Contractor shall wire supply power, power supply, surge suppressor, and radar detection unit in accordance with the manufacture’s recommendations. The radar detection unit shall be wired to support RS-232 serial communications. The 6 outlet power strip shall be plugged into the duplex NEMA 5-15R.

All holes shall be free of burs and sharp edges prior to the installation of all cable, conduit, and conduit nipples. All cable entrances in structures, conduits, and cabinets shall be sealed and waterproofed. All wiring and electrical connections shall be performed in conformance with the latest version of the NEC.

REVISION OF SECTION 614
OPTICAL TRANSCEIVER

Section 614 of the Standard Specifications is hereby revised for this project to include the following:

DESCRIPTION

For this project Optical Transceiver shall be a Meridian fiber optic modem and shall be installed in both traffic signal, ramp metering and automated traffic recorder station controller cabinets. The fiber optic modems shall be compatible with both the existing Colorado Department of Transportation Ramp Metering system and Traffic Signal system.

MATERIALS

The Optical Transceiver shall be a multi-drop data modem designed to accept RS-232, RS-422 and 2 & 4 wire RS-485 signals and optically transmits these signals in either string or dual, counter-rotating, self-healing rings with either single or dual masters. The units shall be available as either shelf-mount or rack-mount units as stated on the plans.

The Optical Transceiver shall consist and have the ability of the following:

- Alarm dry contact output
- Selectable anti-streaming
- Local and remote loop back test/diagnostics
- Configurable as either a master or a slave
- Bus, single ring or dual redundant, counter rotating capabilities

The Optical Transceiver shall have LED's to provide status information which shall include as a minimum:

- Optical Fiber Link A – Receiving Optical Signal
- Optical Fiber Link B – Receiving Optical Signal
- Alarm
- Data Transmit A present
- Data Receive A present
- Data Transmit B present
- Data Receive B present

The Optical Transceiver shall operate on external power from a standard 3-prong receptacle that will supply 90 to 135 VAC 60 Hz and shall meet the following environmental and .

- Power 90-135 VAC 50-60 Hz < 2 Watts
- Temperature -37^{o}C to +74^{o}C
- Humidity 5% to 95% Non-Condensing
- Fiber Interface ST Type Connectors
- Fiber 1310 nm Single Mode fiber

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REVISION OF SECTION 614
OPTICAL TRANSCEIVER

Shelf Mount Optical Transceivers shall consist of:

- LED displays for Alarm, Power, Master/Slave, Optical Fiber Link A, Optical Fiber Link B, Data TX, Data RX, Handshake TX and Handshake RX.
- Have the ability to be assigned a unique address without disassembly for network diagnostic identification.
- Have an RS-232 interface for connection to Diagnostic computer
- Capable of being programmed as either a master or slave unit
- Have complete data re-clocking and regeneration
- Include the necessary power cord and transformer

Rack Mount Optical Transceivers shall consist of:

- Shall meet all requirements and operational functions as listed under the Shelf Mounted Optical Transceiver
- Have an RS-232 or USB ports for connection to the remote computer network management and diagnostic software
- Fit in a standard 19” rack

The Contractor shall supply two units of optical transceivers to the Engineer for specification compliance testing and approval. If the product passes the specification compliance testing and approval evaluation, the Contractor will be notified to complete the order. If the product does not pass the specification compliance testing and approval evaluation by the CDOT, the test units will be returned to the Contractor. The Contractor shall supply additional units until satisfactory test results are achieved.

~~REVISION OF SECTION 614~~
~~COURSE WAVELENGTH DIVISION MULTIPLEXING SFP~~

~~DESCRIPTION~~

~~For this project the Course Wavelength Division Multiplexing SFP shall be single wavelength CISCO Small Form Factor Pluggable, (SFP) optic modules for installation in both the field CISCO IE 3000 Ethernet Switches and in the CISCO 3600 Ethernet Router at the Colorado Transportation Management Center in Golden, Colorado. All course wavelength division multiplexing SPF optic modules shall be manufactured by CISCO Systems.~~

~~MATERIALS~~

~~The Contractor shall furnish and install the course wavelength division multiplexing SFP optic modules as shown in the item tables below. This table describes items for installation in CISCO IE 3000 Ethernet switches and in the CISCO 3600 Ethernet switch at the Colorado Transportation Management Center.~~

~~Item Table – For CISCO 3000 Ethernet switches~~

~~ITEM DESCRIPTION~~		~~ITEM NUMBER~~	~~QUANTITY~~
	~~CISCO CWDM 1470-nm SFP~~	~~CWDM-SFP-1470=~~	~~2~~
	~~CISCO CWDM 1490-nm SFP~~	~~CWDM-SFP-1490=~~	~~2~~
	~~CISCO CWDM 1510-nm SFP~~	~~CWDM-SFP-1510=~~	~~2~~
	~~CISCO CWDM 1530-nm SFP~~	~~CWDM-SFP-1530=~~	~~2~~
	~~CISCO CWDM 1550-nm SFP~~	~~CWDM-SFP-1550=~~	~~2~~
	~~CISCO CWDM 1570-nm SFP~~	~~CWDM-SFP-1570=~~	~~1~~
	~~CISCO CWDM 1590-nm SFP~~	~~CWDM-SFP-1590=~~	~~1~~
	~~CISCO CWDM 1610-nm SFP~~	~~CWDM-SFP-1610=~~	~~1~~

~~Item Table – For CISCO 3600 Ethernet switch and Ethernet Router~~

~~ITEM DESCRIPTION~~		~~ITEM NUMBER~~	~~QUANTITY~~
	~~CISCO CWDM 1470-nm SFP~~	~~CWDM-SFP-1470=~~	~~2~~
	~~CISCO CWDM 1490-nm SFP~~	~~CWDM-SFP-1490=~~	~~2~~
	~~CISCO CWDM 1510-nm SFP~~	~~CWDM-SFP-1510=~~	~~2~~
	~~CISCO CWDM 1530-nm SFP~~	~~CWDM-SFP-1530=~~	~~2~~
	~~CISCO CWDM 1550-nm SFP~~	~~CWDM-SFP-1550=~~	~~2~~
	~~CISCO CWDM 1570-nm SFP~~	~~CWDM-SFP-1570=~~	~~1~~
	~~CISCO CWDM 1590-nm SFP~~	~~CWDM-SFP-1590=~~	~~1~~
	~~CISCO CWDM 1610-nm SFP~~	~~CWDM-SFP-1610=~~	~~1~~

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~~**REVISION OF SECTION 614**~~
~~**COURSE WAVE DIVISION MULTIPLEXING SFP**~~

~~If for any reason the SFP optic modules are defective or are damaged at the time of installation by either the Contractor or by CISCO Systems, the optic module shall be removed and replaced at no additional cost to the project. Items shall also be replaced if any failures occur do to by manufacture's defects, at no additional cost to the project prior to the final acceptance.~~

~~**CONSTRUCTION**~~

~~For field Ethernet switch installations, a single course wavelength division multiplexing SFP shall be installed. Two (2) lateral fiber strands shall be brought into the communications cabinet. One strand shall be used for transmitting data and the other shall be used for receiving data.~~

~~For each group of eight (8) Ethernet switches in the add / drop chain, a different wavelength optic module shall be installed. No add / drop chain shall have an optic with identical wavelengths.~~

~~Course Wavelength Division Multiplexing SFP will not be measured or paid for separately, but will be considered incidental to the Ethernet Switch and Ethernet Router pay items.~~

REVISION OF SECTION 614
COURSE WAVELENGTH DIVISION MULTIPLEXING SFP

DESCRIPTION

For this project the Course Wavelength Division Multiplexing SFP shall be single wavelength Course Wavelength Division Multiplexing (CWDM) Small Form-Factor Pluggable (SFP) optic modules for installation in both the field Ciena 3930 Carrier Ethernet Service Delivery Switch (SDS) and the Ciena 5150 Carrier Ethernet Service Aggregation Switch (SAS) at both roadway field device locations and in communication node buildings as part of this project. All Course Wavelength Division Multiplexing SPF optic modules shall be the type and manufacturer as recommended by Ciena.

MATERIALS

The Contractor shall furnish and install the Course Wavelength Division Multiplexing SFP optic modules as shown in the item tables below. These tables describe optic modules for installation in both the Ciena 3930 Carrier Ethernet SDS and in the Ciena 5150 Carrier Ethernet SAS.

Item Table – CWDM SFP Optic Modules For Ciena 3930 Carrier Ethernet SDS Switches

ITEM DESCRIPTION	**ITEM NUMBER**	

100M/1 GIG, SM SFP OPTIC, LC CONNECTOR, 80 KM, 1430 NM, EXT. TEMP	XCVR-A80D43	
100M/1 GIG, SM SFP OPTIC, LC CONNECTOR, 80 KM, 1450 NM, EXT. TEMP	XCVR-A80D45	
100M/1 GIG, SM SFP OPTIC, LC CONNECTOR, 80 KM, 1470 NM, EXT. TEMP	XCVR-A80D47	
100M/1 GIG, SM SFP OPTIC, LC CONNECTOR, 80 KM, 1490 NM, EXT. TEMP	XCVR-A80D49	
100M/1 GIG, SM SFP OPTIC, LC CONNECTOR, 80 KM, 1510 NM, EXT. TEMP	XCVR-A80D51	
100M/1 GIG, SM SFP OPTIC, LC CONNECTOR, 80 KM, 1530 NM, EXT. TEMP	XCVR-A80D53	
100M/1 GIG, SM SFP OPTIC, LC CONNECTOR, 80 KM, 1550 NM, EXT. TEMP	XCVR-A80D55	
100M/1 GIG, SM SFP OPTIC, LC CONNECTOR, 80 KM, 1570 NM, EXT. TEMP	XCVR-A80D57	
100M/1 GIG, SM SFP OPTIC, LC CONNECTOR, 80 KM, 1590 NM, EXT. TEMP	XCVR-A80D59	
100M/1 GIG, SM SFP OPTIC, LC CONNECTOR, 80 KM, 1610 NM, EXT. TEMP	XCVR-A80D61	

Item Table – CWDM SFP Optic Modules For Ciena 5150 Carrier Ethernet SAS Switches

ITEM DESCRIPTION	**ITEM NUMBER**	
100M/1 GIG, SM SFP OPTIC, LC CONNECTOR, 80 KM, 1430 NM, EXT. TEMP	XCVR-A80D43	
100M/1 GIG, SM SFP OPTIC, LC CONNECTOR, 80 KM, 1450 NM, EXT. TEMP	XCVR-A80D45	
100M/1 GIG, SM SFP OPTIC, LC CONNECTOR, 80 KM, 1470 NM, EXT. TEMP	XCVR-A80D47	
100M/1 GIG, SM SFP OPTIC, LC CONNECTOR, 80 KM, 1490 NM, EXT. TEMP	XCVR-A80D49	
100M/1 GIG, SM SFP OPTIC, LC CONNECTOR, 80 KM, 1510 NM, EXT. TEMP	XCVR-A80D51	
100M/1 GIG, SM SFP OPTIC, LC CONNECTOR, 80 KM, 1530 NM, EXT. TEMP	XCVR-A80D53	
100M/1 GIG, SM SFP OPTIC, LC CONNECTOR, 80 KM, 1550 NM, EXT. TEMP	XCVR-A80D55	
100M/1 GIG, SM SFP OPTIC, LC CONNECTOR, 80 KM, 1570 NM, EXT. TEMP	XCVR-A80D57	

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REVISION OF SECTION 614
COURSE WAVE DIVISION MULTIPLEXING SFP

Item Table – For Ciena 5150 Carrier Ethernet SAS Switches (cont)

ITEM DESCRIPTION	**ITEM NUMBER**	
100M/1 GIG, SM SFP OPTIC, LC CONNECTOR, 80 KM, 1590 NM, EXT. TEMP	XCVR-A80D59	
100M/1 GIG, SM SFP OPTIC, LC CONNECTOR, 80 KM, 1610 NM, EXT. TEMP	XCVR-A80D61	

If for any reason the Course Wavelength Division Multiplexing SFP optic modules are defective or are damaged at the time of installation by either the Contractor or by Ciena, the optic module shall be removed and replaced at no additional cost to the project. The SFP optic modules shall also be replaced if any failures occur do to manufacture's defects, at no additional cost to the project prior to the final acceptance.

CONSTRUCTION

For Ciena 3930 Carrier Ethernet SDS installations, a Single Course Wavelength Division Multiplexing SFP optic module shall be installed for both upstream and downstream data communications.

For connection to the optical fiber network, one (1) lateral fiber optic cable shall be brought into the device communications cabinet from the CWDM splice closure for termination. Two (2) lateral fiber strands shall be used for communication, one strand for transmitting data and the other shall be used for receiving data.

The Contractor shall ensure that the Course Wavelength Division Multiplexing optic module wavelength installed in the Ciena 3930 Carrier Ethernet SDS switch at field device location and the corresponding Ciena 5150 Carrier Ethernet SAS Single Course Wavelength Division Multiplexing optic module wavelength in the communications node building are cabled properly to ensure proper data communications.

Course Wavelength Division Multiplexing SFP will not be measured or paid for separately, but will be considered incidental to the Ethernet Switch and Ethernet Router pay items.

~~REVISION OF SECTION 614~~
~~ETHERNET SWITCH~~

~~DESCRIPTION~~

~~For this project Ethernet Switch shall be a CISCO Systems IE-3000-8TC Ethernet Switch and shall be installed in communication cabinets and variable message signs to transport Ethernet data to and from roadway Intelligent Transportation System devices on this project. The switch shall be configured with 8 10/100 Ethernet ports in addition to two (2) Small Form-Factor Pluggable (SFP) based 1 Gigabit Ethernet ports. All components shall be manufacturer by CISCO Systems.~~

~~The switches shall be utilized for course wavelength division multiplexing (CWDM). Each switch shall be provided with a single CWDM SFP optic module with a wavelength as stated in the Project Plans and the Project Specification 614 - Course Wave Division Multiplexing SFP, included in the project specification package. All CWDM SFP optic modules shall be paid for as part of the Ethernet switch item.~~

~~MATERIALS~~

~~The Contractor shall furnish and install the Ethernet Switch as configured in the item table below. This table describes items for a single CISCO Ethernet switch.~~

~~Item Table -~~

~~ITEM DESCRIPTION~~		~~ITEM NUMBER~~	~~QUANTITY~~
	~~CISCO IE 3000 Switch, 8 10/100 + 2 T/SFP~~	~~IE-3000-8TC~~	~~1~~
	~~IE 3000 Power Transformer~~	~~PWR-IE3000-AC=~~	~~1~~
	~~Smartnet 8x5xNBD~~	~~CON-SNT-IE38TC~~	~~1~~

~~The Ethernet Switch shall be installed with a basic configuration in conformance with CISCO Systems by a certified CISCO representative either prior to installation or at the installation site. Final configuration for data transport will be conducted by Colorado Department of Transportation personnel after the basic configuration.~~

~~All associated hardware not listed in the item table is considered subsidiary and is required for a complete installation and shall be included as part of the work.~~

~~Upon delivery to the Contractor, the Ethernet switch shall be delivered to the Colorado Transportation Management Center. At that time, IP Addressing shall be the responsibility of the Colorado Department of Transportation. After the switches have been fully configured for the intended location, CDOT will return the switches to the Contractor for installation.~~

~~If field changes are made which would affect the Contractor's original order for the Ethernet Switch which would require any modifications to the Ethernet Switch order, the Contractor shall~~

~~ensure that the CISCO Systems representative is contacted and made aware of such changes in order to alleviate any possible delays in delivery.~~

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~~**REVISION OF SECTION 614**~~
~~**ETHERNET SWITCH**~~

~~If for any reason the switch or associated device modules are defective or are damaged at the time of installation by either the Contractor or by CISCO Systems, the item shall be removed and replaced at no additional cost to the project. Items shall also be replaced if any failures occur do to by manufacture's defects, at no additional cost to the project prior to the final acceptance.~~

~~**CONSTRUCTION**~~

~~Ethernet switches shall be installed in linear switch strings, in an add / drop configuration with each switch having one course wavelength division multiplexing optic. The optics shall be provided in the wavelengths shown in the 614- Course Wavelength Division Multiplexing SFP specification.~~

~~The Ethernet switch and all of its components shall be DIN Rail mountable. A field site survey for final placement of the Ethernet switch at each location shall be conducted prior to installation.~~

~~For field installations, the Contractor shall install a single mode, bend optimized, pre-connectorized duplex patch cable from the course wavelength division multiplexing SFP optic module to the communications termination patch panel. Connectors for the patch cable shall be LC on the Ethernet switch end and ST on the termination panel end.~~

~~For installations in variable message signs, the contractor shall install an aluminum backplane on the internal structural supports of the sign housing. The backplane shall be large enough to mount the fiber optic termination patch panel, and DIN rails for both the Ethernet switch and the Serial to IP Converter and Power Supply. It shall be mounted in a location which will not interfere with future maintenance of the variable message sign electronics and cabling.~~

~~Ethernet Switch will be measured by the actual number of Ethernet Switches installed and accepted for a complete installation. Also included shall be the course wavelength division multiplexing small form-factor pluggable optic module, power transformer, all basic configuration, wiring, patch cables, aluminum backplane, documentation, and testing by the CISCO representative. All costs associated with arranging for the CISCO representative to be on-site will not be paid for separately, but shall be included in the cost of the item.~~

REVISION OF SECTION 614
ETHERNET SWITCH

DESCRIPTION

For this project Ethernet Switch shall be a Ciena 3930 Carrier Ethernet Service Delivery Switch (SDS) and shall be installed in communication cabinets and variable message signs to transport Ethernet data to and from roadway Intelligent Transportation System devices on this project. All Ethernet switches shall be manufactured by Ciena.

