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**ADAMS COUNTY  
DEPARTMENT OF PUBLIC WORKS  
ENGINEERING DIVISION  
TRAFFIC SIGNAL PROJECT SPECIAL PROVISIONS**

5 The 2017 Standard Specifications for Road and Bridge Construction by the Colorado Department of  
6 Transportation (CDOT) controls construction of this project. The following special provisions supplement  
7 or modify the Standard Specifications and take precedence over the Standard Specifications and plans.  
8 When specifications or special provisions contain both English units and SI units, the English units apply  
9 and are the specification requirement.

10 In addition to requirements of the Colorado Department of Transportation Standard Specifications for  
11 Road and Bridge Construction, and the Contract Documents, all material and work shall conform to the  
12 requirements of the National Electrical Line Construction of the Public Utilities Commission, the Standards  
13 of the American Society for Testing and Materials (ASTM), the American Standards Association (ASA),  
14 and any local ordinance which may apply.

15 Reference to any portion of the Adams County Traffic Standard Details contained herein shall imply  
16 precedence over the CDOT Standard Specifications and Plans, and shall be the requirement.

17

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1 **REVISION OF SECTION 105**  
2 **CONTROL OF WORK**

3 Section 105 of the Standard Specifications is hereby revised as follows:

4 Subsection 105.2(b) shall hereby include the following:

5 After contract award, prior to installation, and/or at the Engineer's request, the Contractor shall  
6 submit shop drawings and specifications for equipment and materials the Contractor proposes to  
7 furnish. The shop drawings and specifications shall be complete as to name of manufacturer,  
8 size, and catalog number of unit, and shall be supplemented by such other data as may be  
9 required. The Engineer's approval shall be required prior to installation.

10 Subsection 105.3 shall hereby include the following:

11 Inspection or sampling of any materials, other than those materials already approved by the  
12 Engineer, must be made by the Engineer prior to installation. If the Contractor proposes a  
13 substitution of material called for in the plans as specifically defined in these specifications, or as  
14 shown in approved submittals and shop drawings, the Contractor shall provide additional  
15 information to prove the substitution item is of equal or superior quality. Any material and/or  
16 equipment installed by the Contractor that is not in conformance with the project specifications  
17 shall be removed or changed at the Contractor's expense.

18 **END REVISION OF SECTION 105**

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**REVISION OF SECTION 107  
LEGAL RELATIONS AND RESPONSIBILITY TO THE PUBLIC**

Section 107 of the Standard Specifications is hereby revised as follows:

Subsection 107.12 shall hereby include the following:

The Contractor shall assume full responsibility and expense for the protection of all public and private property, structures, water mains, sewers, utilities, etc., both above and below ground, at or near the site or sites of the work being performed under the Contract, or which are in any manner affected by the prosecution of the work or the transportation of personnel and materials in connection therewith.

**END REVISION OF SECTION 107**

1 **REVISION OF SECTION 202**  
2 **REMOVAL OF STRUCTURES AND OBSTRUCTIONS**

3 Section 202 of the Standard Specifications is hereby revised as follows:

4 Subsection 202.02 shall be revised to include the following:

5 The Engineer will mark the limits of removals in the field.

6 Subsection 202.03 is hereby replaced as follows:

7 All salvable material shown on the plans shall be removed, without unnecessary damage, in  
8 sections or pieces that may be readily transported, and delivered by the Contractor to the location  
9 noted on the plans, or as directed by the Engineer. The Contractor shall be held responsible for  
10 the safekeeping of all salvable materials during the period of the Contract until they are delivered  
11 to the County. The Contractor shall make good or replace at his own expense any such materials  
12 damaged, stolen or otherwise lost prior to receipt by the County. All salvable materials, as  
13 designated on the plans, shall remain the property of the County.

14 Subsection 202.07 is hereby replaced as follows:

15 All concrete pavement, sidewalks, structures, curbs, gutters, asphalt pavement, etc., designated  
16 for removal, shall be broken into pieces and disposed of outside the limits of the project, unless  
17 otherwise designated on the plans, or as directed by the Engineer.

18 Old concrete construction which abuts new construction, edges of pavement, sidewalks, curbs,  
19 etc., to be left in place shall be saw cut to true line with a vertical face.

20 Where old asphalt construction abuts new construction, edges of asphalt pavement, patching,  
21 etc., asphalt to be left in place shall be wheel cut or sawcut to a neat vertical face with minimal  
22 jagged edges to the satisfaction of the Engineer. The Engineer, at his discretion, may require  
23 asphalt to be sawcut.

24 Removal of stone curb shall include the complete removal of the curb head and concrete  
25 foundation. No payment will be made for sprinkler relocation, utility relocation, etc., beyond the  
26 limits of construction as shown on the plans. Stone curb designated for salvage shall be carefully  
27 removed to prevent damage and delivered to the location indicated in the plans or specifications,  
28 or as directed by the Engineer.

29 Subsection 202.09 shall be revised to include the following:

30 Removal of asphalt mat from gutters shall be accomplished by planing, and/or scraping. If the  
31 existing gutter is to remain, the gutter shall be cleaned by sandblasting until the pan is completely  
32 clean of residue. Gutters which are excessively (greater than one-quarter inch in depth) planed or  
33 damaged shall be removed and replaced by the Contractor at his expense. If gutter is designated  
34 for removal, no separate payment shall be made for asphalt removal.

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**REVISION OF SECTION 202  
REMOVAL OF STRUCTURES AND OBSTRUCTIONS**

Subsection 202.11 shall be revised to include the following:

Removal of concrete paving, crosspans, curb ramps, driveways will be measured by area in square yards, regardless of thickness. Removal of asphalt mat will be measured by square yard. If the existing asphalt mat is over 9" thick, the unit price will be increased in proportion to the additional thickness (18" asphalt mat will be paid at twice the unit price). If the asphalt mat is greater than 4" and is over concrete pavement, both asphalt removal and concrete pavement removal will be paid. If the asphalt mat is less than 4" and is over concrete pavement, only concrete pavement removal will be paid.

Removal of asphalt mat (planing) will be measured by the square yard, regardless of thickness.

Removal of asphalt mat from concrete gutter and other concrete designated to remain shall be measured by the square yard. Removal of asphalt mat from gutter shall include sandblasting and compressed air cleaning as part of that pay item.

Subsection 202.12 is hereby deleted and replaced as follows:

The accepted quantities will be paid for at the contract unit price for each of the pay items listed below that appear in the bid schedule. Payment shall be full compensation for sawcutting, scraping, sandblasting, removing, hauling and disposal of such items, excavation and subsequent backfill (with moisture/density control per the Revision of Subsection 203.07) to proposed subgrade elevation. The price shall also include salvageable materials removed, their custody, preservation, storage, haul and disposal as provided herein.

Payment will be made under:

<b>Pay Item</b>	<b>Pay Unit</b>
Removal of Structures and Obstructions	Lump Sum.
Removal of _____	Each, L.F., C.F.
	S.F., S.Y.
Removal of Stone Curb (Salvaged and Returned to County)	L.F.
Removal of Asphalt Mat from Gutter	S.Y.
Removal of Asphalt Mat	S.Y.
Plug _____	Each
Clean _____	Each
Abandon _____	Each
Sandblasting	S.F.
Sandblasting Existing Reinforcing Steel	S.Y.

When the Contract does not include pay items for Removal of Structures and Obstructions, the removal will not be paid for separately but shall be included in the work.

**END REVISION OF SECTION 202**

1 **REVISION OF SECTION 202**  
2 **REMOVAL OF TRAFFIC SIGNAL EQUIPMENT**

3 Section 202 of the Standard Specifications is hereby revised as follows:

4 Subsection 202.02 shall include the following:

5 Removal items shall be as indicated in the pay item list and shall consist of the items specifically  
6 identified on the plans, or in writing by the Engineer. It shall be the Contractor's responsibility to  
7 assure that the Contractor has a full and complete understanding of included items prior to  
8 bidding.