The Ethernet switches shall utilize Course Wavelength Division Multiplexing (CWDM), Small Form-Factor Pluggable (SFP) optic modules. Each switch shall be provided with both a Course Wavelength Division Multiplexing SFP optic module and a 1310nm optic module. Optic modules shall be provided as shown in the Project Plans and the Project Specifications, 614 - Course Wave Division Multiplexing SFP and 614 – Small Form-Factor Pluggable – 1310nm included in the project specification package. All optic modules shall be paid for as part of the Ethernet switch item.

MATERIALS

The Ethernet switch shall be configured with four (4) 100M/1000M Small Form-Factor Pluggable Ethernet ports, four (4) 100M/1000M Small Form-Factor Pluggable/RJ-45 Ethernet ports and two (2) 1G/10G Small Form-Factor+ Ethernet ports.

The Contractor shall furnish and install the Ethernet switch and associated items shown in the item table below. The table describes items for a single Ciena 3930 Ethernet switch.

Item Table – Ciena 3930 Carrier Ethernet SDS Switch

ITEM DESCRIPTION	ITEM NUMBER	QUANTITY
3930, (4) 100M/100M SFP, (4)100/1000M SFP/RJ-45, (2)1G/10G SFP+, EXT.TEMP, (2) SLOTS AC/DC PWR SUP	170-3930-900	1
3930, AC PLUGGABLE POWER SUPPLY, WIDE RANGE 120/240V	170-0014-900	2
SAOS ADVANCED ETHERNET PERPETUAL SOFTWARE LICENCE FOR 3930	S70-0001-900	1
SAOS ADVANCED OAM PERPETUAL SOFTWARE LICENSE FOR 3930	S70-0001-901	1
SAOS ADVANCED SECURITY PERPETUAL SOFTWARE LICENSE FOR USE WITH SAOS 6.X	170-0204-900	1
SMARTSUPPORT, 3930, 3 YEARS	80M-3930-SM3	1
HARDWARE REPAIR SERVICE 10 DAY MAINTENANCE, 3930, 2 YEARS	80M-3930-HW2	1
NEXT BUSINESS DAY MANAGED SPARES, CN 3930, 3 YEARS	80M-3930-NA3	1

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REVISION OF SECTION 614
ETHERNET SWITCH

All associated hardware not listed in the item table is considered subsidiary and is required for a complete installation and shall be included as part of the work.

Each Ethernet Switch shall be furnished and installed with a G.8032 ring protection configuration in conformance with Ciena's Ethernet Design and Configuration Services per the Colorado Department of Transportation (CDOT) requirements either prior to installation or at the individual installation sites.

Final configuration including all IP schema design for data transport will be conducted by CDOT personnel after installation and G.8032 configuration.

If field changes are made which affect the original Contractor's material order for the Ethernet switches and require any reconfiguration of the original Ethernet switch order, the Contractor shall ensure that the Ciena representative is contacted and made aware of such changes to alleviate any possible delays in delivery and installation. If for any reason the switch or associated materials are defective or are damaged at the time of installation by either the Contractor or by Ciena, the item shall be removed and replaced at no additional cost to the project. Items shall also be replaced if any failures occur do to manufacture's defects, at no additional cost to the project prior to the final acceptance.

CONSTRUCTION

The 3930 SDS Ethernet switch installed in field communication cabinets will be connected via the fiber optic backbone to Ciena 5150 Service Aggregation Switches (SAD) located in corresponding communications node buildings in a protected ring design. Each switch shall have both a Course Wavelength Division Multiplexing SFP optic module and 1310nm SFP optic module. There shall be two (2) Ethernet switches interconnected per CWDM wavelength with a maximum of ten (10) wavelengths per fiber pair. Each fiber pair will support up to a total of twenty (20) 3930 SDS switches creating a single Carrier Ethernet diverse path sub-ring.

The 3930 SDS Ethernet switch shall include one (1) Course Wavelength Division Multiplexing SFP and one (1) 1310nm SFP optic module. For connection of the switch to the optical fiber network, one (1) lateral fiber optic cable shall be brought into the device communications cabinet from the CWDM splice closure for termination. A total of four (4) lateral fiber strands shall be used for data communications to the Ethernet switch. Two (2) lateral fiber strands shall be used for communications upstream and downstream connecting the SFP optics carrying CWDM traffic, and two (2) lateral fiber strands shall be used for communications upstream and downstream connecting the 1310nm SFP optics. Each pair of fiber strands shall be designed for transmitting data on one strand and receiving data on the other.

The Contractor shall install a single mode, bend optimized, pre-connectorized duplex patch cable with a polyurethane jacket for connection from the course wavelength division multiplexing

SFP optic module and the 1310nm optic module to the termination patch panel. Connectors for the patch cable shall be LC on the Ethernet switch end and ST on the termination panel end.

The patch cable shall be of sufficient length to span from the Ethernet switch to the patch panel with a maximum of two (2) feet of slack. It shall be installed in a manner which will not interfere

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REVISION OF SECTION 614
ETHERNET SWITCH

with device equipment in the communication cabinet and will include cable management so as not to interfere with future maintenance within the cabinet.

For installations in variable message signs, the Contractor shall install an aluminum backplane on the internal structural supports of the sign housing. The backplane shall be large enough tomount the Ethernet switch, fiber optic termination patch panel, and DIN rails for mounting of a serial to IP converter and power supply. The backplane and equipment shall be mounted in a location which will enable protection of the equipment, fiber optic connectors for the Ethernet switch optic modules, wiring and cabling while allowing ease of access for future maintenance of both the variable message sign electronics and communications equipment.
Ethernet Switch will be measured by the actual number of Ethernet Switches installed and accepted for a complete installation. Also included shall be Course Wavelength Division Multiplexing Small Form-Factor Pluggable optic modules, 1310nm Small Form-Factor Pluggable optic modules, power supplies, power cables, licenses, switch software, basic configuration, wiring, patch cables, aluminum backplane, documentation, and testing by the Ciena representative. All costs associated with arranging for the Ciena representative to be on-site will not be paid for separately, but shall be included in the cost of the item.

~~REVISION OF SECTION 614~~
~~ETHERNET ROUTER~~

~~DESCRIPTION~~

~~For this project Ethernet Router shall be a WS-3600-24FS-M CISCO Catalyst Ethernet Switch and shall be installed at the Colorado Transportation Management Center (CTMC) in Golden, Colorado for transport of Ethernet data to and for roadway devices on this project. The switch shall be configured with twenty four (24) Small Form-Factor Pluggable (SFP) 1 Gigabit Ethernet ports and two (2) SFP based 10 Gigabit Enhanced Services (ES) ports. All components shall be manufacturer by CISCO Systems.~~

~~The switch shall be utilized for course wavelength division multiplexing (CWDM). The switch shall be provided with CWDM SFP optic modules with wavelengths stated in the 614 - Course Wavelength Division Multiplexing SFP specification. All CWDM SFP optic modules shall be paid for as part of the Ethernet switch item.~~

~~MATERIALS~~

~~The Contractor shall furnish and install the Ethernet Switch as configured in the item table below. The table describes items for a single CISCO Ethernet switch~~

~~Item Table -~~

	~~ITEM DESCRIPTION~~	~~ITEM NUMBER~~	~~QUANTITY~~
	~~CISCO Catalyst 3600M Series Switch~~	~~WS-3600X-24FS-M~~	~~1~~
	~~ME3600X AC Power Supply~~	~~PWR-ME3KX-AC~~	~~2~~
	~~Advanced Metro IP Access License~~	~~ME3600X-A~~	~~1~~
	~~Smartnet 8x5xNBD~~	~~CON-SNT-M36X24FS~~	~~1~~
	~~10GE Upgrade License~~	~~ME3600X-10G~~	~~1~~
	~~10GBASE-ER SFP Module~~	~~SFP-10G-ER=~~	~~2~~

~~The Ethernet Switch shall be installed with a basic configuration in conformance with CISCO Systems by a certified CISCO representative either prior to installation or at the installation site. Final configuration for data transport will be conducted by Colorado Department of Transportation personnel after the basic configuration.~~

~~All associated hardware not listed in the item table is considered subsidiary and is required for a complete installation and shall be included as part of the work.~~

~~All IP Addressing shall be the responsibility of the Colorado Department of Transportation.~~

~~If field changes are made which would affect the Contractor's original order for the Ethernet Switch and would require modifications to the Ethernet Switch order, the Contractor shall ensure that the CISCO Systems representative is contacted and made aware of such changes in order to alleviate any possible delays in delivery.~~

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~~REVISION OF SECTION 614~~
~~ETHERNET ROUTER~~

~~If for any reason the switch or associated device modules are defective or are damaged at the time of installation by either the Contractor or by CISCO Systems, the item shall be removed and replaced at no additional cost to the project. Items shall also be replaced if any failures occur do to by manufacture's defects, at no additional cost to the project prior to the final acceptance.~~

~~CONSTRUCTION~~

~~The Ethernet switch shall be installed in an existing communication rack at the CTMC and will include course wavelength division multiplexing optics with wavelengths stated in the 614 - Course Wavelength Division Multiplexing SFP specification.~~

~~The Contractor shall install a single mode pre-connectorized duplex patch cable from the course wavelength division multiplexing SFP optic module to the associated wavelength port of the 8 channel course wavelength multiplexing module. Connectors for the patch cable shall be LC on the Ethernet switch end and LC on the 8 channel course wavelength multiplexing module end.~~

~~Ethernet Router will be measured by the actual number of Ethernet Switches installed and accepted for a complete installation. Also included shall be the course wave division multiplexing small form-factor pluggable optic modules, 10 Gigabit -ER SFP Modules, all basic configuration, wiring, patch cables, documentation, and testing by the CISCO representative. All costs associated with arranging for the CISCO representative to be on-site will not be paid for separately, but shall be included in the cost of the item.~~

REVISION OF SECTION 614
ETHERNET ROUTER

DESCRIPTION

For this project Ethernet Router shall be a Ciena 5051 Carrier Ethernet Service Aggregation Switch (SAS) utilizing Course Wavelength Division Multiplexing (CWDM), Small Form-Factor Pluggable (SFP) optic modules and shall be installed in communication node buildings to transport Ethernet data to and from Ciena 3930 Carrier Ethernet Service Delivery Switches at roadway Intelligent Transportation System device on this project. The Ethernet switch shall be uplinked to either a new or existing 10G Ethernet backbone switch using multimode optics. All 5150 Carrier Ethernet Service Aggregation switches shall be manufactured by Ciena.

The Ethernet switches shall have the ability to accept up to a maximum of forty eight (48) 1G ports. The switch shall also accept four (4) 10G ports. 1G ports will have a combination of CWDM and 1310nm SFP optic modules as shown in the Project Plans and the Project Specifications, 614 - Course Wave Division Multiplexing SFP and 614 – Small Form-Factor Pluggable – 1310nm included in the project specification package. All optic modules shall be paid for as part of the Ethernet Router item.

MATERIALS

The Ethernet switch shall be configured with forty eight (48) 100M/1000M Small Form-Factor Pluggable Ethernet ports two (2) 10G Module Slots and two (2) 10G XFP ports per module.

The Contractor shall furnish and install the Ethernet switch and associated items shown in the item table below. The table describes items for a single Ciena 5150 Ethernet switch.

Item Table – Ciena 5150 Carrier Ethernet SAS Switch

ITEM DESCRIPTION	ITEM NUMBER	QUANTITY
5150, (48) 100/1000M SFP, (2) SLOTS 10G DUAL XFP MODULE, EXT. TEMP, (2)SLOTS AC OR DC PLUG POWER SUPPLY	170-5150-900	1
AC PLUGGABLE POWER SUPPLY,CN 5051	170-0100-902	2
10 GIG,MM XFP OPTIC,LC CONNECTOR,300 METERS,850NM,EXTENDED TEMPERATURE	XCVR-A00Z85	2
SAOS ADVANCED ETHERNET PERPETUAL SOFTWARE LICENSE FOR 48-PORT CN	170-0205-904	1
SAOS ADVANCED OAM PERPETUAL SOFTWARE LICENSE FOR 48-PORT CN 5150 CHASSIS	170-0206-904	1
SAOS ADVANCED ETHERNET PERPETUAL SOFTWARE LICENSE FOR CN 5150 (2) 10	170-0205-905	1
SAOS ADVANCED OAM PERPETUAL SOFTWARE LICENSE FOR CN 5150 (2) 10 GIG MODULE	170-0206-905	1
SAOS ADVANCED SECURITY PERPETUAL SOFTWARE LICENSE	170-0204-900	1

FOR USE WITH SAOS 6.X		

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REVISION OF SECTION 614
ETHERNET ROUTER

All associated hardware not listed in the item table is considered subsidiary and is required for a complete installation and shall be included as part of the work.

Each Ethernet Switch shall be furnished and installed with a G.8032 ring protection configuration in conformance with Ciena's Ethernet Design and Configuration Services per the Colorado Department of Transportation (CDOT) requirements either prior to installation or at the individual communications nodes.

Final configuration including all IP schema design for data transport will be conducted by CDOT personnel after installation and G.8032 configuration.

If field changes are made which affect the original Contractor's material order for the Ethernet switches and require any reconfiguration of the original Ethernet switch order, the Contractor shall ensure that the Ciena representative is contacted and made aware of such changes to alleviate any possible delays in delivery and installation. If for any reason the switch or associated materials are defective or are damaged at the time of installation by either the Contractor or by Ciena, the item shall be removed and replaced at no additional cost to the project. Items shall also be replaced if any failures occur do to manufacture's defects, at no additional cost to the project prior to the final acceptance.

CONSTRUCTION

The 5051 SAS Ethernet switch installed in communications node buildings and will be connected via the fiber optic backbone to Ciena 3930 Service Delivery Switches (SDD) located in field communication cabinets configured in a protected ring design. Each Switch shall have a combination of both Course Wavelength Division Multiplexing SFP optic modules and 1310nm SFP optic modules. The Ethernet switch will also be connected to a 10G backbone Ethernet switch. This connection shall be made using a 10G multimode optic module and multimode patch cables.

The Contractor shall install both single mode and multimode, bend optimized, pre-connectorized duplex patch cables with a polyurethane jacket for connection from the Course Wavelength Division Multiplexing SFP optic modules and the Course Wavelength Division Multiplexing filter cassette in the communication node building. Connectors for the patch cable shall be LC on the Ethernet switch end and ST on the termination panel end.

The patch cables in the communication node buildings shall be of sufficient length to span from the Ethernet switch to the Course Wavelength Division Multiplexing filter cassette with a maximum of four (4) feet of slack. It shall be installed in a manner which will not interfere with equipment in the communication racks and will be installed within existing cable management hardware.

Ethernet Router will be measured by the actual number of Ethernet Switches installed and accepted for a complete installation. Also included shall be Course Wavelength Division Multiplexing Small Form-Factor Pluggable optic modules, 1310nm Small Form-Factor Pluggable optic modules, 10G multimode optics, power supplies, power cables, licenses, switch software, basic configuration, wiring, patch cables, documentation, and testing by the Ciena

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REVISION OF SECTION 614
ETHERNET ROUTER

representative. All costs associated with arranging for the Ciena representative to be on-site will not be paid for separately, but shall be included in the cost of the item.

~~REVISION OF SECTION 614~~
~~TELEMETRY (FIELD)~~

~~DESCRIPTION~~

~~For this project Telemetry (Field) shall be an AFL Dual Single Channel Course Wavelength Division Multiplexor Optical Add/Drop OSP Cassette, (ODAM) unit manufactured for use in coarse wavelength division multiplexing (CWDM) at all CISCO IE 3000 Ethernet switch locations. The unit shall have the capabilities of splitting a single wavelength from the multiple signals traveling along the fiber strands to the proposed Ethernet switch while allowing the remaining wavelengths to travel both upstream and downstream to adjoining switches.~~

~~MATERIALS~~

~~The single wavelength ODAM units shall have an operating range of 1260nm to 1620nm and a channel center wavelength of;~~

~~1471nm, 1491nm, 1511nm, 1531nm, 1551nm, 1571nm, 1591nm and 1611nm~~

~~The Contractor shall furnish and install the individual single wavelength ODAM at each switch matching the wavelength of the switch's small form factor pluggable (SFP) optic module in order of wavelength beginning from the Colorado Transportation Management Center head end as follows:~~

~~Ethernet switch SFP Optic Wavelengths~~

~~Ethernet Switch Number 1 1471 nm~~
~~Ethernet Switch Number 2 1491 nm~~
~~Ethernet Switch Number 3 1511 nm~~
~~Ethernet Switch Number 4 1531 nm~~
~~Ethernet Switch Number 5 1551 nm~~
~~Ethernet Switch Number 6 1571 nm~~
~~Ethernet Switch Number 7 1591 nm~~
~~Ethernet Switch Number 8 1611 nm~~

~~If for any reason the single wavelength ODAM is defective or is damaged at the time of installation by the Contractor, the item shall be removed and replaced at no additional cost to the project. Items shall also be replaced if any failures occur do to by manufacture's defects, at no additional cost to the project prior to the final acceptance.~~

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~~**REVISION OF SECTION 614**~~
~~**TELEMETRY (FIELD)**~~

~~**CONSTRUCTION**~~

~~The single wavelength ODAM shall be installed and fusion spliced to two (2) lateral fiber cables in a canister separate from the canister used to splice the backbone fiber cable. The canister required for the single wavelength ODAM shall be sized to accept two (2) 12 strand fiber optic cables and one single wavelength ODAM, a full size canister is not required for this work.~~

~~The single wavelength ODAM shall have six (6) fiber connections for spicing to the two lateral fiber optic cables from the backbone splice canister and the field communications cabinet. The connections shall give the ability of splitting out appropriate wavelengths at each splice location. The fiber connections shall facilitate the transmitting and receiving of individual wavelengths as follows for each of the fiber strands of the Ethernet switch optic:~~

~~COMM Port - All wavelengths enter the ODAM~~
~~PASS Port - Allows the intended wavelength to pass through both to and from the Ethernet Switch SFP~~
~~EXP - Allows all non-required wavelengths to pass through the ODAM to Ethernet switches upstream or downstream in the linear configuration design.~~

~~If for any reason the Contractor installs or splices the single wavelength ODAM in a location which does not match the CISCO course wavelength division multiplexing SFP optic module, The Contractor shall replace the ODAM and resplice all fibers at no additional cost to the project.~~

~~Telemetry (Field) will be measured by the actual number of Dual Single Channel Course Wavelength Division Multiplexor Optical Add/Drop OSP Cassette installed and accepted for a complete installation.~~

REVISION OF SECTION 614
TELEMETRY (FIELD)

DESCRIPTION

For this project Telemetry (Field) shall be a Single Channel Course Wavelength Division Multiplexing (CWDM) optical filter manufactured for use in Course Wavelength Division Multiplexing at all Ciena 3930 Carrier Ethernet Service Delivery Switch field locations. The filter shall have the capabilities of splitting a single wavelength from the multiple signals traveling along the optical fiber strands to the proposed Ethernet switch while allowing the remaining wavelengths to travel both upstream and downstream to adjoining switches.

MATERIALS

The single wavelength Course Wavelength Division Multiplexing optical filters shall be provided in the operating range of 1430nm to 1610nm. to match the wavelengths of the Course Wavelength Division Multiplexing Small Form-Factor Pluggable optic modules. The individual filters shall have the following channel center wavelengths.

1430nm, 1450nm, 1470nm, 1490nm, 1510nm, 1530nm, 1550nm, 1570nm, 1590nm and 1610nm

A 1310nm wavelength filter shall also be required.

The Contractor shall furnish and install the individual single wavelength filters at each switch location matching the wavelength of the switch's Course Wavelength Division Multiplexing (SFP) optic module and the 1310nm SFP optic module.

If for any reason the single wavelength filter is defective or is damaged at the time of installation by the Contractor, the filter shall be removed and replaced at no additional cost to the project. Filters shall also be replaced if any failures occur do to by manufacture's defects, at no additional cost to the project prior to the final acceptance.

All course wavelength division multiplexing filters shall be the type and manufacturer as recommended by Ciena.

CONSTRUCTION

The single wavelength filter shall be fusion spliced to the lateral fiber optic cable strands and installed in a splice tray within a splice closure separate from the closure used to splice the backbone fiber cable. The closure required for the single wavelength filter shall be sized to accept up to three (3) strand fiber optic cables and multiple single wavelength filters, a full size canister is not required for this work.

The single wavelength filter shall have three (3) fiber pigtails for spicing to the lateral fiber optic strands from the backbone splice closure and the field communications cabinet. The filter splice connections shall give the ability of splitting out appropriate wavelengths to each Ethernet switch.

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REVISION OF SECTION 614
TELEMETRY (FIELD)

To ensure that both the CWDM wavelength and the 1310 wavelength are delivered to each switch, splicing of multiple filters is required.

If for any reason the Contractor installs or splices any single wavelength filters in a location which does not match the course wavelength division multiplexing SFP optic module, The Contractor shall replace the filter and re-splice all fibers at no additional cost to the project. Telemetry (Field) will be measured by the actual number of Single Channel Course Wavelength Division Multiplexor Optical Filters installed and accepted for a complete installation.

~~REVISION OF SECTION 614~~
~~TELEMETRY (MASTER)~~

~~DESCRIPTION~~

~~For this project Telemetry (Master) shall be an AFL 8-Channel Course Wavelength Division Multiplexing LGX Module, 1471-1611NM, LC/APC Bulkheads, Test In/Out Ports, Upgrade Port module installed at the Colorado Transportation Management Center Data Center (CTMC) in Golden, Colorado. The unit shall have the capabilities of accepting multiple wavelengths from a CISCO network switch containing CISCO course wavelength division multiplexing small form factor pluggable (SFP) optic modules and multiplexing them onto a one single mode fiber or receiving multiple wavelengths over a single mode fiber.~~

~~MATERIALS~~

~~The 8-channel course wavelength division multiplex (CWDM) module shall have twelve (12) ports including ports to accommodate 8 separate wavelengths, fiber optic test ports and communications ports. These ports shall include:~~

~~Test and Communications Ports~~
~~Test Transmit Port 1~~
~~Test Receive Port 2~~
~~Upgrade Port 3~~
~~Communications Port 4~~

~~Wavelength Ports~~
~~1611nm Port 5~~
~~1591nm Port 6~~
~~1571nm Port 7~~
~~1551nm Port 8~~
~~1531nm Port 9~~
~~1511nm Port 10~~
~~1491nm Port 11~~
~~1471nm Port 12~~

~~The 8-channel CWDM module shall have the ability of either combining or splitting up to 8 individual wavelengths. The wavelength compatibility shall match those being transmitted and received from both the CISCO Ethernet switch at the CTMC and the field single wavelength optical add / drop multiplexor at the field switch sites.~~

~~If for any reason the 8-channel CWDM module is defective or is damaged at the time of installation by the Contractor, the item shall be removed and replaced at no additional cost to the project. Items shall also be replaced if any failures occur do to by manufacture's defects, at no additional cost to the project prior to the final acceptance.~~

~~The 8-channel CWDM shall also include a single chassis capable of mounting in an existing communications equipment rack at the CTMC.~~

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~~REVISION OF SECTION 614~~
~~TELEMETRY (MASTER)~~

~~CONSTRUCTION~~

~~The 8-channel CWDM and chassis shall be installed in an existing communications equipment rack at the CTMC. The Contractor shall install single mode patch cable from the individual wavelength ports to the corresponding optic ports in the CTMC CISCO Ethernet switch.~~

~~All transmit wavelengths shall originate from the CTMC CISCO Ethernet switch SFP transmit port and be connected via a single mode patch cable to the 8-channel CWDM module designated as transmit, multiplexed and sent to the appropriate Ethernet switch.~~

~~All receive wavelengths originating from the Ethernet switch linear strings number 1 or number 2, shall be connected via a single mode patch cable from the 8-channel CWDM module designated as receive to the appropriate CTMC CISCO Ethernet switch SFP receive port.~~

~~Telemetry (Field) will be measured by the actual number of 8-Channel Course Wavelength Division Multiplexing LGX Module, 1471-1611NM, LC/APC Bulkheads, Test In/Out Ports, Upgrade Port modules and a single chassis installed and accepted for a complete installation.~~

REVISION OF SECTION 614
TELEMETRY (MASTER)

DESCRIPTION

For this project Telemetry (Master) shall be a 10-Channel Course Wavelength Division Multiplexing Module, 1430-1610NM, LC/APC Bulkheads, Test In/Out Ports and Pass module installed in communication node building equipment racks. The unit shall have the capabilities of transmitting and receiving multiple wavelengths from a Ciena 3930 Carrier Ethernet Service Delivery Switches (SDS) to the Ciena 5150 Carrier Ethernet Service Aggregation Switches (SAS) installed in the same node buildings.

MATERIALS

The 10-channel Course Wavelength Division Multiplexing (CWDM) module shall have twelve (12) ports including ports to accommodate 10 separate wavelengths, fiber optic test ports and communications ports.

The individual filter ports shall have the following wavelengths.

1430nm, 1450nm, 1470nm, 1490nm, 1510nm, 1530nm, 1550nm, 1570nm, 1590nm and 1610nm

The 10-channel CWDM module shall have the ability of combining or splitting up to 10 individual wavelengths. The wavelength compatibility shall match those being transmitted and received from both the Ciena 3930 SDS Ethernet switch at field device locations and the Ciena 5150 SAS in the communications node building.

If for any reason the 10-channel Course Wavelength Division Multiplexing module is defective or is damaged at the time of installation by the Contractor, the item shall be removed and replaced at no additional cost to the project. Modules shall also be replaced if any failures occur do to by manufacture's defects, at no additional cost to the project prior to the final acceptance.

The 10-channel CWDM shall also include a single chassis capable of mounting in an existing communications equipment rack at the communications node building equipment rack

CONSTRUCTION

The 10-channel CWDM and chassis shall be installed in communication equipment racks at either the field communications node building or at the Colorado Transportation Management Center..

The Contractor shall install a single mode, bend optimized, pre-connectorized duplex patch cable with a polyurethane jacket for connection from the Course Wavelength Division Multiplexing SFP optic module to the termination patch panel. Connectors for the patch cable shall be LC on the Ethernet switch end and ST on the termination panel end.

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REVISION OF SECTION 614
TELEMETRY (MASTER)

The patch cable shall be of sufficient length to span from the termination patch panel and to the Ciena SAS Ethernet switch with a maximum of two (2) feet of slack. It shall be installed in a manner which will not interfere with device equipment in the communication cabinet and will include cable management so as not to interfere with future maintenance within the cabinet

All wavelengths shall originate from the Ciena SAS Ethernet switch Course Wavelength Division Multiplexing SFP optic module and be connected via a single mode duplex patch cable to the 10-channel CWDM module designated as for that wavelength, multiplexed and sent to the appropriate Ciena 3930 SDS Ethernet switch.

Telemetry (Master) will be measured by the actual number of 10-Channel Course Wavelength Division Multiplexing Module, 1430-1610NM, LC/APC Bulkheads and a single chassis installed and accepted for a complete installation.

REVISION OF SECTION 614
SMALL FORM-FACTOR PLUGGABLE – 1310NM SFP

DESCRIPTION

For this project the Small Form-Factor Pluggable – 1310NM SFP shall be single wavelength Small Form-Factor Pluggable (SFP) optic module for installation in both the field Ciena 3930 Carrier Ethernet Service Delivery Switch (SDS) and the Ciena 5150 Carrier Ethernet Service Aggregation Switch (SAS) at both roadway field device locations and in communication node buildings as part of this project. All Small Form-Factor Pluggable optic modules shall be the type and manufacturer as recommended by Ciena.

MATERIALS

The Contractor shall furnish and install the 1310nm SFP optic module as shown in the item tables below. These tables describe optic modules for installation in both the Ciena 3930 Carrier Ethernet SDS and in the Ciena 5150 Carrier Ethernet SAS.

Item Table – CWDM SFP Optic Modules For Ciena 3930 Carrier Ethernet SDS Switches

ITEM DESCRIPTION	ITEM NUMBER	
100M/1 GIG, SM SFP OPTIC, LC CONNECTOR, 10 KM, 1310 NM, EXTENDED TEMPERTURE	XCVR-A10Y31	

Item Table – CWDM SFP Optic Modules For Ciena 5150 Carrier Ethernet SAS Switches

ITEM DESCRIPTION	ITEM NUMBER	
100M/1 GIG, SM SFP OPTIC, LC CONNECTOR, 10 KM, 1310 NM, EXTENDED TEMPERTURE	XCVR-A10Y31	

If for any reason the 1310nm SFP optic modules are defective or are damaged at the time of installation by either the Contractor or by Ciena, the optic module shall be removed and replaced at no additional cost to the project. The SFP optic modules shall also be replaced if any failures occur do to manufacture's defects, at no additional cost to the project prior to the final acceptance.

CONSTRUCTION

For Ciena 3930 Carrier Ethernet SDS installations, a single 1310nm SFP optic module shall be installed for both upstream and downstream data communications.

For connection to the optical fiber network, one (1) lateral fiber optic cable shall be brought into the device communications cabinet from the CWDM splice closure for termination. Two (2) lateral fiber strands shall be used for communication, one strand for transmitting data and the other shall be used for receiving data.

Small Form-Factor Pluggable – 1310NM SFP will not be measured or paid for separately, but will be considered incidental to the Ethernet Switch and Ethernet Router pay items.

REVISION OF SECTION 614
GLOBAL POSITIONING SYSTEM (GPS)

DESCRIPTION

The Contractor shall provide Global Positioning System Coordinates (GPS) information for all device, pull box and manhole locations on this project. Both proposed and existing device coordinates shall be provided.

CONSTRUCTION REQUIREMENTS

The Contractor shall provide geodetic datum for all roadway devices, fiber optic pull boxes and manholes within the project limits. This shall include Intelligent Transportation Devices, traffic signal controller cabinets, ramp metering cabinets, automated traffic recorder cabinets in addition to pull boxes and fiber optic cable running line manholes.