9 Subsection 202.03 shall include the following:

10 Removal of the traffic signal equipment shall include signal poles, luminaries, pedestal poles,  
11 footings, span wire cable, mast arms, traffic signal controller and cabinet, pedestrian push button,  
12 cabinet footings, all attachment hardware, and all incidental equipment, except as noted on plans.  
13 All existing foundations shall be removed to a depth indicated by the Engineer. All wiring shall be  
14 removed from existing conduit and the conduit shall be abandoned in place. The Contractor shall  
15 restore disturbed areas affected by removals. Restoration of landscaped areas shall include  
16 reseeding, re-sodding, or other such treatment that restores the disturbed area to its original  
17 condition. Restoration shall be considered incidental to the work being performed.

18 Subsection 202.04 shall include the following:

19 All "Light Emitting Diode" (LED) signal lenses in existing signal faces shall be removed prior to  
20 the removal of the signal face and shall be protected from damage. All traffic signal equipment  
21 which is removed shall remain the property of the County unless otherwise specified by the  
22 Engineer. County property shall be removed from the work site and returned by the Contractor to  
23 the County at 4955 East 74<sup>th</sup> Ave., Commerce City, Colorado 80022. Delivery of salvaged  
24 equipment shall be included in the cost of Removal of Traffic Signal Equipment and will not be  
25 paid for separately.

26 Subsection 202.12 shall include the following:

27 <b>Pay Item</b>	<b>Pay Unit</b>
28 Removal of Traffic Signal Equipment	Lump Sum
29 Payment includes all labor, equipment and materials necessary to complete the work.	

30 **END REVISION OF SECTION 202**

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1 **REVISION OF SECTION 210**  
2 **RESET STRUCTURES**

3 Section 210 of the Standard Specifications is hereby revised as follows:

4 Subsection 210.01 shall hereby include the following:

5 Reset pay items shall be as indicated in the pay item list and shall consist of the items specifically  
6 identified in the plans, or in writing by the Engineer. It shall be the Contractor's responsibility to  
7 assure that the Contractor has a full and complete understanding of included items prior to bidding.

8 Subsection 210.12 shall hereby include the following

9 Reset items are to be initially removed, then adjusted or modified as directed by the Engineer, and  
10 finally reinstalled to full operational capability. Modifications and adjustments shall be detailed on  
11 the plans or stated in writing by the Engineer, and shall be incidental to the reset pay item.

12 **END REVISION OF SECTION 210**

13



**REVISION OF SECTION 613  
ELECTRICAL CONDUIT – GENERAL**

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

Add the following to subsection 613.07:

New conduit runs shown on the plans are for bidding purposes only and may be changed at the direction of the Engineer.

Directional boring is the preferred method of conduit installation. Bored conduit shall be used in all hard paved areas and installed per industry standard. Bored conduit runs shall be un-spliced from pull box to pull box. For all new conduit installations, PVC or Schedule 80 polypipe shall be understood unless otherwise defined. Excavation of roadway surfaces will not be allowed unless approved by the Engineer, or as specified in the plans. All roadway and/or hard paved surfaces damaged during the installation of conduit shall be restored in kind equal to or exceeding the original conditions, or as approved by the Engineer, at no additional cost.

The installation of conduit or cable requiring excavation shall be performed in such a manner as to avoid unnecessary damage to streets, sidewalks, landscaping, sprinkler systems and other improvements. Trenches shall not be excavated wider than necessary for the installation of the electrical appurtenances. Excavation shall not be performed until immediately before installation of conduits. The material from the excavation shall be placed in a position not to cause damage or obstruction to vehicular or pedestrian traffic or interfere with surface drainage.

Conduit bends, except factory bends, shall have a radius of not less than six (6) times the inside diameter of the conduit. Where factory bends are not used, conduit shall be bent without crimping or flattening, using the longest radius practicable. Conduit bends feeding pull boxes and foundations shall have an eighteen (18) inch radius as shown on the standard details. All signal wiring conduit installed shall be fully compatible with fiber optic cable.

Conduit shall be laid at a depth of not less than thirty (30) inches below the finished roadway grade and twenty-four (24) inches below the finished grade in all other areas. Conduit under railroad tracks shall be at the minimum depth below the bottom of tie required by the particular railroad company.

Conduit shall always enter a pedestal base, pull box, pole foundation, cabinet foundation, or any other type structure from the direction of the run only. Conduit connections at junctions shall be tightly secured.

All conduit runs that exceed ten (10) feet in length shall have a continuous one-eighth (1/8) inch diameter nylon line pulled into the conduit along with the specified electrical cables. The line shall be firmly secured at each end of the conduit run with three (3) feet of slack. The purpose of this line is to be able to pull future electrical cable through the existing conduit runs. Mule tape shall be installed in place of the nylon line when specified in the plans.

Each conduit with a length greater than 400' between pull boxes, shall be equipped with a pull tape. The pull tape shall have a minimum tensile strength of 1250 lbs. and be of a design and manufacture that prevents cutting or burning into the conduit during cable installation. A 14 AWG locate wire shall be installed for the complete length of all new conduit runs installed as part of the project. No less than three (3) feet of slack shall remain in each pull box in which the conduit terminates. Where joint trenching is used, only one locate wire need be installed for each joint trench.

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**REVISION OF SECTION 613**  
**ELECTRICAL CONDUIT - GENERAL**

Splicing of the locate wire shall not be permitted. Costs for the locate wire shall be incidental to the conduit pay item.

Any spare or unused conduits shall be capped. Conduit plugs for sealing conduit shall also be supplied and installed in all open conduit ends as soon as the conduit is installed. Plugs shall be durable, fabricated from no metallic parts, be of the split design to allow removal and reinstallation around in-place cables and be easily removable and reusable. Plugs shall be capable of being installed by hand without any tools and shall provide a water and air tight seal of at least 100 psi and shall cause no damage to the cable when installed.

Polypipe to PVC coupling shall be completed with the use of "E-Loc" couplings or approved equal.

A two (2) inch PVC conduit shall be installed between the local utility company demarcation point and the controller cabinet home run pull box.

A two (2) inch PVC conduit shall be installed to all signal poles for the exclusive use of the local utility company providing electrical power for luminaires. The conduit may be laid in trenches cut for signal wire conduit and shall run from the controller cabinet home run pull box to signal poles through associated signal pole pull boxes.

When a cabinet is defined as a master cabinet, a two (2) inch PVC conduit shall be installed from the controller cabinet to the designated telephone company demarcation point.

When inductance loops and/or micro loops are required, a two (2) inch PVC conduit shall be installed from the nearest signal pole pull box to a water valve pull box located within the roadway. The material and installation requirements of the water valve pull box shall be as follows;

- Be constructed of aluminum, with the capability of accepting riser rings for future overlays. The lid shall have the word "TRAFFIC" imprinted on it.
- Have ¾" to 1" diameter holes either drilled or torched 3" from the top to accept a 4" to 6" long rubber tube (garden hose). The number of holes shall be as per the plans or as directed by the engineer.
- 2 feet of slack loop wires is to be provided and stored in the water valve pull box.
- The lid is to be sealed water tight by caulking.
- To be located in an area of the street where tire traffic is not present, preferably 12" from the concrete gutter pan.
- The conduit under the roadway serving the pull box shall be at a depth of no less than 30".

The water valve pull box shall be as shown in the Adams County Standard Details. The water valve pull box shall not be paid for separately, but shall be included in the cost of the conduit.

The two (2) inch conduit shall be routed through and terminated within a pull box located adjacent to both the roadway and the associated inductance loop(s). The conduit may be laid in trenches cut for signal wire conduit.

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**REVISION OF SECTION 613  
ELECTRICAL CONDUIT - GENERAL**

The following conduit schedule is in effect unless otherwise specified in the traffic signal plans.

Run Type	Qty	Size	Use
Street Crossing	1	3"	120VAC Signal Load Wiring
	1	3"	Low Voltage Signal Wiring & Interconnect
	1	3"	Spare
	1	2"	Luminaire Wiring
Signal Pole	1	3"	All Signal Wiring
	1	2"	Luminaire Wiring
Controller Cabinet	1	3"	120VAC Signal Load Wiring
	1	3"	Low Voltage Wiring & Interconnect
	1	3"	Spare
	1	2"	Public Service Utility Power Feed
Inductance Loop	1	2"	Inductance/Micro Loops
Interconnect	1	3"	Interconnect
Service Points	1	2"	Public Service Utility Power Feed
	1	2"	Telephone Service Feed

When a cabinet is defined as a master cabinet, a two (2) inch PVC conduit shall be installed from the controller cabinet to the designated telephone company demarcation point.

If the contractor is unable to bore the conduit at the lengths shown on the plans from pull box to pull box, all splice couplings and associated work to splice the conduit shall be included in the cost of this item. This shall include excavation down to the required depth of conduit at the splice location. Also included in the cost of this item are all landscape repairs, which will be required after excavation of conduit at all splice locations. All splice couplings shall be water and air tight and installed at a depth to match the remaining run of conduit. No elevation difference will be allowed. 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.

If approved, trenches shall be made with a rock-wheel or other machine capable of cutting a narrow trench (4") so as to allow traffic to pass over prior to back filling. The machine shall be equipped with shields to direct the spoil downward and away from passing vehicles, workmen and pedestrians.

Off-street trenches shall be back-filled with the same material that was removed and shall be compacted and shaped to match the surrounding surface. On-street trenches within ALL roadway areas shall be back-filled with CDOT approved Structure Backfill (Flow-Fill) and capped with 6" of Hot Bituminous Pavement (Patching) in accordance with Section 403.

**REVISION OF SECTION 613  
ELECTRICAL CONDUIT - GENERAL**

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All surface materials including sprinkler systems, landscaping, shrubs, sod grass, and native growth vegetation which is disturbed by trenching and back-filling operation shall be restored in kind equal to or exceeding the original conditions. Restoration work shall be incidental to the conduit pay item.

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

Subsection 613.10 shall include the following:

Conduit shall be measured and paid for by the linear foot of conduit installed from center of pull box to center of pull box, center of pull box to center of pole, or center of pull box to center of cabinet and shall include all labor, equipment, and materials necessary to install the item complete-in-place. Conduit shall be paid for under the 2" Electrical Conduit (Plastic), 2" Electrical Conduit (Bored) and the 3" Electrical Conduit (Plastic), 3" Electrical Conduit (Bored) pay items.

Subsection 613.11 shall include the following:

<b>Pay Item</b>	<b>Pay Unit</b>
2" Electrical Conduit (Plastic)	Lineal Foot
3" Electrical Conduit (Plastic)	Lineal Foot
2" Electrical Conduit (Bored)	Lineal Foot
3" Electrical Conduit (Bored)	Lineal Foot

**END REVISION OF SECTION 613**

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**REVISION OF SECTION 613  
LIGHTING**

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

Subsection 613.02 shall include the following:

Highway lighting materials and equipment for installation and modifications shall be compatible or interchangeable with standard materials and equipment as stocked by the local utility provider.

Contractor shall submit a lighting materials list to the local utility provider for approval prior to ordering XCEL Contact: (Steve Smith, at 303-571-3945), United Power, Inc Contact: (Main: 303-659-0551)

Subsection 613.08 shall include the following:

At least one grounding electrode shall be installed adjacent to each light standard. Wiring shall be a 120/240 volt or 120/208 volt, 3-wire system with individual luminaries wired for 120 volts.

Subsection 613.11 shall include the following:

<b>Pay Item</b>	<b>Pay Unit</b>
Luminaire HPS (250 Watt)	Each

**END REVISION OF SECTION 613**

**REVISION OF SECTION 613  
PULL BOX – GENERAL**

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

Subsection 613.01 shall include the following:

At locations shown in the plans, the Contractor shall install one or more pull boxes of the size and type indicated in the following section. This work shall include removal and replacement of the primary cabinet pull box at new cabinet locations.

Subsection 613.02 shall include the following:

A pull box shall be installed at all locations shown on the plans and at such additional points as ordered by the Engineer.

Pull boxes shall be installed so that the covers are level with curb or sidewalk grade or level with the surrounding ground when no grade is established. **The bottoms of all pull boxes shall be set on twelve (12) inches of crushed rock.**

Pull box size shall be as shown in the Plans. With the exception of water valves, pull boxes shall be of "Quazite" or pre-cast ANSI/SCTE 77 2007 polymer concrete type. The following pull box schedule is in effect unless otherwise specified in the traffic signal plans:

Pull Box Usage	Size	Pull Box Lid Marking
Cabinet Home Run Pull Box	24" x 36" x 18"	Traffic
Signal Pole Pull Box	13" x 24" x 12"	Traffic
Detector Pull Box (Side of Road)	12" x 12" x 12"	Traffic
Detector Water Valve	Water Valve	Traffic
Communications Pull Box	24" x 36" x 18"	T/S Communications
Telephone Demarcation	12" x 12" x 12"	T/S Communications
Electrical Demarcation	12" x 12" x 12"	Electric

Pull box lids shall be imprinted with markings as defined in the pull box schedule. Painted markings shall not be permitted.

When a new conduit run enters an existing pull box, the Contractor shall temporarily remove the pull box, or tunnel under the side at no less than eighteen inches (18") below the pull box bottom, and enter from the direction of the run. No new conduit will be allowed to enter a new or existing pull box in any other manner than that shown on the standard details.

Subsection 613.10 shall include the following:

Pull Boxes shall include the removal of any existing pull box, installation of the new pull box, modification of conduit ends, restoration of disturbed surface materials, and all other work necessary to complete the installation.

Subsection 613.11 shall include the following:

Pull Boxes will not be measured and paid separately, but shall be included in the cost of the appropriate conduit pay item.

**END REVISION OF SECTION 613**

**REVISION OF SECTION 613  
WIRING**

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

Section 613.08 shall include the following:

Wiring shall conform to appropriate National Electrical Code, as applicable. Wiring within cabinets, junction boxes, etc., shall be neatly arranged. Signal conductors shall be No.14 AWG stranded, conforming to IMSA Spec 20-1-1984.

Power feed cable shall be THHN/THWN copper, installed in conduit, and be sized for the electrical load served. The power feed cable shall have a minimum size of #8 and be sized such that the overall voltage drop, between the local utility company demarcation point and controller cabinet, does not exceed 5%. The Contractor shall install a continuous, un-spliced power feed cable from the local utility company power demarcation point to the controller cabinet thru an URD Mold connector located in the controller cabinet home run pull box. URD Mold connectors shall be installed in the home run pull box and shall be used to extend electrical service from the local utility company power demarcation point to the controller cabinet and to street lights on signal poles.

Whenever a raceway is not UL approved, direct burial type insulation shall be required on all associated wiring.

Power cable between the controller cabinet home run pull box and the street lights pole bases shall be type 12-2 UF. Daisy chaining of power cable through the pole bases using SLK connectors shall be permitted. With the exception of the URD Mold connector in the controller cabinet home run pull box, power cable splices within pull boxes shall not be permitted.

Power cable from the end of each street light davit to the base of the signal pole shall be type 12-2 UF with ground. All street light feeds shall be independently fused at the base of each pole.

All signal cables shall be labeled with colored electrical tape based on the table below.

Direction	Tape Color
Northbound Thru	Red
Northbound Left Turn	Red + White
Northbound Pedestrian	Red + Yellow
Southbound Thru	Green
Southbound Left Turn	Green + White
Southbound Pedestrian	Green + Yellow
Eastbound Thru	Orange
Eastbound Left Turn	Orange + White
Eastbound Pedestrian	Orange + Yellow
Westbound Thru	Blue
Westbound Left Turn	Blue + White
Westbound Pedestrian	Blue + Yellow

Signal circuit wiring shall be accomplished in the following manner:

A separate 21 conductor cable shall be installed between the cabinet and each signal pole. Cables shall be continuous with no splices. Conductor usage has been defined in the table below. All unused conductors shall become spare conductors and shall be coiled and taped back to minimize the chance for a short.