The Contractor shall use a device designed specifically for mapping GPS information to Universal Transverse Mercator (UTM) Zone 13 coordinate system utilizing 1983 North American Datum (NAD83). Cell phones with GPS capabilities shall not be allowed for determining GPS location.

The GPS data shall be expressed in Latitude/Longitude and Universal Transverse Mercator (UTM) Zone 13utilizing 1983 North American Datum (NAD83). Altitude shall be expresses in meters:

- Latitude / Longitude:
  - In Decimal Degree (DD) format to a precision of 6 decimal places.
    - Example - Latitude: _____ Longitude _____ Altitude (m) _____

- North American Datum :
  - In Coordinates to a precision of 3 decimal places.
    - Example - X(easting) _____ Y(northing) _____ Z (m) _____

For data collection, the Contractor shall use averaged waypoint at the proposed locations. Minimum averaging time at each location shall be 2 minutes (120 seconds) prior to documenting the information.

Accuracy tolerances for data collected by the GPS unit shall be within a maximum of 3 meters.

Documentation verifying the type of GPS unit being proposed for use and the specifications of the unit shall be provided to the Project Engineer for review prior to data gathering.

The Contractor shall completely fill in all information on the attached form for submittal to the Project Engineer.

Global Positioning System (GPS) information gathering will not be measured or paid for separately but will be considered incidental to the pay item being installed. This work shall include all labor, materials and equipment required to complete the work.

REVISION OF SECTION 614
TEST FIBER OPTIC CABLE

Section 614 of the Standard specifications is hereby revised for this project as follows:

DESCRIPTION

Subsection 614.01 shall include the following:

Test fiber optic cable shall include an OTDR test on all fiber optic cable strands install on the project by the Contractor. In addition, an optical power meter test shall be conducted on fiber strands from all device locations to the regen buildings.

TESTING

Subsection 614.08 shall include the following:

(r) Test Fiber Optic Cable. For this project this work shall consist of the testing of either multimode or Single Mode fiber optic cable as shown and tabulated in the plans. The testing procedures involve an OTDR test and an Optical Power Meter Test.

Guidelines for fiber optic cable testing include:

(1) Test jumpers and patch cords must be of the same fiber core size and connector type as the cable system:
Multimode fiber 62.5/125 μm
Single Mode fiber 8.3/125 μm
(2) The light source and OTDR must operate within the range of 850±30 nm or 1300±20 nm for multimode testing in accordance with ANSI/EIA/TIA-526-14.
(3) The light source and OTDR must operate with the range of 1310±10 nm or 1550±20 nm for Single Mode testing in accordance with ANSI/EIA/TIA-526-7.
(4) The power meter and the light source must be set to the same wavelength during testing.
(5) The power meter must be calibrated and traceable to the National Institute of Standards and Technology (NIST).
(6) All system connectors, adapters and jumpers must be cleaned as per manufacturer's instructions before measurements are taken.

A) Fiber Optic Cable Testing Equipment. The following is required to perform fiber optic cable tests:
(1) An OTDR
(2) A test reel, if necessary
(3) A light source at the appropriate wavelength
(4) Optical Power Measurement Equipment
(5) Test Jumpers as specified below

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REVISION OF SECTION 614
TEST FIBER OPTIC CABLE

Multimode Fiber Testing

CPR Test Jumper-1 shall be 1-5 meters long with connectors compatible with the light source and power meter and have the same fiber construction as the link segment being tested.

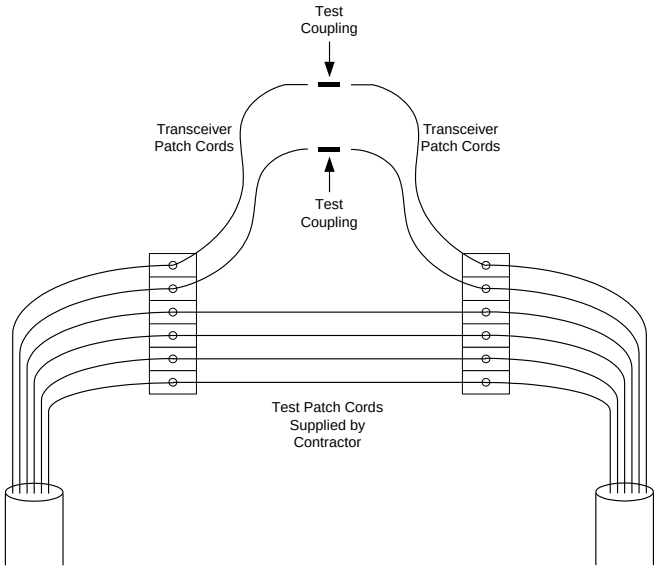
CPR Test Jumper-2 shall be 1-5 meters long with connectors compatible with the light source and power meter. Test Jumper-2 shall contain Class IV a single-mode fiber for tests on 1300 nm light sources and from which is single-moded at 850 μm for tests on 850 nm light sources.

Single Mode Fiber Testing

CPR Test Jumper-1 and Test Jumper-2 shall be 1-5 meters long with connectors compatible with the light source and power meter and have the same fiber construction as the link segment being tested.

B) Optical Fiber Cable Testing with OTDR. The Contractor shall perform an OTDR test of all fibers in all tubes on the reel prior to installation of the fiber. The test results shall be supplied to CDOT prior to installation of the cable.

All fiber testing shall be performed on all fibers in the completed end-to-end system. Testing shall consist of a bi-directional end-to-end OTDR trace performed per TIA/EIA-455-61. The system margin loss measurements shall be provided at 850 and 1300 nm for multimode fibers and 1310 and 1550 for Single Mode fibers. If the Plans require installation of a fiber optic patch panel, the Contractor shall supply patch cords to patch all terminated fibers through the panel for all fiber testing. If patch cords are specified in the Plans for final equipment installation, these patch cords shall be connected using a test coupling for the end-to-end test.



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REVISION OF SECTION 614
TEST FIBER OPTIC CABLE

OTDR readings will be used to ensure proper installation and to troubleshoot faults. OTDR signature traces will be used for documentation and maintenance. An OTDR provides an indirect estimate of the loss of the cable plant, generally, more accurate or reliable values will be obtained by using an Optical Power Meter. For fibers that are identified in the Plans to be left unterminated, an OTDR shall be used to test end-to-end attenuation.

Loss numbers for the installed link shall be calculated by taking the sum of the bi-directional measurements and dividing that sum by two.

The Contractor shall use an OTDR that is capable of storing traces electronically and shall save each final trace.

To ensure the traces identify the end points of the fiber under test and the fiber designation, the Contractor shall use a test reel, if required, to eliminate the “dead zone” at the start of the trace so that the start of the fiber under test can be identified on the trace. Indicate the length of the test reel for all test results.

If the fiber designation is not indicated on the trace itself, the Contractor shall provide a cross-reference table between the stored trace file name and the fiber designation.

In compliance with EIA/TIA-455-61 “Measurement of Fiber or Cable Attenuation Using an OTDR” the Contractor shall record the following information during the test procedure:

(1) Names of personnel conducting the test.
(2) Type of test equipment used (manufacturer, model, serial number, calibration date).
(3) Date test is being performed.
(4) Optical source wavelength and spectral width.
(5) Fiber identification.
(6) End point locations.
(7) Launch conditions
(8) Method of calculation for the attenuation or attenuation coefficient.
(9) Acceptable link attenuation.

C) Optic Fiber Cable Testing with Optical Power Meter. The Contractor shall conduct an Optical Power Meter Test for each fiber installed.

Multimode segments shall be tested in one direction at both the 850 nm and the 1300 nm wavelength.

Single Mode segments shall be tested in one direction at both the 1310 nm and 1550 nm wavelength.

In compliance with TIA/EIA-526-14A “Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant” and TIA/EIA-526-7 “Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant,” the following information shall be recorded during the test procedure:

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REVISION OF SECTION 614
TEST FIBER OPTIC CABLE

(1) Names of personnel conducting the test.
(2) Type of test equipment used (manufacturer, model, serial number, calibration date).
(3) Date test is being performed.
(4) Optical source wavelength, spectral width, and for multimode, the coupled power ratio (CPR).
(5) Fiber identification.
(6) End point locations.
(7) Test direction.
(8) Reference power measurement (when not using a power meter with a Relative Power Measurement Mode).
(9) Measured attenuation of the link segment.
(19) Acceptable link attenuation.

The minor attenuation differences due to test direction are on par with the accuracy and repeatability of the test method. Lateral segments within a building are limited to 90 meters. Therefore, attenuation differences caused by wavelength are insignificant, and as a result, single wavelength testing is sufficient.

D) Acceptable Attenuation Values. Acceptable attenuation values shall be calculated for each fiber tested. These values represent the maximum acceptable test values.

1) Multimode Fiber. The general attenuation equation for any multimode link segment is as follows:

Acceptable Link Attn.=Cable Attn.+Connection Attn.+Splice Attn.+CPR Adj.

62.5 μm Multi-mode Attenuation Coefficients:

Cable Attn.=Cable Length (km) x (3.40 dB/km@850 nm or 1.00 dB/km@1300 nm)
Connection Attn. (ST or SC connectors)=(No. of Connections x 0.39 dB)+0.42 dB.
Connection Attn. (LC connectors)=(No. of Connections x 0.14 dB)+0.24 dB.
Splice Attn. (Mechanical or Fusion)=Splices x 0.30 dB.
CPR Adj.=See table below.

A connection is defined as the joint made by mating two fibers terminated with re-mateable connectors (e.g. ST, SC, LC).

Multi-mode Light Source CPR Adjustment

	Cat. 1 Overfilled	Cat. 2	Cat. 3	Cat. 4	Cat. 5 Underfilled
Links with ST or SC Connections	+0.50	0.00	-0.25	-0.50	-0.75
Links with LC Connections	+0.25	0.00	-0.10	-0.20	-0.30

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REVISION OF SECTION 614
TEST FIBER OPTIC CABLE

The Coupled Power Ratio of a light source is a measure of the modal power distribution launched into a multimode fiber. A light source that launches a higher percentage of its power into the higher order modes of a multimode fiber produces a more over-filled condition and is classified as a lower category than a light source that launches more of its power into just the lower order modes producing an under-filled condition. Under-filled conditions result in lower link attenuation, while over-filled conditions produce higher attenuation. Therefore, adjusting the acceptable link attenuation equation to compensate for a light source's launch characteristics increases the accuracy of the test procedure.

2) Singlemode Fiber. The general attenuation equation for any Single Mode link segment is as follows:

Acceptable Link Attn. = Cable Attn. + Connector Attn. + Splice Attn.

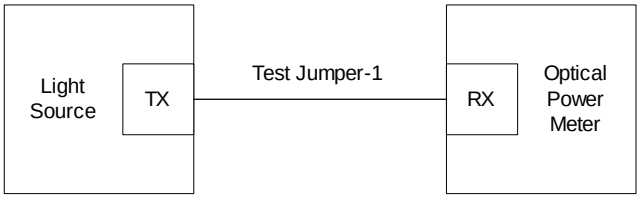
8.3 μm Single-mode Attenuation Coefficients:

Cable Attn.=Cable Length (km) x (0.34 dB/km@1310 nm or 0.25 dB/km@1550 nm)
Connection Attn. (ST or SC connectors)=(No. of Connections x 0.39 dB)+0.42 dB.
Connection Attn. (LC connectors)=(No. of Connections x 0.14 dB)+0.24 dB.
Splice Attn. (Mechanical or Fusion)=Splices x 0.30 dB.

E) Test Procedures. All fiber testing shall be performed on all fibers in the completed end-to-end system.

(1) Multimode Fiber. The multimode fiber cable test shall be conducted as follows:

Clean the test jumper connectors and the test coupling per manufacturer's instructions.
Follow the test equipment manufacturer's initial adjustment instructions.
Connect Test Jumper-1 between the light source and the power meter. Avoid placing bends in the jumper that are less than 100 mm (4 inches) in diameter.



If the power meter has a Relative Power Measurement Mode, select it. If it does not, reduce the Reference Power Measurement (P_{ref}). If the meter can display power levels in dBm, select this unit of measurement to simplify subsequent calculations.

Disconnect Test Jumper-1 from the power meter. Do NOT disconnect the test jumper from the light source.

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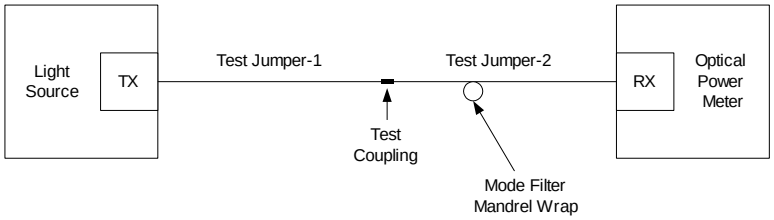
REVISION OF SECTION 614
TEST FIBER OPTIC CABLE

Connect Test Jumper-2 between the power meter and Test Jumper-1 using the test coupling. Test Jumper-2 should include a high order mode filter. This can be accomplished by wrapping the jumper three times around a 30 mm (1.2 inches) diameter mandrel.

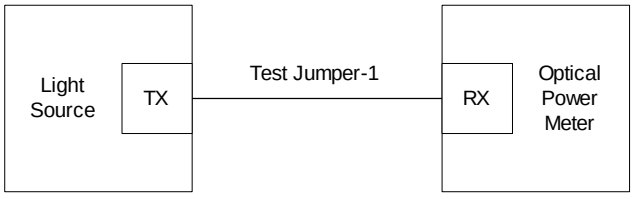


Record the Power Measurement (P_{sum}). If the power meter is in Relative Power Measurement Mode, the meter reading represents the CPR value. If the meter does not have a Relative Power Measurement Mode, perform the following calculation:

If P_{sum} and P_{ref} are in the same logarithmic units (dBm, dBu, etc.):
CPR (dB) = P_{sum} - P_{ref}
If P_{sum} and P_{ref} are in watts:
CPR (dB)= 10 x $\log_{10}$ [O_{sum}/P_{ref}]

(2) Single Mode Fiber. The Single Mode Optical Power Meter fiber test shall be conducted as follows:

Clean the test jumper connectors and the test coupling per manufacturer's instructions. Follow the test equipment manufacturer's initial adjustment instructions.
Connect Test Jumper-1 between the light source and the power meter. Avoid placing bends in the jumper that are less than 100 mm (4 inches) in diameter.



If the power meter has a Relative Power Measurement Mode, select it. If it does not, reduce the Reference Power Measurement (P_{ref}). If the meter can display power levels in dBm, select this unit of measurement to simplify subsequent calculations.

Disconnect Test Jumper-1 from the power meter. Do NOT disconnect the test jumper from the light source.

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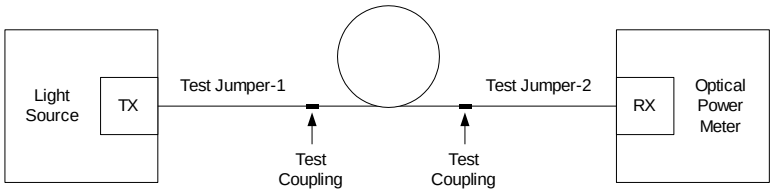
REVISION OF SECTION 614
TEST FIBER OPTIC CABLE

Attach Test Jumper-1 to one end of the cable plant to be measured and Test Jumper-2 to the other end.



Record the Power Measurement (P_{sum}). If the power meter is in Relative Power Measurement Mode, the meter reading represents the true value. If the meter does not have a Relative Power Measurement Mode, perform the following calculation:

If P_{sum} and P_{ref} are in the same logarithmic units (dBm, dBu, etc.):
CPR (dB) = P_{sum} - P_{ref}
If P_{sum} and P_{ref} are in watts:
CPR (dB)= 10 x $\log_{10}$ [O_{sum}/P_{ref}]

F) Test Acceptance. The Contractor shall demonstrate that each Optical Power Test results in acceptable attenuation values.