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**REVISION OF SECTION 613 -  
WIRING**

21 Conductor Color to Phase Assignment	
<b>Main Street</b>	
Color	Phase
Solid Green	Green
Solid Orange	Yellow
Solid Red	Red
Solid Blue	Left Turn Green
Solid Black	Left Turn Yellow
Red with White Trace	Left Turn Red
Blue with White Trace	Walk
Black with Red Trace	Don't Walk
<b>Side Street</b>	
Green with Black Trace	Green
Orange with Black Trace	Yellow
Red with Black Trace	Red
Blue with Black Trace	Left Turn Green
Black with White Trace	Left Turn Yellow
Red with Green Trace	Left Turn Red
Blue with Red Trace	Walk
Orange with Green Trace	Don't Walk
<b>Right Turn</b>	
Green with White Trace	Right Turn Green
Orange with Red Trace	Right Turn Yellow
<b>AC Return</b>	
Solid White	AC Return
White with Black Trace	AC Return
White with Red Trace	AC Return

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Each signal head shall have its own signal cable to the base of the pole that it is mounted on. Cables shall be continuous with no splices. Conductor usage has been defined in the table below. All unused conductors shall become spare conductors and shall be coiled and taped back to minimize the chance for a short.

Conductor Color	7 Conductor (5 Section Head)	5 Conductor (3 Section Head)	5 Conductor (Pedestrian Head)
Red	Red Ball	Red Ball or Red Arrow	Don't Walk
Orange	Yellow Ball	Yellow Ball or Yellow Arrow	Spare
Green	Green Ball	Green Ball or Green Arrow	Walk
Blue	Green Arrow	Not Available	Not Available
Black	Yellow Arrow	Spare	Spare
White	AC Return	AC Return	AC Return
White/Black	AC Return - LT	Not Available	Not Available

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**REVISION OF SECTION 613 -  
WIRING**

Outboard signal heads shall use "7 Conductor" cable to accommodate for present or future left turns.

When a cabinet is defined as a master cabinet, phone cable shall be installed in conduit from the controller cabinet to the designated telephone company demarcation point. Phone cable shall be #REA-PE54 or equivalent for telephone service. The cable shall be continuous with no splices and run from the telephone service point to the controller cabinet. Adequate cable length shall remain on both cable ends to permit for proper termination.

Pedestrian push button wire shall be shielded single or multiple twisted pairs in polyethylene jacketed cable. Conductors shall be No. 18 AWG stranded copper, minimum. A stranded tinned copper drain wire shall be provided. Pedestrian push button common wire shall not be connected to the signal neutral circuit.

Inductance detector loop lead-in cable shall be shielded single or multiple twisted pairs in polyethylene jacketed cable. Conductors shall be No. 18 AWG stranded copper, minimum. A stranded tinned copper drain wire shall be provided.

Emergency vehicle detection wiring, Opticom wiring, shall be of the type as specified by equipment manufacturer.

Splicing any conductor, cable or wiring, except loop detector wiring and power cable as defined in these specifications, shall not be permitted in conduit or in pull boxes. All signal conductor splices shall be in the signal pole near the hand hole above grade. Signal load splices shall utilize copper crimp sleeves that compress from four directions as manufactured by Buchanan Company, or approved equal. The crimped sleeve shall then be protected within a flexible rubber insulating cover as manufactured by Ideal Wrap Company, or approved equal. Detector loop lead-in splices in pull boxes below grade shall be fully waterproofed using a DBY-6 splice kit as manufactured by 3M, or approved equal. A minimum of 12-inches of slack shall be left at each splice.

Powdered soapstone, talc, or other approved lubricant shall be used in placing conductors in conduit.

A small permanent tag with the phase and direction printed on it shall be securely attached near the end of each conductor in the controller cabinet. An example is "Ø1-NBLT" where Ø1 is the phase number.

Section 613.10 shall include the following:

Wiring and cabling shall be shall be paid for on a lump sum basis and shall include all labor, equipment and materials necessary to install the item complete-in-place. All cabling and wiring shall be paid for under the "Wiring" pay item.

Section 613.11 shall include the following:

Payment will be made under:

<b>Pay Item</b>	<b>Pay Unit</b>
Wiring	Lump Sum

**END REVISION OF SECTION 613**

1 **REVISION OF SECTION 613**  
2 **SOLAR COLLECTION SYSTEM**

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

4 Section 613.02 shall include the following:

5 The solar collection system shall be of sufficient size to adequately support the power  
6 requirements of the attached equipment year round.

7 The solar collection system shall incorporate a solid-state solar controller including a high output  
8 solar regulator and low voltage disconnect.

9 The solar collection system shall operate on input voltages ranging from 11.5 VDC to 25 VDC.

10 The solar regulator's minimum rating shall be 25A at 12 VDC, temperature compensation.

11 The solar panel position shall be field settable to the correct degree required at the location.

12 The solar collection system shall use automatic night dimming to conserve power.

13 Section 613.10 shall include the following:

14 The solar collection system shall not be paid for separately but shall be included in the cost for  
15 the equipment it is powering and shall include all labor, equipment, and materials necessary to  
16 install a solar collection system, complete-in-place, on a single pole.

17 **END REVISION OF SECTION 613**

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1 **REVISION OF SECTION 614**  
2 **ILLUMINATED SIGNS**

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

4 Subsection 614.05 shall include the following:

5 FLOURESCENT

6 Illuminated street name signs housings shall be constructed of extruded aluminum. All ferrous  
7 hardware parts shall be galvanized and cadmium plated.

8 The reflectors shall have a minimum reflectance of 85%.

9 Background sheeting shall be 3M brand DG3 reflective sheeting, series 4090T translucent white.  
10 Green transparent overlay film shall be 3M brand electro cut series 1177 green. The County shall  
11 provide transparent County logo to be placed on the sign by the manufacturer. Sign panels shall  
12 be protected by overlay clear film and shall be 3M brand series 1150 clear. The sign colors shall  
13 not fade when exposed to an accelerated test of ultraviolet light equivalent to eight (8) years of  
14 outdoor exposure.

15 The entire surface of the sign panel shall be evenly illuminated. The average of brightness  
16 reading for the letters shall be 150 feet – lamberts minimum. The light transmission factor of the  
17 sign panel shall provide a letter-to-background brightness ratio between 10:1 and 20:1.

18 The sign ballasts shall be the high power factor type, rated at 100-125 V. at 60 Hz., and there  
19 shall be a separate ballast for each fluorescent lamp. Fuses shall be miniature slow-blowing type,  
20 with a separate fuse provided for each ballast. Fluorescent lamps shall meet ANSI Standard C78.  
21 One lamp holder for each lamp shall be the spring loaded type. The entire sign and its  
22 components shall operate over a temperature range of -30 degrees F. to +160 degrees F.

23 Terminal blocks shall be molded, phenolic, barrier type rated at 15 ampere, 1000 V and shall  
24 have waterproof marking strips. No wiring splices will be permitted within the sign without the  
25 permission of the Engineer or his designee.

26 Illuminated street name signs shall be measured and paid for per unit count and shall include all  
27 labor, equipment, and materials necessary to install the item complete-in-place. Illuminated street  
28 name signs shall be paid for under the "illuminated street name sign" pay item.

29 LED/OTHER

30 LED or other type illuminated street name signs shall only be used where specified in the plans  
31 and specifications and may be considered by the Engineer on a per project basis. When specified  
32 in the project plans and/or specifications, LED or other type illuminated street name signs shall be  
33 of the manufacturer and model number as specified.

34 Subsection 614.13 shall include the following:

35 Illuminated signs shall include all labor, equipment and materials necessary to install the items  
36 complete-in-place. Illuminated signs shall be measured and paid by the number of units at which  
37 the sign is installed. The item shall include all labor, materials, and ancillary hardware required to  
38 provide a fully functioning sign system to the satisfaction of the Engineer. Illuminated street name  
39 signs shall be paid for under the "Illuminated Sign" pay item.

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**REVISION OF SECTION 614 -  
ILLUMINATED SIGNS**

Subsection 614.14 shall include the following:

<b>Pay Item</b>	<b>Pay Unit</b>
Illuminated Sign	Each

**END REVISION OF SECTION 614**

**REVISION OF SECTION 614  
BLANK OUT SIGNS**

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

Subsection 614.05 shall include the following:

Blank out regulatory or warning sign housings shall be constructed of aluminum unless directed otherwise by the Engineer. All ferrous hardware parts shall be galvanized cadmium plated, or stainless steel.

The lens panel shall be capable of removal or be swung open without the use of tools.

The sign panel shall be completely blanked out when not energized. The sign color shall not fade when exposed to an accelerated test of ultraviolet light equivalent to five years of outdoor exposure.

The entire surface of the sign panel shall be evenly illuminated. All messages shall be clearly legible attracting attention under any lighting conditions for an advance distance of at least 500 feet. When illuminated, the sign shall be visible anywhere within the approximately a 60 degree cone centered about the optic axis.

Terminal blocks shall be molded, phenolic, barrier type rated at 15 ampere, 1000 V and shall have waterproof marking strips. No wiring splices will be permitted within the sign without the permission of the Engineer.

The overall weight of the complete sign assembly including mounting hardware shall not exceed 90 lbs.

Blank out regulatory or warning signs shall be of LED or fiber optic light source type as specified in the project plans and specifications.

If a fiber optic light source is specified, the lamps shall be 50 watts or less, operating at 15 volts or less and shall have an average rated life of 8000 hours or more. The color of any message shall be changeable in the field by replacement of the color filters without removing the sign from the case.

Subsection 614.13 shall include the following:

Blank out regulatory/warning signs shall be measured and paid for per unit count and shall include all labor, equipment, and materials necessary to install the item complete-in-place. Blank out regulatory/warning signs shall be paid for under the "Blank Out Sign" pay item.

Subsection 614.14 shall include the following:

<b>Pay Item</b>	<b>Pay Unit</b>
Blank Out Sign	Each

**END REVISION OF SECTION 614**

1 **REVISION OF SECTION 614**  
2 **TRAFFIC CONTROL DEVICES**

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

4 Subsection 614.01 shall include the following:

5 The Contractor shall obtain any and all permits as necessary from the County Public Works  
6 Department, Construction Inspection Group. The Contractor shall obtain and have in his/her  
7 possession all required permits prior to initiation of work. County permits shall be no fee permits.

8 Subsection 614.10 (a) shall include the following:

9 All new traffic control equipment including, but not limited to, loops, cameras, poles, control  
10 cabinets, conduit, pull boxes, pole foundations and permanent pavement marking material shall  
11 be field located by the Engineer. All pole locations shall conform to current ADA requirements  
12 regarding accessibility to the pedestrian push buttons that may be mounted to the poles.

13 Subsection 614.10 (c) shall include the following:

14 **BONDING AND GROUNDING**

15 All metallic appurtenances containing electrical conductors (metallic cable sheaths, metal conduit,  
16 metal poles and pedestals) shall be made electrically and mechanically secure to form continuous  
17 systems that shall be effectively grounded. Bonding and grounding jumpers shall be copper wire  
18 or copper strap of the same cross-sectional area, #8 AWG for all systems, installed in accordance  
19 with the NEC. Loop lead-in cable for loop detectors is to be grounded in controller cabinet only.  
20 The other end of the sheath is to be taped and left ungrounded.

21 Bonding of light standards shall be by means of a bonding strap attached to a brass bolt or a  
22 3/16-inch or larger brass or bronze bolt installed in the lower portion of the shaft.

23 The controller cabinet and each individual traffic signal pole and/or pedestal shall be attached to  
24 its own separate ground electrode via #6 AWG solid bare copper wire, installed in accordance  
25 with the NEC. The ground electrodes may be placed in the foundation of the item to be grounded  
26 or may be placed in an adjacent pull box located at least 6-feet away from said foundation.  
27 Ground electrodes shall be a one piece copper weld rod of 5/8-inch diameter, 8-feet in length.  
28 The connection of the grounding electrode conductor to the grounding electrode shall be made  
29 with two approved ground clamps.

30 All connectors between bonding jumpers and equipment grounding conductors shall be installed  
31 in accordance with the NEC. Identification of the equipment grounding conductor shall conform  
32 to all code requirements.

33 Grounding shall be incidental to the pay item for which it is associated.

34 Electrical service shall be installed as per NEC or as amended by the County. The grounding and  
35 bonding of services shall be completed in accordance with all national, state, and local  
36 ordinances that apply.

37 Electrical service shall not be paid for separately, but shall be included in the cost of the  
38 work, and shall include all labor, equipment and materials necessary to install the electrical  
39 service, complete-in-place.

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**REVISION OF SECTION 614  
TRAFFIC CONTROL DEVICES**

Subsection 614.10 (d) shall include the following:

EXCAVATION AND BACKFILLING

The Contractor shall replace or reconstruct sidewalks, curbs, gutters, rigid or flexible pavement, and any other improvements removed during construction with material meeting the requirements of Section 206 of the Colorado Department of Transportation's latest edition or as otherwise directed by the Engineer.

Whenever a part of a square or slab of existing concrete is broken or damaged by the Contractor during construction, the entire square or slab shall be removed and the concrete reconstructed, at no cost to the County.

Concrete and asphalt removal shall be cut to a minimum depth of one-and-one-half (1 ½) inches. The cut for the remainder of the required depth may be made by a method satisfactory to the Engineer. Cuts shall be neat and true with no shatter outside the removal area. When, in the course of concrete removal, damage occurs to a square or slab of existing concrete outside of the removal area, the square or slab shall be considered damaged with the entire square or slab requiring replacement.

All excavations shall be done in conformance with OSHA regulations. Excavated material shall be removed at the completion of the project or as directed by the Engineer.

Subsection 614.10 (i) shall include the following:

MAINTAINING EXISTING AND TEMPORARY ELECTRICAL SYSTEMS

During the construction, reconstruction, fourteen (14)-day test period, and until signal acceptance by the County, the Contractor shall maintain the system or systems on a 24 hour basis. The cost of any maintenance necessary except electrical energy, and maintenance due to damage by public traffic, shall not be paid for separately but shall be included in the cost of the work.

Acceptance by the County of the work performed by the Contractor shall only take place after all punch list items have been satisfactorily completed and inspected by the County.

The Contractor shall provide the County with a 24 hour one call phone number for reporting of any and all signal malfunctions. Fees incurred for such service shall not be paid for separately but shall be included in the cost of the work.

All malfunctions of a controller and its accessory equipment shall be considered an emergency unless otherwise identified by the County. Equipment malfunctions and/or damage, which in the opinion of the Engineer or other County authorized person, constitutes a serious hazard or inconvenience to the public, shall be considered an emergency. The Contractor shall undertake emergency repairs no later than one (1) hour after the County notifies the Contractor of the emergency.

Malfunctions of a controller and its accessory equipment, which are identified by the Engineer or other County authorized person, as non-emergency repairs shall be considered non-emergency. The Contractor shall undertake non-emergency repairs no later than 24 hours after the County notifies the Contractor of the non-emergency.

If the Contractor fails to respond within the defined response time, the Engineer may elect to employ the services of the County's designated Traffic Signal Maintenance Contractor to perform the said maintenance work. In such cases, the Contractor shall reimburse the County for labor,

**REVISION OF SECTION 614  
TRAFFIC CONTROL DEVICES**

equipment, and material charges associated with the utilization of the County's designated Traffic Signal Maintenance Contractor plus a fifteen percent administration fee.