The Contractor, solely at the Contractor's cost, shall remake any fusion splices that have test results exceeding acceptable attenuation values.

The Contractor, solely at the Contractor's cost, shall retest any fiber links that have been re-spliced.

The Contractor, solely at the Contractor's cost, shall bring any link not meeting the requirements of this specification into compliance.

G) Submittals. The Contractor shall submit test results documentation as both a hard copy and electronic copy.

After each reel test, the Contractor shall submit four (4) hard copies of the OTDR trace for every fiber on the reel. After installation, the Contractor shall submit four (4) hard copies of the OTDR trace for every spliced fiber. Hard copy traces shall be organized and bound in logical order in an 8 ½" x 11" 3 ring hard cover binder in addition to other documentation listed in this Special Provision and other splicing documentation listed in the project Special Provision package.

The Contractor shall submit, after approval of the hard copy traces, electronic copies of all traces and appropriate software to allow reading the traces.

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REVISION OF SECTION 614
TEST FIBER OPTIC CABLE

The Contractor shall submit, four (4) copies of all Optical Power Test results.

The Contractor shall submit four (4) copies of the complete contract Plans, including additional drawings issued as part of any change orders, with any deviations clearly marked in color. Deviations to be noted and shall include but not be limited to the following:

(1) Fiber Splice location
(2) Fiber Splice configuration
(3) Termination layout

REVISION OF SECTION 614
TRAVEL TIME INDICATOR (TTI)

Section 614 of the Standard Specifications is hereby revised to include the following:

DESCRIPTION

This work shall consist of furnishing and installing a Travel Time in accordance with the Plans, these Modified Special Provisions, and manufacturer's recommendations.

MATERIALS

For this project Travel Time Indicator shall include furnishing and installing a four channel multi-protocol IDentity 5204 Reader with power supply. The IDentity 5204 reader with power supply shall be part number ID5204-001 as manufactured by Federal Signal (Sirit Inc.), 1321 Valwood Parkway, Suite 620, Carrollton, Texas 75006, Phone: 972.243.7208, Fax: 972.243.8034. The IDentity 5204 Reader shall be compatible with existing hardware and software protocols currently in use by The Department. Travel Time Indicator shall include furnishing and installing one IDentity 5000, directional 42 degree antenna per read direction, corresponding antenna mounts, antenna signal cable, waterproofing mastic, related mounting hardware, device configuration software, and any other associated cabling and adaptors. The antenna shall be Sirit part number ANTENNA-013-K which includes a mount bracket. The Contractor is responsible for installing and aligning the ANTENNA-013-K directional antennas and antenna mounts as shown on the plans and per manufacturer's recommendations. Contractor shall contact Matthew Becker at 303-435-8288 for field location of each pair of antennas at each site. Mounting heights will vary per location.

Travel Time Indicator shall also include:

1) 0.75 inch Type 201 stainless steel strap with Type 201 stainless steel buckles.
2) Liquid tight flexible conduit with compatible connectors
3) Water-proofing mastic
4) Communication Cable, 6 meter (20') length, RJ-45 terminated, Sirit Part Number S3114-021 or, alternatively Communication Cable, 2 meter (7') length, RJ-45 terminated, Sirit Part Number: S3114-20, whichever length is required.
5) Connector kit, Sirit part number CONN-5200-K which includes 2 Male N-Type Connectors. One kit to facilitate one antenna.
6) Antenna signal cable and terminations.
    a. The antenna signal cable type is determined by the cable distance from the reader to the antenna. Signal loss at 900 Mhz must be less than 4db per run. The following outdoor rated cable shall be used.
        i. For runs 100 feet or less- LMR-400.
        ii. For runs from 101-155 feet- LMR-600
        iii. For runs from 156-230 feet- LMR 900

    Signal cable shall be terminated with weatherproof male N-type crimp on straight plugs that have the following properties:
        i. Ferrule-Copper with Albaloy plating
        ii. Contact pin- Brass with minimum 15µm gold plating
        iii. Retaining ring-304 stainless
        iv. Gasket- Silicone

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REVISION OF SECTION 614
TRAVEL TIME INDICATOR (TTI)

v. Insulator - Teflon
vi. Shell/Body- Brass with Albaloy plating
vii. Impedance- 50 Q
viii. Insulation resistance- Greater than 5,000 MQ
ix. Peak operating Voltage- 1,500 V

7) One pole mounted IDentity 5000, directional 42 degree antenna per direction of detection.
(ANTENNA-013-K)
   a. The antenna shall weigh 3 kg or less and have dimensions (17.7 x 17.7 x 1.4 in.). The antenna shall have a wind survival rating of 150 mph as defined in EIA-222-F and/or ETS 300 019-I-4.The antenna shall accommodate a male N-type coaxial connection. The antenna shall have a 902-928 MHz frequency range with 13.0 dBi gain and 50 ohm (nominal) input impedance. The antenna shall have a front to back ratio of -24db with a VSWR 1.7:1 or less.

CONSTRUCTION REQUIREMENTS

The Travel Time Indicator reader shall be mounted inside the communications cabinet allowing room for all communication cable connections. A hook & loop fastening system shall be used to mount the reader to the cabinet for ease of removal.

The power supply shall be mounted to the DIN rail inside the communications cabinet. All wiring shall conform to the most current version of the NEC.

The Contractor shall supply and install one-inch type 201 stainless steel strap used in conjunction with type 201 stainless steel buckles shall be used to band the antenna mount to the structure at the mounting height directed by CDOT per guidance from Matthew Becker at 303-435-8288. The Antenna shall be mounted horizontally polarized using the included stainless hardware. The antenna shall be oriented such that it intersects with the oncoming traffic at a 45 degree angle, and is aimed to the center of lane 2.

The Contractor shall install flexible conduit from the communication cabinet enclosure to the structure for signal cable and/or power cable installation as shown in the plans. Holes made in mounting structures shall be the minimum size necessary to secure the conduit connectors and shall not exceed 2 inches in diameter.

All holes shall be free of burs and sharp edges prior to the installation of all cable, conduit, and conduit nipples. All cable entrances in structures, conduits, and enclosures shall be sealed and waterproofed. All wiring and electrical connections shall be performed in conformance with the latest version of the NEC.

The signal cable shall connect RF input/output channels from the telemetry master (toll tag reader) to the telemetry (antenna) units- one cable per antenna. The contractor shall route

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REVISION OF SECTION 614
TRAVEL TIME INDICATOR (TTI)

signal cable through existing structures or through new flexible or rigid PVC conduit mounted to existing structures as shown on the plans. Each signal cable shall be a continuous cable, with

no splices, terminated with male N-type crin1p on straight plugs on both ends. Installed length of any one signal cable shall not exceed 100 ft.

Installations that require lengths in excess of 100 ft should utilize lower loss cable as to not exceed 3-4dB of loss per run. All signal cables shall be labeled on both ends with UV resistant colored tape before installation. The same color label shall be used on both ends of one cable and label colors shall not repeat at the same installation site. Labels shall be installed such that they are distinguishable from the ground.

The Contractor shall ensure strain relief and drip loops in coaxial antenna cable. The Contractor shall provide full support to all coaxial cable not in conduit and/or wiring trays. All cable entrances in conduits, conduit entrances in structures and cabinets shall be sealed and waterproofed. Conduit/signal cable shall not enter the top of the cabinet housing the telemetry master device. Entering through the bottom of the cabinet is preferred, although side entrances will be permitted. It is suggested that the signal cables be cut longer than needed and installed with the terminated end on the telemetry (antenna) side. Cables can then be re-labeled, cut to length, and terminated once they are run into the telemetry master enclosure. Waterproofmg mastic shall be applied at all antennas to signal cable connections following manufacturer's recommendations.

The Contractor shall connect antenna signal cables to the Travel Time Indicator such that:

Northbound vehicle detection corresponds to Port 1,
Southbound vehicle detection corresponds to Port 2,
Eastbound vehicle detection corresponds to Port 3, and
Westbound vehicle detection corresponds to Port 4.

The Contractor shall configure the Travel Time Indicator in accordance with manufacturer's recommendations. The unit shall have CalTrans Title 21 and 18000-6C protocols enabled for tag detection with only active antenna channels enabled and power levels set to the minimum needed for reliable transponder detection.

The unit shall be configured for serial communication with the following:
19,200 bits per second
8 data bits
No parity
1 stop bit
No flow control

The following shall be set to run in the TPS script:

1) Interval: 60s
2) Reader ID: as per plan sheet
3) Heartbeat: 1Os

REVISION OF SECTION 614
WEATHER MONITORING SYSTEM

Section 614 of the Standard Specifications is hereby revised as follows:

DESCRIPTION

This work consists of furnishing, installing, and configuring a weather monitoring station (WMS) at the locations shown on the Plans. The WMS shall be specifically designed to monitor and collect real time atmospheric and pavement conditions along with color still frame video images of the roadway. The WMS shall be capable of sending this information to a centralized computer system compatible with existing CDOT ITS infrastructure. The CDOT server will poll the WMS to ask for data on a preset time interval specified by CDOT to transfer and refresh its data. The data from the new Remote Processing Unit (RPU) shall seamlessly integrate with the existing CDOT WMS network servers.

The Contractor shall provide a detailed description (technical cut sheets) of the WMS to be supplied and the experience of the vendor/manufacturer in supplying such WMS to other agencies. The Contractor shall also provide written justification of the selection process used in the selection of a WMS vendor/manufacturer. Such justification shall assure that CDOT receives a state of the art WMS from a responsible vendor/manufacturer that is compatible with the existing statewide WMS system currently in place. CDOT may require the Contractor to document the proposed WMS can provide interoperability and connectivity to the existing statewide WMS system. The WMS equipment vendor chosen by the contractor must have at least 10 successful WMS installations in North America. As part of the equipment approval process, CDOT may ask the Contractor to provide the names of at least ten (10) agencies, with names, telephone numbers and contact person to verify said WMS installations were successful.

After completion of the equipment installation, the equipment manufacturer representative shall perform all final system checks, sensor alignments, software setup, and software configuration to provide a fully operational WMS. The equipment vender shall provide a limited, on-site warranty covering all equipment for a 12-month period from the WMS commissioning date.

MATERIALS

The WMS shall include a remote processing unit, a precipitation occurrence sensor, an air temperature/relative humidity sensor, an ultrasonic wind sensor, 2 wireless road surface sensors, a non-intrusive road surface condition sensor, a pan-tilt-zoom camera, and all mounting/attachment hardware, cables, test equipment, and manufacturer site commissioning necessary for a full and complete installation.

Remote Processing Unit (RPU)
The RPU shall gather, process, and store data from all connected atmospheric sensors, pavement sensors and camera. The data shall be transmitted to a centralized server upon polled request. The RPU shall utilize a Linux based operating system, and be capable of multi-tasking operations to optimize data acquisition from all connected devices. The RPU design shall maximize the use of solid-state components; no platter type drives or mechanized parts

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REVISION OF SECTION 614
WEATHER MONITORING SYSTEM

will be permitted. The RPU shall incorporate "watch-dog" circuitry and monitor its own operation and reset itself if the RPU software enters an indeterminate state. The RPU shall also have the

capability to be reset from the centralized server. The RPU shall include a minimum of two 10/100 Ethernet ports. The RPU shall include 20 differential and 11 single–ended channels. The RPU shall include ten serial ports configurable for RS-232 or RS-422/485 operating at full or half duplex from 300 to 115,200bps. All circuitry of the RPU, the voltage inputs, the sensor inputs, and the communications ports shall be designed and tested to provide transient and surge protection. The RPU shall include lightning protection for all channels and serial ports including auto-reset circuit breakers for power. The RPU shall operate in a range of 100-130 VAC at 50-60 Hz and shall use not more than approximately 60 Watts of continuous power.

The RPU shall have the capability of being modified to utilize solar power or other power sources in place of conventional commercial electric power. Solar powered RPU sites shall operate a minimum of 72 hours without sunlight or solar charging of the batteries. All RPU electronics shall be capable of operation over a minimum temperature range of -40°F to 160°F and 0-90% RH non-condensing. The RPU shall support full software configuration via a standard web browser. The RPU shall be capable of communication to the centralized server via serial RS-232/422/485 utilizing PPP or PMPP protocols or 10/100 Ethernet connection utilizing TCP/IP protocol. The RPU hardware and software provided shall be compliant with the most current Federal standard NTCIP ESS protocols.

At minimum the RPU shall be capable of collecting data from the following:
- 1 wired precipitation type sensor
- 1 wired air temperature/relative humidity sensor
- 1 wired ultrasonic wind speed/direction sensor
- 2 wireless in-pavement traffic/weather sensors
- 1 non-intrusive pavement condition sensor
- 1 wired pan-tilt-zoom camera

The RPU shall include an NEMA 4 rated lockable aluminum enclosure that is resistant to damage by weather and vandalism. The NEMA 4 enclosure shall be large enough to house all RPU electronics, power supplies, and communication equipment.

Precipitation Type Sensor
The precipitation sensor shall utilize optical, infrared technology to detect precipitation with beam interruptions by precipitation particles. The precipitation occurrence sensor shall sense the onset and cessation of precipitation in the form of rain, snow, sleet, and freezing rain and shall indicate when precipitation is occurring. The sensor shall provide any precipitation classification, measurements of intensity or water accumulation, as well as visibility. It shall provide proper operation over a minimum temperature range of -22°F to 140°F. The sensor shall operate to specifications at cable lengths up to 150 ft from the RPU.

Air Temperature/Relative Humidity Sensor

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REVISION OF SECTION 614
WEATHER MONITORING SYSTEM

The Air Temperature/Relative Humidity Sensor shall have an air temperature-sensing element that operates within the temperature range of -40°F to 176°F. The relative humidity sensing should measure a range from 10 to 100% RH. The minimum operating temperature range shall be -31°F to 158°F. System dew point temperature shall be calculated from the air temperature

and relative humidity. The combined sensor shall operate to specifications at cable lengths up to 1000 ft from the RPU.

Ultrasonic Wind Sensor
The ultrasonic wind sensor shall measure wind speed and direction without any moving parts. The sensor shall be corrosion resistant and satisfy IP66 and IP67 ratings. The sensor shall include both 0 to 5000 mV analog and RS-232/RS-485 digital outputs. The sensor shall have an operating range of 0 to 145 mph, with a survival operation limit of 190 mph. Accuracy for measured wind speed shall be less than 3% of actual wind speed. Wind speed direction operating azimuth shall be measurable from 0 to 360°, with an accuracy of +/- 2°, and resolution of 1°. The minimum operating temperature range shall be -40° to 140°. The sensor shall include provisions to deter animal perching or nesting. The sensor shall operate to specification at cable lengths up to 30ft from the RPU, and include all mounting hardware.

Wireless Road Surface Sensor
The wireless road surface sensor shall detect road surface temperature, sub surface temperature, provide a wet, dry, trace moisture, chemical wet, or ice watch status reading along with a chemical percent index. The sensor shall also utilize magnetic imaging to provide accurate vehicle count, speed, and classification data. All data shall be transmitted wirelessly to the RPU utilizing the ISM 902 - 928 MHz band with a minimum transmission range of 300 ft. The sensor shall utilize external sensors to measure both pavement and sub-surface temperatures. The sensor shall be powered from a Lithium thionyl chloride battery and operate in a minimum range of -40ºF to +185ºF. The sensor shall be self contained and removable to allow for battery replacement. The sensor shall include compatible wireless receiver for data transmission to the RPU.