Subsection 614.10 (j) shall include the following:

FIELD TESTS AND TURN ON

Prior to completion of the work, the Contractor shall make the following tests on all traffic signals in the presence of the Engineer:

- Each circuit shall be tested for continuity.
- Each circuit shall be tested for grounds.
  - This shall include physical examination of the installation to ensure that all required ground jumpers, devices, and related accessories have been installed and are mechanically firm.
- An insulation resistance test shall be made on each circuit between the circuit and a ground. The insulation resistance shall not be less than the values specified in the provisions of the NEC.
- A functional test shall be made in which it is demonstrated that each and every part of the system functions as specified or intended herein.
  - The functional test for each traffic signal system shall consist of at least fourteen (14) days of continuous satisfactory operation.
  - If unsatisfactory performance of the system develops, the condition shall be corrected and the test shall be repeated until the fourteen (14) days of continuous, satisfactory operation is obtained.

Testing and testing equipment for signals shall be incidental to the pay item for which signal testing is required.

There shall be a twelve (12) month guarantee on all traffic signal work performed by the Contractor. Said twelve (12) month period shall commence from the date of Final Acceptance.

Materials shall be warranted for a minimum of one (1) year, except as otherwise noted in the project plans and specifications. The Contractor shall supply the County with all manufacturers' warranties covering material and parts.

At Final Acceptance, normal operation and maintenance of the traffic signal shall become the responsibility of the Owner.

Unless otherwise specified, all bonding and grounding, excavation and backfilling, maintaining existing and temporary electrical systems, and field tests and turn-on shall not be paid for separately, but shall be included in the cost of the work.

**END REVISION OF SECTION 614**



1 **REVISION OF SECTION 614**  
2 **TRAFFIC SIGNAL CONTROLLER**

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

4 Subsection 614.08 (b) shall be replaced with the following:

5 *(b) Traffic Signal Controllers*

6 General

7 The traffic signal controller shall consist of a complete electrical mechanism to control the  
8 operation of traffic control signals, including the timing mechanism and all necessary auxiliary  
9 equipment. Controllers shall be Cobalt ATC Traffic Controller by Econolite or an approved  
10 equivalent fully compatible with the County's current Econolite Centracs® central system. All  
11 equipment furnished shall be the manufacturers' latest production model, complete with all  
12 standard accessories, tested and delivered by a domestic manufacturer who is regularly engaged  
13 in the construction of such equipment.

14 The controller shall be configurable to meet, at a minimum, all applicable sections of the NEMA  
15 Standards Publications for TS2; all "mandatory" conformance groups in NTCIP 1202, as a  
16 minimum, must be met to claim compliance to this standard; and ATC 5201 standard 6.10 leading  
17 to 6.25 as supported by the manufacturer. Where differences occur, these specifications shall  
18 govern. Controller version shall comply with NEMA TS2 Type 1. Controller shall operate in the  
19 temperature range of -34.6°F to +165°F (-37°C to +74°C).

20 Hardware

21 External dimensions shall not be larger than 8.5" x 15.2 1/4" x 6.375" (H x W x D). The top and  
22 bottom of the chassis shall be made from extruded aluminum and include an integral handle on  
23 the back for easy transport. The sides shall be constructed of injection molded polycarbonate.  
24 The model, serial number, and program information shall be displayed on the outside of the  
25 controller.

26 Power

- 27 • 110VAC @ 50/60 Hz or optional 220/240 VAC @ 50/60 Hz
- 28 • Fuse protection for either 110 or 220/240V
- 29 • Protection for the 24VDC supply is provided by a resettable electronic fuse

30 Front Panel

- 31 • The front of the controller shall consist of a panel for the display, keyboard and  
32 connectors for all necessary user connections.
- 33 • The display shall be a seven-inch (7"), color, TFT (Thin Film Transistor) LCD (Liquid  
34 Crystal Display) with high brightness. It shall be readable in direct sunlight. The display  
35 shall meet or exceed the NEMA temperature range and shall have a resolution of 800 X  
36 480 with an 18 bit color depth. The luminous intensity shall be a minimum of 800 nits.  
37 The display shall include an industrial, resistive touch screen that can be operated with  
38 gloved hands. The touch screen and display shall not be affected by condensation or  
39 water drops.
- 40 • Front-panel operator inputs shall be via touch screen or by clearly labeled elastomeric  
41 keypad. These shall include a 10-digit numeric keypad, Main and Sub keys, toggle keys,  
42 special function and enter keys, six function keys, status and help keys and a large four-  
43 direction cursor control key.
- 44 • The front panel shall include a built in speaker for enhanced controller audio feedback.
- 45 • The front panel shall include a tri-color status LED.

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**REVISION OF SECTION 614**  
**TRAFFIC SIGNAL CONTROLLER**

4       **Electronics**

- 5       • The electronics shall be modular in design and shall consist of vertical circuit boards.  
6       Horizontal circuit boards shall not acceptable.
- 7       • In the interest of reliability, no sockets shall be used for any electronic device. All devices  
8       shall be directly soldered to the printed circuit board. Surface mount parts shall be used  
9       for the majority of the electronic components in the controller.
- 10      • A built-in, high-efficiency switching power supply shall generate the primary, +5 VDC  
11      internal voltage, an isolated +24 VDC for internal and external use, VSTANDBY,  
12      LINESYNC, POWERUP and POWERDOWN signals. All voltages shall be regulated.
- 13      • The 120 or 220 VAC fuse shall be mounted on the front of the controller. Protection for  
14      the 24 VDC supply shall be provided by a resettable electronic fuse.
- 15      • All printed circuit boards shall meet the requirements of the NEMA Standard plus the  
16      following requirements to enhance reliability:
  - 17      ○ Both sides of the printed circuit board shall be covered with a solder mask material.
  - 18      ○ The circuit reference designation for all components and the polarity of all polarized  
19      capacitors and two-leaded diodes shall be clearly marked adjacent to the component.  
20      Pin 1 for all integrated circuit packages shall be designated on all printed circuit  
21      boards.
  - 22      ○ All printed circuit board assemblies shall be coated on both sides with a clear  
23      moisture-proof and fungus-proof sealant.
- 24      • Timing of the controller traffic application shall be derived from the AC power line.
- 25      • To facilitate the transfer of user-programmed data from one controller to another, a serial  
26      flash memory device shall be an available hardware option. In addition, two USB sockets  
27      and one SD Card socket shall be provided for memory devices that can be used for data  
28      transfer. These data transfer devices shall be easily removable and directly accessible  
29      from the outside of the controller. The controller will not require this data-key, USB  
30      memory thumb drive, or SD Card to be present for proper operation.
- 31      • All controller software shall be stored in Flash Memory devices. The controller software  
32      shall be easily updated without the removal of any memory device from the controller.  
33      The use of removable Programmable Read Only Memory (PROM) or Erasable  
34      Programmable Read Only Memory (EPROM) from the controller shall not be acceptable.  
35      The controller shall include an option that allows updating software using a Windows  
36      based computer, a USB memory thumb drive, or an SD card.

37       **ATC Engine Board**

- 38      • The controller shall include an ATC engine board compliant to ATC standard 5.2b and  
39      proposed version 6.10 leading to 6.25 as supported by the manufacturer.
- 40      • The engine board shall include a PowerPC 83XX family processor with QUICC engine.
- 41      • The engine board shall have a minimum of the following memory:
  - 42      ○ 128Mbytes of DDR2 DRAM memory used for application and OS program execution
  - 43      ○ 64 Mbytes of FLASH memory used for storage of OS software and user applications
  - 44      ○ 2MB of SRAM memory used for non-volatile parameter storage
- 45      • The engine board shall provide the seven ATC serial ports, Ethernet, USB and all other  
46      control signal required by ATC standard.
- 47      • The operating system shall be Linux 2.6.35 or later kernel and Board Support Package  
48      (BSP)

49       **Graphical User Interface (GUI)**

- 50      • The controller shall include an advanced graphics card.

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**REVISION OF SECTION 614  
TRAFFIC SIGNAL CONTROLLER**

- The graphics card shall enable:
  - Graphical display of status and programming selections
    - The status displays shall include direction arrows for each of the phases and overlaps.
    - The selection of programming sections menus shall be by use of icons.
    - Programming shall use touch data entry, allowing touch gestures to select yes/no, select enable/disable, pull-down list selections, and more.
  - Touch selection of status and programming
  - Swiping to advance from one screen to the next
- Program values shall be entered through either the keypad or the touch screen.

**Ports**

- The controller shall have the capability of supporting Ethernet communications, using TCP/IP communications protocols.
  - The controller shall provide four front-panel Ethernet ports.
  - Two of the ports shall be connected to Ethernet switch ENET1 and the other two shall be connected to Ethernet switch ENET2.
- The controller shall provide two USB 2.0 ports.
  - USB ports shall be used for USB thumb drives to update software, upload or download configuration, or uploading logged data.

**Connectors**

- All non-optional interface connectors shall be accessible from the front of the controller and configured for NEMA TS2 Type 1.
- The D connector shall be compatible with the Econolite Model ASC/2, ASC/2S, and ASC/3 D connectors.
- To facilitate special applications the controller shall have the capability of assignment of any input or output function to any input or output pin respectively on the interface connectors, with the exception of Flashing Monitor, Controller Voltage Monitor, AC+, AC-, Chassis Ground, 24 VDC, Logic Ground and TS2 Mode bits.
- The controller shall as a minimum have the following communications ports:
  - Port 1 SDLC for communications to other devices in the cabinet
  - Port 2 serial port for systems communications
  - Console serial port for local communications
- Serial communications shall operate at from 1200 to 115.2 K baud

**Service**

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

**Software**

The controller software shall meet, as a minimum, all applicable sections of the NEMA Standards Publications for TS2; all "mandatory" conformance groups in NTCIP 1202, as a minimum, must be met to claim compliance to this standard; and ATC 5201 standard 6.10, leading to 6.25 as supported by the manufacturer.

The controller shall support Econolite Linux-based software or other pre-qualified ATC/Linux software.

**REVISION OF SECTION 614  
TRAFFIC SIGNAL CONTROLLER**

The operating system shall be 2.6.35 or later kernel and Board Support Package (BSP) and Compliant to ATC Standard V. 5.2.b Annex B specifications.

**Control**

- 16 phases, 8 configurable concurrent groups in 4 timing rings
- 16 pedestrian phases that can be configured as pedestrian overlaps
- Exclusive pedestrian operation
- Dynamic max operation
- Extendable walk and pedestrian clearance
- Advanced Walk
- Bike input and green timing
- Adaptive red clearance

**Coordination**

- 120 coordination patterns, each with its own cycle, offsets and split plan selection
- 120 split plans, each with its own coordinated phases, vehicle and pedestrian recall and phase omits
- Offset and split entries displayed in percent or seconds
- Automatic permissive periods
- Fixed or floating force-off
- Crossing arterial coordination
- Quick-sync feature

**Preemption**

- Ten preemption sequences. Each may be configured as priority, first-come-first-serve, or bus preemption operation
- ECPI interlock to provide added monitoring
- Railroad gate-down input and timing.
- Conditional delay when entering preemption
- Multiple exit preemption options
  - Exit to selected exit phase
  - Exit to coordination (no transition)
  - Exit to interrupted pedestrian phase
  - Exit to interrupted vehicle phase
  - Use timing from an exit timing plan once, then the normal timing plan
  - Exit to a selected phase first then to free or coordination (selectable)
  - Exit free for one complete cycle then resume coordination (no transition)
  - Exit to the phases where the most drivers have waited the longest

**Timing & Phasing**

- 200 schedule programs, configurable for any combination of months, days of the week, and days of the month
- Fixed or floating exception day programs that override the day plan event on a specific day
- 50 day plan events that can use any of 100 action plans
- 100 action plans that can be used by any of the 50 day plans
- Intersection phasing shall be as defined in the table below regardless of direction of the coordinated vehicular movements. When intersection phasing defined in the plans and/or

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**REVISION OF SECTION 614  
TRAFFIC SIGNAL CONTROLLER**

project special provisions conflict with that defined here, the Engineer shall make final determination as to the intersection phasing.

Controller Phase	Vehicular Movement
1	Northbound Left Turn
2	Southbound
3	Eastbound Left Turn
4	Westbound
5	Southbound Left Turn
6	Northbound
7	Westbound Left Turn
8	Eastbound

**Detectors**

- 64 vehicle detectors
- 16 system or speed detectors
- Unique detector types and operation
- Individually assignable to phase and functions
- Lock/non-lock function by detector
- 4 detector plans
- 4 detector diagnostics plans
- Logging of volume and/or occupancy assignable by detector
- 4 pedestrian diagnostic plans

**Logging**

- Separate buffers for detector activity, detector failures, controller events, and MMU events
- Logged data can be:
  - Viewed on front panel
  - Retrieved via a RS-232 terminal port, USB flash drive, or SD Card
  - Transferred via telemetry to a traffic management center

Subsection 614.13 shall be amended as follows:

Traffic signal controllers (Econolite Cobalt ATC Traffic Controller or an approved equivalent) shall include the cabinet, pedestrian detectors, and all auxiliary equipment required on the plans and shall include all work necessary to provide and install a complete system.

**END REVISION OF SECTION 614**

1 **REVISION OF SECTION 614**  
2 **TRAFFIC SIGNAL CONTROLLER CABINET**

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

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

5 *(c) Controller Cabinets.*

6 General

7 This specification sets forth the minimum requirements for a TS2 Type 1 traffic control modular  
8 cabinet assembly. The cabinet assembly shall meet, as a minimum, all applicable sections of the  
9 NEMA Standard Publication No.TS2-2016 or most recent version. Where differences occur, this  
10 specification shall govern.

11 The manufacturer must be ISO 9001-2015 Registered and have been certified in the IPC "Class  
12 II" Electronics standards and training for all manufacturing staff to ensure manufacturing quality,  
13 documentation, and proper ongoing/continuing employee training for manufacturing processes by  
14 IPC Certified Trainers. The cabinet and controller supplied under this specification must be by the  
15 same manufacturer to ensure matched component system testing.

16 Cabinet Design & Construction

17 The cabinet shall be constructed from type 5052-H32 aluminum with a minimum thickness of  
18 0.125 inches.

19 The cabinet shall be designed and manufactured with materials that will allow rigid mounting,  
20 whether intended for pole, base or pedestal mounting. The cabinet must not flex on its mount.

21 A rain channel shall be incorporated into the design of the main door opening to prevent liquids  
22 from entering the enclosure. The cabinet door opening must be a minimum of 80 percent of the  
23 front surface of the cabinet. A stiffener plate shall be welded across the inside of the main door to  
24 prevent flexing.

25 The top of the cabinet shall incorporate a 1-inch slope toward the rear to prevent rain  
26 accumulation.

27 Unless otherwise specified, the cabinet shall be supplied with a natural aluminum finish. Sufficient  
28 care shall be taken in handling to ensure that scratches are minimized. All surfaces shall be free  
29 from weld flash. Welds shall be smooth, neatly formed, free from cracks, blowholes and other  
30 irregularities. All sharp edges shall be ground smooth.

31 Where painted cabinets are specified, the exterior shall be degreased and primed with a spray  
32 applied iron phosphate coat- equivalent to a four-stage iron phosphate coat prior to painting. The  
33 final coat shall consist of a powder coat paint (TGIC or equivalent) applied with a minimum  
34 thickness of 2 mils.

35 All seams shall be sealed with RTV sealant or equivalent material on the interior of the cabinet.

36 All cabinets shall be supplied with a two removable shelves manufactured from 5052-H32  
37 aluminum. Shelf shall be a minimum of 10 inches deep.

38 The shelf shall have horizontal slots at the rear and vertical slots at the front of the turned down  
39 side flange. The shelf shall be installed by first inserting the rear edge of the shelf on the cabinet  
40 rear sidewall mounting studs, then lowering the shelf on the front sidewall mounting studs. The  
41 shelf shall be held in place by a nylon tie-wrap inserted through holes on the front edge of the  
42 shelf and around the front sidewall mounting studs.

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TRAFFIC SIGNAL CONTROLLER CABINET**

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The front edge of the shelf shall have holes punched at a minimum of every 6 inches to accommodate tie-wrapping of cables/harnesses.