Non-Intrusive Pavement Condition Sensor
The non-intrusive pavement condition sensor shall utilize Class 1 Laser technology to accurately measure presence of water, ice, slush, snow, or frost. The sensor shall also measure the level of grip or friction coefficient of the roadway. The sensor shall be powered from a 9 - 30 VDC source and use no more than 4 watts of power. The sensor shall operate in a minimum temperature range of -40 to 140 °F at 0 to 100% RH. The sensor shall be capable of accurate measurements at distances of 10-40ft from the roadway. The sensor shall provide RS-232 and RS-485 serial data communication interfaces and be capable of operation on cable lengths up to 300 ft from the RPU. The Contractor is responsible for ordering the correct cable length based on planned installation. If the weather monitoring system is greater than 25ft from the white edge line of the roadway being measured then the non-intrusive pavement condition sensor shall include breakaway pole that is 27ft above ground height

Pan-Tilt-Zoom Camera

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REVISION OF SECTION 614
WEATHER MONITORING SYSTEM

The pan-tilt-zoom camera shall be of dome type construction and be capable of gathering a minimum of 50 preset color video still frame images with a minimum 176x120 resolution and maximum 704x480. The camera shall be enclosed in a sealed, heated, pressurized environmental video dome housing to operate in 100% humidity at a minimum operating temperature of -40° to 122°F carrying both IP66 and NEMA 4x ratings. The camera shall provide dual mode, day (color) and night (monochrome) video down to 0.008 lux. The lens shall

be f=3.4 – 119mm, F1.4 – 4.2, autofocus; focus range of 35 mm(wide) to 800 mm (telephoto) to infinity. The angle of view shall be 2.8°-48° horizontal with minimum zoom capability of 35x optical, 12x digital. Minimum illumination color 0.5 lux at 30 IRE and B/W 0.005 lux at 30 IRE. The pan function shall provide 360° of continuous rotation at 0.05 – 450°/s and a 220° tilt range allowing for 20° view above the horizon at 0.05 – 450°/s Shutter speed shall be variable from 1/30000 – 0.5 seconds at 60Hz. The camera shall utilize Ethernet protocol for native communications and be capable of sending multiple individually configurable video streams in H.264 and MJPEG format up to 30fps. The camera shall have an internal web interface for configuration with security functionality allowing multiple user access levels with password protection. The camera shall support IPv4/v6, HTTP, HTTPS, SSL/TSL, QOS Layer 3 DiffServ, FTP, SMTP, SNMP v1/2/3, UPnP, DNS, DynDNS, NTP,RTSP, TCP, UDP, IGMP, RTCP, ARP, SOCKS.

CONSTRUCTION REQUIREMENTS

The Contractor shall install the WMS in accordance with the WMS vendor's recommendations, CDOT plans and Standard Specifications and all federal, state and local codes and requirements. The Contractor will be responsible for providing all traffic control/safety work zones for the installation of the roadway sensors in accordance with the CDOT traffic control requirements.

The Contractor shall install a 120VAC electrical supply from the power source shown on the plans to a location near the RPU. The Contractor shall connect the 120VAC service to the RPU power disconnects. The primary power should be installed to the RPU and fused for 20 amps, with voltage surge protection. The Contractor shall install the RPU electronics enclosure on the fold over tower per manufacturer recommendations.

The precipitation type sensor shall be mounted on the WMS tower per manufacturer's recommendations above ground level at the RPU.

The air temperature/relative humidity sensor shall be mounted on the WMS tower per manufacturer's recommendations at the standard meteorological height of approximately 6 ft above ground level in a UV stabilized white thermoplastic solar/wind-radiation shield.

The ultrasonic wind sensor shall be mounted on the WMS tower per manufacturer's recommendations at the standard meteorological height of approximately 30 ft above ground level at the top of the WMS tower. The sensor shall be mounted such that birds are not able to perch or nest on the sensor.

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WEATHER MONITORING SYSTEM

The wireless in-pavement traffic/weather sensors shall be installed per manufacturer's recommendations after the top layer of pavement has been completed. One sensor will be installed in each lane of travel. Exact sensor placement shall be as determined by the Project Engineer with guidance from the equipment supplier.

The non-intrusive pavement condition sensor shall be mounted on the WMS tower per manufacturer's recommendations at a height and angle that will allow measurement of the

middle of the closest lane of travel. If the WMS is greater than 25ft from the white edge line of the roadway being measured then the sensor shall be mounted on a fiberglass pole installed 15ft from the same white edge line. Conduit and pull boxes shall be installed between the WMS and pole to connect the sensor to the WMS RPU.

The pan-tilt-zoom camera shall be installed per manufacturer recommendations on the WMS tower approximately 27 feet above ground level and configures for a minimum of two preset positions as determined by the Project Engineer.

Cables for all sensors and camera shall enter through the bottom of the NEMA 4 enclosure and connect to the RPU electronics.

The Contractor is responsible for connecting the WMS to communication infrastructure provided by the project where applicable.

After completion of the equipment installation, the equipment manufacturer representative shall perform all final system checks, sensor alignments, sensor setup, RPU configuration including site communication setup, and central server configuration to provide a fully operational WMS.

The existing CDOT owned WMS server utilizes the Windows Server 2003 Operating System, and will collect sensor data from all RPUs in the system, including this new site. The CTMC server will poll the RPU to ask for data on a preset time interval, typically every 10 minutes, or as specified by the CDOT to transfer and refresh its data. CDOT users will access the WMS data via any PC running a commercial web browser which is connected to the CDOT statewide WAN.

Any associated hardware not listed is considered subsidiary and is required for a complete installation and shall be included as part of the work.

WARRANTY

The Contractor shall ensure that the manufacturer can warranty the product for a minimum of 1 year for all parts returned to the factory and 1 year telephone technical support at no additional charge to the Department. The technical support shall include access to a trained service representative who can respond within 24 hours to questions related to all WMS related equipment problems and maintenance issues. This one-year service shall also include an eight (8) hour training session for CDOT staff.

REVISION OF SECTION 614
FOLD-OVER TOWER (ITS)

Section 614 of the Standard Specifications is hereby revised to include the following:

DESCRIPTION

This work consists of the installation of a heavy duty fold-over tower, base assembly, concrete footing, concrete pad and chain link fencing with perimeter at the locations shown on the plans to support a Roadway Weather Information System (RWIS). In addition to the footing, a concrete pad shall be poured and formed with the following dimensions, 7' 6" x 7 ' 6" x 4" deep. This concrete pad will be poured after the footing has been installed. The pad will be poured separately from the footing. The footing shall be located in the very middle of the pad. All incoming conduits shall be cast directly in this concrete and/or footing. Around the outside perimeter of the concrete pad, contractor shall install chain link fencing. This chain link fencing shall be installed within 6" to 2' of the edge of concrete all along the perimeter. The height of the perimeter fence shall be a minimum of 5' tall and no more than 7' feet tall measured from ground level. A 3' 6" to 4' gate shall be added along with locking hasps and end-caps. This gate shall be centered opposite the hinged side of the tower to allow access for the fold down tower to retract and be maintained. Tower should be mounted in a direction that will not impede traffic when folded down.

MATERIALS

The heavy duty fold-over tower and base assembly shall be a Glen Martin Engineering, Heavy Duty Fold-Over Tower – Model MF 1333, 30 feet in length as supplied by Glen Martin Engineering, Inc., 13620 Old Hwy 40, Boonville, MO., 65233, (660) 882-2734. (www.glenmartin.com)

CONSTRUCTION REQUIREMENTS

The heavy duty fold-over tower and base assembly shall be installed in accordance with the details shown in the plans and in accordance with manufacturer's recommendations. The Contractor shall make all arrangements for a qualified manufacturer's representative to be on-site to ensure proper installation.

The Contractor shall perform an acceptance test procedure for Acceptance by the Department in the presence of CDOT.. The acceptance test shall include demonstrating the tower raises and lowers according to the manufacturer's design and is fully functional at completion.

REVISION OF SECTION 614
WIRELESS MAGNETOMETER VEHICLE DETECTION SYSTEM

Section 614 of the Standard Specifications is hereby revised as follows:

Subsection 614.01 shall include the following:

This work includes furnishing and installing wireless battery-powered magnetometer vehicle detection systems in accordance with these specifications at the locations shown on the plans. These systems shall be used at all RMS and CDOT Region 6 ATR stations.

Add subsection 614.08(m) which shall include the following:

(m) *Wireless Magnetometer Vehicle Detection System.* The Wireless Magnetometer Vehicle Detection System (WVDS) shall consist of one Access Point (AP), one or more battery-powered wireless Vehicle Sensor Nodes (VSN) per detection zone, one or more battery powered Wireless Repeaters (RP), one Access Box (AB), one Contact Closure (CC) card, the required number of Extension Interface (EX) cards, and installation materials for each detection zone.

One WVDS is required for each ramp or intersection as indicated on the plans.

The VSN shall detect a vehicle by measuring a change in the earth's magnetic field near the VSN caused by the vehicle (i.e. magnetometer type detection).

The VSN shall transmit detection information within 125 ms of a detected event.

The VSN shall automatically recalibrate in the event of a detector lock.

The wireless radio frequency (RF) communications link between the AP, RP, and VSN shall utilize an IEEE-approved wireless communications protocol.

Communications shall use an unlicensed band.

The VSN and RP shall be reconfigurable by a user over the wireless interface to avoid interference from other users of the communications band. A minimum of 16 channels shall be provided for this purpose.

The RF link budget shall be 93dB or greater.

The AP to VSN (or RP to VSN) RF range shall be at least 150 feet for an AP/RP installed at 24 feet above the roadway and at least 100 feet at 18 feet above the roadway.

The RP to AP RF range shall be at least 750 feet when both units are installed 18 feet above the roadway.

Each VSN shall transmit a unique identifying code.

The VSN shall respond within 100 seconds when the AP is powered on.

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REVISION OF SECTION 614
WIRELESS MAGNETOMETER VEHICLE DETECTION SYSTEM

The AP shall have the capability to transmit detection information to a 170E-HC11 traffic controller to provide real time detection information via a standard contact-closure based input shelf.

The VSN, RP and AP shall be capable of accepting software and firmware upgrades.

1. Vehicle Sensor Node Hardware:

   The vehicle sensor node (VSN) shall consist of a 3 Axis magnetometer, a microprocessor, a wireless transmitter and receiver, and a battery.

   The VSN shall have the following characteristics:

   (1) components shall be contained within a single housing meeting NEMA 6P and IP68 standards;
   (2) components shall be fully encapsulated within the housing to prevent degradation from moisture;
   (3) operate in a temperature range from -37 °F to +176 °F;
   (4) housing shall be capable of being installed in a 4 inch diameter 2-1/4 inch deep cored hole;
   (5) be designed to operate from its battery for a period of 10 years of life under normal traffic conditions after it is put into operation;
   (6**)** be able to transmit the complete X-Y-Z magnetic signature of a vehicle, sampled at a minimum of 128 samples per second. In this mode, the VSN shall be designed to operate from its battery for a minimum of 1 year.

2. Access Point Hardware:

   The access point (AP) shall be the communication hub of the sensor network.

   The AP shall have the following characteristics:

   (1) capable of communicating with up to 24 VSN's;
   (2) be powered via 48 V DC, 3W or via non-isolated external 10 to 15 V DC, 2 W power. Power shall be provided by the CC Card;
   (3) have at least one powering option that provides 1500 V isolation and 5 KV surge protection;
   (4) operate in a temperature range of -37 °F to +176 °F;
   (5) meet NEMA 4X and IP67 standards;
   (6) weigh 3 pounds or less.

   The AP shall communicate to the controller via the CC and optional EX Contact Closure Board(s).

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REVISION OF SECTION 614
WIRELESS MAGNETOMETER VEHICLE DETECTION SYSTEM

3. Repeater Hardware:

   If required, one or more wireless repeaters (RP) shall be provided.

   The RP shall have the following characteristics:

   (1) extend the effective communication range of the sensor to the AP an additional 750 feet;
   (2) be powered by a field-replaceable battery;
   (3) operate in a temperature range of -37 °F to +176 °F;
   (4) meet NEMA 4X and IP67 standards;
   (5) weigh 3 pounds or less.

4. Contact Closure and Extension Interface Contact Closure Cards:

   The CC and EX cards shall provide detector outputs to the controller.

   The CC card shall communicate with the access point via an outdoor rated Cat5e Ethernet cable.

   The CC and EX cards shall have the following characteristics:
   (1) directly plug into standard 170/2070 Input Files and NEMA detector racks;
   (2) provide up to 4 channels of detection;
   (3) be capable of providing pulse or presence detection outputs;
   (4) provide for up to 31 seconds of delay;
   (5) provide up to 7.5 seconds of extension;
   (6) be powered by 11 to 26 V DC;
   (7) be surge protected to GR-1089 standards;
   (8) operate within a -37° F to +176 °F temperature range;
   (9) operate in up to 95 percent humidity (non-condensing).

   The front panel of the CC and EX cards shall provide:
   (1) status LEDs displaying detection channel status, line quality, fault monitor;
   (2) ten configuration DIP switches to enable presence or pulse mode, delay and extension;
   (3) a rotary switch to program time functions for delay and extension functions; and
   (4) two Ethernet-style RJ45 connectors.

   The CC card shall provide power to the AP over the Ethernet cable.

5. Access Box:

   The Access Box shall provide a communication link between the AP and the CC card.

   The Access Box shall have the following characteristics:

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REVISION OF SECTION 614
WIRELESS MAGNETOMETER VEHICLE DETECTION SYSTEM

(1) provide the ability for remote communications;
(2) have 3 Ethernet style RJ45 connectors.
(3) not exceed 2-3/8 inches by 1-1/2 inches by 7/8 inch in size.

6. Configuration Software:

   The WVDS shall include the software necessary to configure the vehicle sensor nodes, wireless repeaters, and access point. The WVDS shall include the software necessary to store and retrieve detection data.

Add subsection 614.10(k) which shall include the following:

(k) *Wireless Magnetometer Vehicle Detection System Installation*. WVDS shall be installed in the configuration shown on the plans.

The vehicle sensor node pavement core shall be circular and shall be made 2 ¼ inches deep and 4 inches in diameter.

The vehicle sensor nodes, access point, repeater, and access box shall be installed in accordance with the manufacturer's guidelines.

REVISION OF SECTION 614
VARIABLE MESSAGE SIGN UNINTERRUPTABLE POWER SUPPLY

DESCRIPTION

The Variable Message Sign shall have a rack mounted Uninterruptable Power Supply (UPS) located inside the sign mounted near the power distribution panel. The Variable Message Sign UPS shall be capable of running the power control panel equipment for up to 8 hours.

The UPS shall be designed for a hot swap of components and shall not compromise existing Variable Message Sign wiring. The unit shall provide for RS232 communication and contact closures for alarm functions.

MATERIALS

The Variable Message Sign UPS shall provide "On-Line" dual conversion control.

The UPS shall be rated per the following:

Input Voltage	85 VAC to 135 VAC
Input Frequency	48 to 62 Hz
Output Voltage	120 VAC +/- 3%
Output Frequency	60 Hz
Power Ratings	1,250 VA/875 Watts

The unit shall be temperature rated to operate from -40 degree C to +74 degree C.

The Variable Message Sign UPS shall be capable of producing simultaneously-fully regenerated, conditioned power with true sine wave and continuous AC outputs with stand by capability.

The unit shall have a re-settable power event counter to record the number of power utility failures, a battery run-time counter and temperature compensated battery charging.

The Variable Message Sign UPS shall be capable of providing continuous, fully conditioned (both voltage and frequency), regulated, sinusoidal (AC) power to selected devices such as controllers, modems, and 5 volt power supply.

Wiring shall comply with NEC standards and approved wiring methods. Properly rated SO/SJO cords shall be allowed to allow easy replacement of the Variable Message Sign UPS.

The interconnect cable shall be protected with abrasion-resistant nylon sheathing.

The UPS shall consist of two major components, the Electronics Module and the Battery System.

A. The Electronics Module shall consist of the following:

1. True Sine wave, high frequency inverter.
2. Minimum 3-stage, temperature compensated, battery charger
3. For connection from the Electronics Module to the Battery System, a dedicated harness shall be provided with quick-release, keyed, circular connectors, and braided nylon sleeving over all conductors.
4. Local and remote control of UPS functions

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REVISION OF SECTION 614
VARIABLE MESSAGE SIGN UNINTERRUPTABLE POWER SUPPLY

5. Local and remote communications capabilities

B. The Battery System shall consist of the following:

1. Shall meet the continuous 8 hour requirement

2. The batteries shall be comprised of extreme temperature, deep cycle AGM/VRLA (Absorbed Glass Mat/Valve Regulated Lead Acid) batteries that have been field proven and tested by the U.S. military.

3. Batteries shall be certified to operate at extreme temperatures from -40'C to +74'C.

4. The batteries shall be provided with appropriate interconnect wiring and a corrosion-resistant mounting trays and/or brackets appropriate for the location into which they will be installed.

5. Battery construction shall include heavy-duty, inter-cell connections for low-impedance between cells and heavy-duty plates to withstand shock and vibration.

The Variable Message Sign UPS shall come standard with software and RS232 interface via a DB-9F connector (optional SNMP Adapter for TCP/IP protocols) allowing full, interactive, remote computer monitoring and control of the UPS functions. The cable between the UPS and computer shall be a standard off the shelf serial cable available at any electronic supply house. The software shall allow the user to set up all operational parameters either locally or remotely and test the functionality of the unit.

The Variable Message Sign UPS Alarm Function Monitoring shall come standard with a DB-9F connector with open collectors (40 V @ 20 mA) indicating:

- Loss of Utility Power
- Inverter Failure
- Low Battery

The Variable Message Sign UPS Front Panel Controls shall come standard with Power ON, Cold (DC) Start, Alarm Silence, Battery Test, Bypass Breaker and DC/Battery Breaker.

Reliability shall be calculated with MTBF as 100,000 hours based on component ratings.

CONSTRUCTION REQUIREMENTS

Contractor shall install the VMS UPS input into the VMS power distribution panel and install UPS output on power control panel circuit per sign manufacture recommendations.

The UPS equipment shall include a minimum two year warranty on parts and labor. Batteries shall include a minimum two year pro rated warranty. Vendor shall be responsible for processing warranty repairs.

A repair option shall be available for UPS equipment no longer covered by the warranty period. Repair cost shall include all labor and materials necessary to complete the repair. Vendor shall be responsible for processing non-warranty repairs.

METHOD OF MEASURMENT

The VMS UPS will not be measured or paid for separately but will be considered subsidiary to VMS item.

REVISION OF SECTION 614
VARIABLE MESSAGE SIGN (LED) (OVERHEAD)

Section 614 of the Standard Specifications is hereby revised for this project to include the following:

DESCRIPTION

This work consists of furnishing and installing a Light Emitting Diode Variable Message Sign (LED VMS) and associated equipment cabinets at locations as shown in the plans. The sign shall be fully compatible with the mounting hardware and support structure shown on the plans. The LED VMS shall be equipped with the ability to display 3 lines of text at a height of 18-inch tall characters and shall have a display made up of a full matrix configuration. The sign shall be 26' wide x 8.5' tall x 4' deep with an allowable variation of 6 inches. The sign shall include a power shut off mounted to the sign structure near the controller interface cabinet. The sign shall be capable of operating without any decrease in performance over a temperature range of -40° F to +158° F with a relative humidity of 0 to 100 percent, condensing. The sign shall have a minimum design life of 20 years.

MATERIALS

a) Certifications: Prior to start of the installation of the LED VMS the Contractor shall provide the following certifications to the Engineer for review and approval:

(1) Certification showing that the manufacturer of the LED VMS is fully compliant with ISO 9001 as of the bid date for this project. The ISO 9001 Certification shall apply to the facility, and to the design, fabrication, installation, and maintenance of the LED VMS. The facility where this company actually designs and manufactures the LED VMS shall be ISO 9001:2000 certified a minimum of one year prior to the bid date for this project.
(2) Working drawings showing the sign housing and tilting brackets shall be sealed by an Engineer registered in the State of Colorado and shall be submitted in accordance with subsection 105.02.
(3) Certification showing that welding of the LED VMS housing is in accordance with the American Welding Society (AWS) Standards, ANSI/AWS D1.2-97. The LED VMS manufacturer's welders and welding procedures shall be certified by an ANSI/AWS Certified Welding Inspector to the ANSI/AWS D1.2-97 Structural Welding Code for Aluminum.
(4) Certification that all aluminum face materials have a coating that meets or exceeds the requirements of the American Architectural Manufacturers Association (AAMA) Specifications Publication No. 2605.
(5) Certification that the LEDs were tested and binned in accordance with the CIE Test Method A.
(6) Documentation and information on software as described in Appendix A of this document.
(7) Documentation verifying the VMS is listed by an accredited 3rd party testing organization for conformance to UL48 and UL 1433.
(8) All workmanship shall comply with IPC-A-610C, Class 2 titled "Acceptability of Electronic Assemblies",
(9) Documentation providing proof PCB silicon conformal coating conformance to MIL-I-46058C Type SR and IPC-CC-830.
(10) Documentation that the sign's structural integrity is in Conformance to AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals (Third Draft).
(11) Documentation that the VMS conforms to the Transient Protection and Vibration of the NEMA Standard TS4, Section2.

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b) Sign Housing: All component parts shall be easily and readily accessible by a single person for inspection and maintenance. There shall be room for a technician to work. Access shall be made by entering the side of the housing. The housing shall be weather tight, and compliant to the NEMA 3R Standard. The bottom panel of the housing shall have a minimum of four drain holes, with snap-in, drain filter plug inserts.

The sign housing shall be capable of withstanding a wind loading of 120 mph without permanent deformation or other damages. The sign housing shall also be designed, stamped and signed by a Professional Engineer licensed in Colorado to withstand current AASHTO specified group loading combinations including: sign weight, repair personnel and equipment, ice and wind loads. It shall also meet strength requirements for truck-induced gusts as specified in NCHRP Report 412. The sign housing shall be engineered to withstand snow loading of 40 pounds per square foot, as well as the ability to be mounted in a manner that prevents the buildup of snow and creates a natural means by which snow can run off without impeding flow of traffic. The performance of the sign, including the visibility and legibility of the display, shall not be impaired due to continuous vibration caused by wind, traffic or other factors. The housing shall be designed to accommodate mounting on the rear vertical plane and shall be structurally sufficient to be mounted to the sign support structure. The sign housing and structural components for the tilting system including bolts and welds, shall be structurally sufficient to perform under all applicable loading conditions including gravity, wind, traffic, weather, roadway deicers, maintenance, and other environmental factors. Working drawings showing the sign housing and tilting brackets shall be submitted in accordance with subsection 105.02. Working drawings shall be sealed and signed by an Engineer registered in the State of Colorado.

All parts shall be made of corrosion resistant materials, such as plastic, stainless steel or aluminum. Painted steel is not acceptable. No self-tapping screws shall be used. The exterior front face surfaces shall be finish coated by a system that meets or exceeds the AAMA Specification No. 2605. The finish shall be matte black. The main body of the sign housing shall be constructed of aluminum with a natural mill finish. All exterior seams shall be continuously welded by an inert gas process, except for the coated fascia material.

The glazing shall be constructed of 0.25 inch thick clear GE LEXAN XL10 or pre-approved equivalent polycarbonate sheets with surfaces that resist hazing from UV light. The glazing shall be protected by a coated 0.090 inch aluminum mask with apertures punched directly in front of each pixel. The coating shall meet or exceed the AAMA Specification No. 2605.

The external front face panels shall have the following minimum dimensions: The perimeter panels shall be a minimum of 12 inches wide. The external front face panels shall be thermally insulated from the rest of the sign housing. The glazing, aluminum mask and the external front face panels shall be easily replaceable from within the sign housing.

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The ventilation system shall be forced air. The system shall be designed to adequately cool the pixels from all sides along with the front and rear of the display module and all other internal components. The ventilation system shall have the following properties:

(1) Positive pressure (exhaust fans are not acceptable).

(2) The fans shall have ball or roller bearings, shall be permanently lubricated and shall require no periodic maintenance. The fans are to be positioned in such a manner so as to provide a balanced air flow to the ventilation system in the event of failure of any fan.

The sign housing shall be provided with a flush-mounted, 150 degree swing, right hinge, heavy-duty, personnel access door with hoisting hardware on door frame that will provide easy access for a single maintenance person. The door shall be constructed of aluminum with a welded aluminum frame and equipped with two closed cell neoprene gaskets. One gasket shall be attached to the door and one gasket shall be attached to the housing door jamb. The housing door shall be attached to the housing with a stainless steel piano hinge with a stainless steel pin spot welded at the top. The hinge shall be mounted so that it is not possible to remove it from the door or cabinet without first opening the door. The door and hinges shall be braced to withstand a 100 pound per vertical foot of door height load applied vertically to the outer edge of the door when standing open. There shall be no permanent deformation or impairment of any part of the door or cabinet body when the load is removed. The door opening shall be double flanged on all four sides. The cabinet door shall also be pad-lockable.

It shall include a three-point locking mechanism with two operating handles, and a dead bolt center-case lock. The lock mechanism and handles shall be corrosion resistant. The door operating handles shall be on both the inside and outside of the door. The door assembly shall also include a device to hold the door open from 90 to 150 degrees. The door shall be provided with a door alarm that is controlled by the sign controller and notifies the Central system control software whenever the door is accessed.

The sign housing shall have a continuous, interior walkway (minimum 24” width) extending the full length of the sign. The internal structural members shall be extruded aluminum and shall accommodate both the display module mountings while allowing air distribution. The display modules shall be removed and replaced without the use of tools and without disturbing adjacent modules. A fold down aluminum shelf shall be provided in the sign housing next to the 2070 controller and in the controller interface cabinet. The sign shall have baseboard heaters that are sufficient to elevate the temperature within the sign to 30° F above the temperature outside the sign. These heaters shall be controlled by a wind up timer in the sign and remotely from the controller interface cabinet and central computers. The angular alignment of the sign housing shall be adjustable in the vertical direction from (0 to 10 degrees) down in one-degree increments to optimize the viewing angle. For surge protection, the system power shall be protected by two stages of transient voltage suppression devices. Also, communication lines shall be protected by two stages of transient voltage suppression devices as required in the Sign Controller Communication Interface section of this specification. In both cases, tripping of each stage (or both if tripped simultaneously) of the surge protection shall cause the sign controller to call central and

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report the error condition (for dialup operation) or report the error condition to central on the next poll (for multi-drop operation).

There shall be an option that is either enabled or disabled and is selected and downloaded from the central system control software to the sign controller. When this option is enabled, tripping of the second stage of surge protection shall prevent power from reaching any components of the sign until the surge protection has been replaced. When this option is disabled, the sign will continue to function normally after the second stage of surge protection is tripped.

c) Sign controller: The sign controller shall be mounted in the sign housing. The sign controller shall be a multiple-sourced, non-proprietary, NTCIP compliant, 19 inch rack mountable, 2070 ATC (Lite) traffic controller, and shall be provided with resident software stored in non-volatile memory. The 2070 ATC controller shall have the capability of upgrading to ATC 5.2b (Linux) specifications.

The 2070 ATC (Lite) shall include a minimum of seven (7) serial communications I/O ports, including three (3) RS-232 ports and one (1) Ethernet port, 2070 accessories 2070-7A serial communication module, 2070-2B field I/O module, 2070-1B CPU Module, and a 2070-4A power supply module shall be supplied as the minimum. The 2070 ATC (Lite) shall have the latest OS-9 (or Linux) operating system.

The sign controller shall be programmed to receive and transmit NTCIP compliant sign control commands from the central system control software or laptop computer.

The controller shall have power-up and auto-restart capabilities with programmable default actions when recovering from a power off condition. A hardware watch dog circuit shall provide automatic reset of the controller and modem device. Central control shall have ability to perform a remote command for the controller and modem device reset.

The Controller shall perform all communication, control and feedback functions and shall not require an intermediate control device and be the only sign controller. Communication and control lines between the sign controller and the system interface circuits shall be opto-coupled.

The following shall be mounted inside the main sign housing:

(1) NTCIP compliant 2070 ATC (Lite) sign controller
(2) Fold-down laptop shelf and document holder for maintaining sign.
(3) Modem/or communication device
(4) Display system interface circuits
(5) Local/remote control switch
(6) Sign to ground voice communication RJ-11 jack
(7) USB plug-in connection or a serial connection with a USB converter cable for the controller interface.
(8) RS-232 cable (a minimum of 4 feet long to connect the controller interface to a laptop computer)
(9) A.C. surge protection and communication surge protection

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There shall be an outside controller interface box that shall be made of aluminum or stainless steel, be weather tight, corrosion resistant, and meet NEMA 3R standards. The separate controller interface box shall be mounted as indicated on the plans. This typically will be on the sign support structure pole furthest from traffic.

The controller interface cabinet shall contain the following assemblies:

(1) Power-on indicator
(2) Waterproof local/remote switch
(3) Local control LED indicator
(4) RS-232cable a minimum of 4 feet long to connect the controller interface to a laptop computer.
(5) 120 VAC GFI outlet
(6) For dialup installations, an RJ-11 jack for connecting the dialup phone line shall be installed with in-line surge protection.

d) Electronics: All electronic components, except printed circuit boards, shall be commercially available, easily accessible, replaceable and individually removable using conventional electronics repair methods.

All Printed Circuit Boards (PCBs) shall be completely conformal coated with a silicone resin that meets the IPC CC-830 standard. The exception for this coating shall be the pixels on the front of the PCB of the LED motherboards and any components in sockets.

All discrete components, such as resistors, capacitors, diodes, transistors, and integrated circuits shall be individually replaceable. Components shall be arranged so they are easily accessible for testing and replacement. All circuit designs shall utilize high quality electronic components and shall provide a meantime before failure of at least 3 years.

Provisions shall be made to prevent face fogging and condensation. The sign controller shall read the internal temperature sensors, external ambient temperature sensor and the humidity sensor. The sign controller shall use these readings in an algorithm that turns on the heat tape to reduce both frost on the face of the sign and condensation on the display modules and other electronic circuitry.

The sign and the controller shall be capable of operating with 120/240 VAC, 50 amp per leg, 60 Hz, single phase power. The sign shall have a 50-amp two-pole breaker (common trip) main, 120/240 VAC, single phase, four wire load center with 20 circuit capability. Each circuit in the sign shall be powered from a circuit breaker. Inside the sign housing, all 120 VAC service lines shall be independently protected by a thermo magnetic circuit breaker at the sign housing entry point. All 120 VAC wiring shall be located in conduit, pull boxes, raceways, or control cabinets as required by the National Electrical Code (NEC). No 120 VAC wiring shall be exposed within or outside of the sign housing. The sign housing shall not be considered as a raceway or control cabinet. There shall be a minimum of three GFI Duplex outlets installed inside the sign housing.

Lighting shall be provided to illuminate the interior of the sign. The lights shall be enclosed in die cast aluminum safety fixtures with twist-on bulb guards secured by four set- screws.

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The light bulbs shall be clear incandescent light bulbs that may be controlled by an adjustable timer.

The pixels shall be amber in color and utilize precision optical performance AlInGaP II LEDs constructed of aluminum indium gallium phosphide. The brightness and color of each pixel shall be uniform over the entire face of the sign within the 15-degree cone of vision from minimum of 200 feet up to and including 1100 feet in all lighting conditions. Each pixel shall be 40 candelas at 20mA as measured by the sum of the brightness of the individual LEDs in each pixel. The brightness of each LED shall be measured in accordance with CIE Test Method A, as described in CIE 127-1997, Technical Report: Measurement of LEDs.

Each pixel shall contain two strings of LEDs. The pixel strings shall be powered from a regulated DC power source and the LED current shall be maintained at 25 plus or minus three milliamperes per string to maximize life of the pixel. The failure of an LED in one string within a pixel shall not affect the operation of any other string or pixel. The LEDs shall be capable of operating in a temperature range of –40 degrees to +100 degrees C. The LEDs shall be moisture resistant epoxy with UV-A and UV-B inhibitors.

Pixel power drawn from the DC supplies shall not exceed 1.5 watts per pixel, including the driving circuitry.

A minimum of three photocells shall be installed on the sign. These devices shall permit automatic light intensity measurement of light conditions at each sign location. These photocells shall be mounted in a manner to measure front, rear and ambient light conditions.

Provisions shall be made to prevent perceivable brightening of the sign due to stray headlights shining upon the photo sensors at night.

The power supplies shall be paralleled in a diode OR configuration such that one supply may completely fail and the sign will still be supplied with enough power to run 40% of all pixels.

All cables shall be securely clamped/tied in the sign housing. No adhesive attachments will be allowed.

The signs shall be capable of displaying ASCII characters 32 through 126 (including all upper and lower case letters and digits from 0 to 9) at any location in a message line.

The Contractor shall be responsible for locating the nearest electrical power and telephone sources and connecting those sources to the appropriate terminations with the LED VMS. The Contractor shall cooperate with the local electrical and telephone utilities to establish a service accounts at the direction of the Engineer.

e) *Communication:* The sign controller shall be capable of being controlled from the central system control software and the controller interface cabinet via RS-232 serial and Ethernet communications.

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The sign controller shall include separate interfaces for communication with the central system control software and the controller interface cabinet.

The communications between the sign controller and the central system control software and controller interface cabinet shall comply with the NEMA National Transportation Communications for ITS Protocol (NTCIP). The sign controller shall support all NTCIP conformance levels, conformance groups, objects, and minimum storage sizes and ranges as specified in APPENDIX A.

In addition to the standard Management Information Base (MIB) objects, the sign shall include any additional manufacturer-specific MIB objects required to support all of the sign and central software functionality defined in this specification and in APPENDIX A.

Dial-up or hardwire multi-drop communication lines shall be protected by two stages of transient voltage suppression devices including MOVS and spark gap arrestor.

The sign controller shall be capable of being remotely reset from the central system control software.

The sign shall provide a minimum of four (4) input and four (4) output contact closures able to receive digital and or analog signals that will allow up to 15 message activations upon contact closure events. These message activations shall permit standard NTCIP operations to occur and also permit contact closure messages to occur without message activation collisions and or message activation errors. Contact closures shall be remotely accessible using standard NTCIP MIB objects. Contact closures shall be capable of issuing NTCIP traps.

The sign controller shall provide software modules that will allow integration with CDOT WIM systems.

The sign controller shall allow user-configuration of maximum and minimum temperature in which to turn fans on and off.

The sign shall have polling capability and at a minimum shall be capable of reporting the status of the following:

(1) Pixel operational status that includes every string of every pixel
(2) Sign and ambient temperature
(3) DC power supply status
(4) The current state (on or off) of each pixel, including any pixel errors, in the actual, currently displayed message without disturbing the message in any way. This shall be real time and shall not be based on a previous pixel test.
(5) Cooling fan status
(6) Access door alarm
(7) Communication failure log
(8) Heat tape status
(9) UPS status
(10) AC surge protector status

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The controller software shall be capable of displaying the following types of messages:

(1) Static messages capable of displaying any character or set of characters
(2) Full Graphic capabilities.
(3) Flashing messages with the following ranges of adjustable timing:
    (a) Message time on from 0.5 to 5.0 seconds in 0.1 second increments.
    (b) Message time off from 0.5 to 5.0 seconds in 0.1 second increments.
(4) Alternating messages capable with the following ranges of adjustable timing:
    (a) Primary message time on from 0.5 to 5.0 seconds in 0.1 second increments.
    (b) Primary message time off from 0 to 5.0 seconds in 0.1 second increments.
    (c) Alternate message time on from 0.5 to 5.0 seconds in 0.1 second increments.
    (d) Alternate message time off from 0 to 5.0 seconds in 0.1 second increments.

It shall be possible to flash any character or set of characters in an alternating message at the adjustable frequencies listed above for flashing messages. The flashing period shall be a sub-multiple of the associated alternating on time. It shall also be possible to flash any character or set of characters in a static message.

The sign controller shall monitor the photo cell circuits in the sign and convert the measured light intensity into the desired pixel brightness.

MANUFACTURER QUALIFICATIONS

The manufacturer shall supply experience documentation showing that the manufacturer has been in business, under the current corporate name, designing and manufacturing Interstate LED Variable Message Signs for a minimum of 5 years; and that the manufacturer has in operation a minimum of 100 walk-in LED VMSs. These 100 VMS shall be from 5 separate projects and operational for a minimum of 5 years.

CONSTRUCTION REQUIREMENTS

Contractor shall be fully responsible for the delivery of the sign to the installation site and any damages that occur in the installation delivery process.

The LED VMS shall be installed in accordance with manufacturer's recommendations. A qualified factory representative shall be available on site to ensure proper installation and testing.

The Contractor shall perform a VMS acceptance test procedure for approval and acceptance by the Department in the presence of the Engineer, a representative of the CDOT Colorado Transportation Management Center, and the manufacturer's representative. The test shall include all items addressed in these specifications and any other requirements from the project plans or Engineer. The test shall also include the use of the latest version of the NTCIP Exerciser, or equivalent, to demonstrate that no proprietary protocols have been used and that the local and central software are NTCIP compliant. The Contractor shall notify the Engineer at least two weeks prior to the test date.

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A minimum of five copies of the operations manual detailing the electrical schematics, operation and maintenance of the VMS system, including spare software copies, shall be provided. Additional copies may be requested by the Engineer. One copy of the manual shall remain inside the sign housing or control cabinet. One copy shall be mailed to the Colorado Transportation Management Center at 425 C Corporate Circle, Golden, Colorado 80401.

WARRANTY

a) *Standard Warranty.* The contractor shall ensure that the manufacturer can warranty the product for a minimum of 3 years for all parts returned to the factory, and full telephone technical support at no additional charge to the Department. The technical support shall include access to a trained service representative who can respond within 24 hours to questions related to all VMS related equipment problems and maintenance issues.

METHOD OF MEASUREMENT

The LED VMS will be measured by the actual number that are installed and accepted, and shall include all labor, materials, and equipment necessary to complete the work, including the sign controller, controller interface box, sign housing, electronics, communications equipment, delivery to the installation site and standard warranty.

NTCIP Requirements

This portion of the specification defines the detailed NTCIP requirements for the Dynamic Message Signs covered by the project specifications.

This specification references several standards through their NTCIP designated names. The following list provides the full reference to the current version of each of these standards. In many cases, the standard is more

widely known by its original NEMA assigned number, in these cases, the NEMA number is also identified. The content of the NEMA standard is identical to that of the NTCIP standard.

Each NTCIP Component covered by these project specifications shall implement the most recent version of the standard that is at the stage of Recommended or higher as of January, 01, 2011, including any and all Approved or Recommended Amendments to these standards as of the same date. It is the ultimate responsibility of the vendor to monitor NTCIP activities to discover any more recent documents.

General Requirements:

Subnet Level

Each NTCIP Component shall support NTCIP 2104 v01.11 over both a null-modem connection and a contractor-provided external dial-up modem connection. The dial-up modem shall support data rates of 14.4 kbps, 9600 bps, 4800 bps, 2400 bps, 1200 bps, 600 bps, and 300 bps. The null-modem shall support the same speeds with a maximum of 19.2 kbps. Additionally, the NTCIP Component shall be able to make outgoing and receive incoming calls as necessary and support the following modem command sets:

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- Hayes AT Command Set
- MNP5
- MNP10
- V.42bis

NTCIP Components may support additional Subnet Profiles at the vendor's option. At any one time, only one Subnet Profiles shall be active on a given serial port of the NTCIP Component. If the NTCIP Component has a serial port that supports multiple Subnet Profiles, the NTCIP Component shall be configurable to allow the field technician to activate the desired Subnet Profile and shall provide a visual indication of the currently selected Subnet Profile.

Transport Level

Each NTCIP Component shall comply with NTCIP 2202, (NEMA TS 3.Internet). NTCIP Components may support additional Transport Profiles at the manufacturer's option. Response datagrams shall use the same Transport Profile used in the request. Each NTCIP Component shall support the receipt of datagrams conforming to any of the identified Transport Profiles at any time.

Application Level

Each DMS shall comply with NTCIP 2301, (NEMA TS 3.AP-STMF), as a Managed Agent and shall meet the requirements for Conformance Level 1 (NOTE – See Amendment to standard). SNMP shall be required and STMP shall not be required. An NTCIP Component may support additional Application Profiles at the manufacturer's option. Responses shall use the same Application Profile used by the request. Each NTCIP Component shall support the receipt of Application data packets at any time allowed by the subject standards.

Information Level

Each NTCIP Component shall provide Full, Standardized Object Range Support of all objects required by these procurement specifications, unless otherwise indicated below or approved by the Project Engineer. The maximum Response Time for any object or group of objects shall be 100 milliseconds.

The vendor's software shall implement all mandatory objects of the mandatory conformance group defined in NTCIP 1201, (NEMA TS 3.4) Global Object Definitions:

- Configuration Conformance Group – Section 3.1
- Security Conformance Group (new in Amendment 1)

The vendor's software shall implement the mandatory objects of the optional conformance groups defined in NTCIP 1201, (NEMA TS 3.4), Global Object Definitions:

- Time Management Conformance Group – Section 3.3
- TimeBase Event Schedule Conformance Group – Section 3.4
- Report Conformance Group – Section 3.5

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The vendor's software shall implement all mandatory objects of all mandatory conformance groups defined in NTCIP 1203 v0239b (NEMA TS 3.6) Object Definitions for Dynamic Message Signs:

- Sign Configuration Capability Objects – Section 5.2
- DMS Configuration Objects – Section 5.3
- Font Definitions Objects – Section 5.4
- Multi Configuration Objects – Section 5.5
- Message Objects – Section 5.6
- Sign Control Objects – Section 5.7
- Illumination/Brightness Objects – Section 5.8
- Scheduling Action Objects – Section 5.9
- Auxiliary I/O Objects - Section 5.10
- Sign Status – Section 5.11

The vendor's software shall implement the following optional objects defined in NTCIP 1203 v0239b, (NEMA TS 3.6):

- dmsMessageBeacon – Section 5.6.8.6
- dmsSWReset – Section 5.7.2
- dmsMessageTimeRemaining – Section 5.7.4
- dmsShortPowerRecoveryMessage – Section 5.7.8
- dmsLongPowerRecoveryMessage – Section 5.7.9
- dmsShortPowerLossTime – Section 5.7.10
- dmsResetMessage – Section 5.7.11
- dmsCommunicationsLossMessage – Section 5.7.12
- dmsTimeCommLoss – Section 5.7.13
- dmsPowerLossMessage – Section 5.7.14
- dmsEndDurationMessage – Section 5.7.15
- dmsMultiOtherErrorDescription – Section 5.7.20
- dmsStatDoorOpen – Section 5.11.1.6
- fanFailures – Section 5.11.2.3.1
- fanTestActivation – Section 5.11.2.3.2
- tempMinCtrlCabinet – Section 5.11.4.1
- tempMaxCtrlCabinet – Section 5.11.4.2
- tempMinAmbient – Section 5.11.4.3
- tempMaxAmbient – Section 5.11.4.4
- tempMinSignHousing – Section 5.11.4.5
- tempMaxSignHousing – Section 5.11.4.6

The vendor's software shall implement the following tags (opening and closing where defined) of MULTI as defined in Section 6.0 of NTCIP 1203 v0239b, (NEMA TS 3.6), Object Definitions for Dynamic Message Signs:

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MULTI Tag

1. Field – Section 6.4.5
2. Flash – Section 6.4.6
3. Font – Section 6.4.7
4. Hexadecimal Character – Section 6.4.9
5. Justification Line – Section 6.4.10
6. Justification Page – Section 6.4.11
7. Moving Text – Section 6.4.13
8. New Line – Section 6.4.14
9. New Page – Section 6.4.15
10. Page Time – Section 6.4.16
11. Spacing – Character – Section 6.4.17

The Field Tag shall support the following field ID's:

	Field Tag ID	Description
1	1	Time, 12-hour format (no AM/PM indicator)
2	2	Time, 24-hour format
3	3	Temperature in degrees Celsius
4	4	Temperature in degrees Fahrenheit
5	7	Day of week
6	8	Day of month
7	9	Month of year
8	10	Year, 2-digits
9	11	Year, 4-digits

Sizes and Ranges

All objects required by these procurement specifications shall support all values within its standardized range, unless otherwise approved by the Project Engineer. The standardized range is defined by a size, range, or enumerated listing indicated in the object's SYNTAX field and/or through descriptive text in the object's DESCRIPTION field of the relevant standard. The following provides the current listing of known variances for this project:

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Object	***Reference***	***Minimum Project Requirements***
NTCIP 1201 (TS 3.4)		
moduleTableEntry	2.2.3	Shall contain at least one row with moduleType equal to 3 (software). The moduleMake shall specify the name of the manufacturer, the moduleModel shall specify the manufacturer's name of the component and the modelVersion shall indicate the model version number of the component.
communityNamesMax	2.8.2	Shall be at least 4.
maxTimeBaseScheduleEntries	2.4.3.1	7
maxDayPlans	2.4.4.1	7
maxDayPlanEvents	2.4.4.2	7
maxEventLogConfigs	2.5.1	50
eventConfigMode	2.5.2.3	2,3,and 4
maxEventLogSize	2.5.3	200
maxEventClasses	2.5.5	7
maxGroupAddress	2.7.1	1
NTCIP 1203 v0239b (TS 3.6)		
dmsNumPermanentMsg	5.6.1	100
dmsMaxChangeableMsg	5.6.3	100
dmsFreeChangeableMemory	5.6.4	500 MB
dmsMaxVolatileMsg	5.6.6	100
dmsFreeVolatileMemory	5.6.7	500 MB
dmsMsgMultiString	5.6.8.3	See attached table
dmsControlMode	5.7.1	2,4,5
numFonts	5.4.1	10
maxFontCharacters	5.4.3	127
DMSCharacterHeightPixels	5.3.1	7
DMSCharacterWidthPixels	5.3.2	5
DMSSignHeightPixels	5.3.3	27
DMSSignWidthPixels	2.3.1.1.1.4	105
DMSHorizontalPitch	5.3.5	70 mm
DMSVerticalPitch	5.3.6	70 mm
defaultBackgroundColor	5.5.1	0 (black)
defaultJustificationLine	5.5.9	2,3,4
defaultJustificationPage	5.5.11	2,3,4
defaultFlashOn	5.5.3	0.5 to 5.0
defaultFlashOff	5.5.5	0.5 to 5.0
defaultPageOnTime	5.5.13	0.5 to 5.0
defaultPageOffTime	5.5.15	0.5 to 5.0
defaultCharacterSet	5.5.21	eightBit (2)
dmsMaxNumberPages	5.5.24	6
dmsColorScheme	5.5.22	1 (monochrome1bit)
dmsSupportedMultiTags	5.5.23	See Section 614 more Multi Tags details.

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Documentation

The Software shall be supplied with full documentation and a CD-Rom containing ASCII versions of the following Management Information Base (MIB) files in Abstract Syntax Notation 1 (ASN.1) format: relevant version of each official standard MIB Module referenced by the device functionality.

- If the device does not support the full range of any given object within a Standard MIB Module, a vendor specific version of the official Standard MIB Module with the supported range indicated in ASN.1 format in the SYNTAX and/or DESCRIPTION fields of the associated OBJECT TYPE macro. The filename of this file shall be identical to the standard MIB Module, except that it will have the extension ".man".
- A MIB Module in ASN.1 format containing any and all manufacturer-specific objects supported by the device with accurate and meaningful DESCRIPTION fields and supported ranges indicated in the SYNTAX field of the OBJECT-TYPE macros.
- A MIB containing any other objects supported by the device.

The vendor shall allow the use of any and all of this documentation by any party authorized by CDOT for systems integration purposes at any time initially or in the future, regardless of what parties are involved in the systems integration effort.