Two (2) sets of vertical "C" channels shall be mounted on each interior side wall of the cabinet for the purpose of mounting the cabinet components. One set of vertical "C" channels shall be mounted on the rear wall for the purpose of mounting the main panel assembly. The channels shall accommodate spring mounted nuts or studs. All mounting rails shall extend to within 7 inches of the top and bottom of the cabinet. Sidewall rail spacing shall be 7.88 inches center-to-center. Rear wall rail spacing shall be 18.50 inches center-to-center.

The main door and police door-in-door shall close against a weatherproof and dust-proof, closed-cell neoprene gasket seal. The gasket material for the main door shall be a minimum of 0.250 inches thick by 1.00 inch wide. The gasket material for the police door shall be a minimum of 0.250 inches thick by 0.500 inches wide. The gaskets shall be permanently bonded to the cabinet.

The lower section of the cabinet shall be equipped with a louvered air entrance. The air inlet shall be large enough to allow sufficient air flow per the rated fan capacity. Louvers must satisfy the NEMA rod entry test for 3R ventilated enclosures. A non-corrosive, vermin- and insect-proof, removable air filter shall be secured to the air entrance. The filter shall fit snugly against the cabinet door wall.

The roof of the cabinet shall incorporate an exhaust plenum with a vent screen. Perforations in the vent screen shall not exceed 0.125 inches in diameter.

The handle on the main door of the cabinet shall be manufactured from cast aluminum or stainless steel. The handle shall include a hasp for the attachment of an optional padlock. The cabinet door handle shall rotate counter-clockwise to open. The handle shall not extend beyond the perimeter of the main door at any time. The lock assembly shall be positioned so that the handle shall not cause any interference with the key when opening the cabinet door.

The main door hinge shall be a one-piece, continuous piano hinge with a stainless steel pin running the entire length of the door. The hinge shall be attached in such a manner that no rivets or bolts are exposed.

The main door shall include a mechanism capable of holding the door open at approximately 90, 145, and 165 degrees under windy conditions. The cabinet may be provided with two doors, one front, and one back if called for in the project special provisions.

The main door shall be equipped with a Corbin tumbler lock number 1548-1 or exact equivalent. Minimum of two keys shall be supplied.

The police door-in-door shall be provided with a treasury type lock Corbin No. R357SGS or exact equivalent and has a minimum of one key.

All base mounted cabinets require anchor bolts to properly secure the cabinet to its base. The cabinet flange for securing the anchor bolts shall not protrude outward from the bottom of the cabinet. Four anchor bolts shall be required for proper installation.

Each cabinet shall be of sufficient size to accommodate all equipment. At a minimum, the minimal cabinet sizes are as follows:

- Size 6S cabinets - 65" H x 44" W x 24" D

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TRAFFIC SIGNAL CONTROLLER CABINET**

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Main door shall incorporate a shroud to cover the filtered louvered openings as appropriate for the design. The assembly is secured on the interior of the door over the filtered Louvers by means of a spring loaded compression bracket assembly. The Shroud is louvered downward and matches the door louvers.

All enclosures must be constructed, approved and marked in accordance with the requirements for Type 1 Industrial Control Panel Enclosures contained in UL 508A, the Standard for Industrial Control Panels. Enclosure must meet NEMA 3R rating requirements and be marked with UL approval sticker.

Terminals and Facilities/Main Panel Design and Construction

The main panel shall be constructed from 5052-H32 brushed aluminum of 0.125 inches minimum thickness and installed so as to minimize flexing when plug-in components are installed.

A sixteen (16) position main panel shall be provided with a mounting mechanism which allows easy access to all wiring on the rear of the panel. Lowering of the main panel can be accomplished without the use of hand tools. Complete removal can be accomplished by the use of simple hand tools.

The terminals and facilities shall be available as a minimum in the following configurations:

- Configuration #4 - Sixteen load switch sockets, six flash transfer relay sockets, one flasher socket, 2- BIU sockets, one 16-channel detector rack with one BIU, and one Type-16 MMU.

All load switch and flash transfer relay socket reference designators shall be silk-screen labeled on the front and rear of the main panel to match drawing designations. Socket pins shall be marked for reference on the rear of the panel.

A maximum of eight load switch sockets may be positioned horizontally or stacked in two rows on the main panel

All load switches shall be supported by a bracket, extending at least half the length of the load switch.

The sixteen (16) load switch main panel shall have all field wires contained on two rows of horizontally mounted terminal blocks. The upper row shall be wired for the pedestrian and overlap field terminations. The lower row shall be reserved for phase one through phase eight vehicle field terminations.

All field output circuits shall be terminated on a non-fused barrier type terminal block with a minimum rating of 10 amps.

All field input/output (I/O) terminals shall be identified by permanent alphanumeric labels. All labels shall use standard nomenclature per the NEMA TS2 specification.

All signal indications shall be programmed to flash red.

Field terminal blocks shall be wired to use four positions per vehicle or overlap phase (green, yellow, and red, flash). It shall not be necessary to de-buss field terminal blocks for flash programming.



-4-  
**REVISION OF SECTION 614**  
**TRAFFIC SIGNAL CONTROLLER CABINET**

The main panel shall contain at least one flasher socket (silk screen labeled) capable of operating a 15-amp, 2-pole, NEMA solid-state flasher. The flasher shall be supported by a bracket, extending at least half its length.

One RC network shall be wired in parallel with each group of three flash-transfer relays and any other relay coils.

All logic-level, NEMA-controller and Malfunction Management Unit input and output terminations on the main panel shall be permanently labeled. Cabinet prints shall identify the function of each terminal position.

At a minimum, three 20-position terminal blocks shall be provided at the top of the main panel to provide access to the controller unit's programmable and non-programmable I/O. Terminal blocks for DC signal interfacing shall have a number 6-32 x 7/32 inch screw as minimum.

All main panel wiring shall conform to the following wire sizes and colors:

Load Switch Output	Wire Color	Gauge
Green/Walk	Brown	14
Yellow	Yellow	14
Red/Don't Walk	Red	14
MMU (other than AC power)	Violet	22
Controller I/O	Blue	22
AC Line (power panel – black wire main panel)	--	8/10
AC Line (main panel)	Black	10
AC Neutral (power panel – white wire main panel)	--	8/10
AC Neutral (main panel)	White	10
Earth Ground (power panel)	Green	8
Logic Ground	Gray	22
Flash Programming	Orange	--
Flasher Terminal	Black; Red or Yellow Field Terminal	14

All wiring, 14 AWG and smaller, shall conform to MIL-W-16878/1, type B/N, 600V, 19-strand tinned copper. The wire shall have a minimum of 0.010 inches thick PVC insulation with clear nylon jacket and rated to 105 degrees Celsius. All 12 AWG and larger wire shall have UL listed THHN/THWN 90 degrees Celsius, 600V, 0.020 inches thick PVC insulation and clear nylon jacketed.

Connecting cables shall be sleeved in a braided nylon mesh or poly-jacketed. The use of exposed tie-wraps or interwoven cables is unacceptable.

All Terminals and Facilities configurations shall be provided with BIU wiring assignments consistent with NEMA TS2-1998 specifications.

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TRAFFIC SIGNAL CONTROLLER CABINET**

All Terminals and Facilities configurations shall be provided with sufficient RS-485 Port 1 communication cables to allow for the intended operation of that cabinet. Each communication cable connector shall be a 15-pin metal shell D subminiature type. The cable shall be a shielded cable suitable for RS-485 communications.

All main panels shall be pre-wired for a Type-16 Malfunction Management Unit (MMU).

All wiring shall be neat in appearance. All cabinet wiring shall be continuous from its point of origin to its termination point. Butt type connections/splices are not acceptable.

All connecting cables and wire runs shall be secured by mechanical clamps. Stick-on type clamps are not acceptable.

The grounding system in the cabinet shall be divided into three separate circuits (AC Neutral, Earth Ground, and Logic Ground). These ground circuits shall be connected together at a single point as outlined in the NEMA TS2 Standard.

The main panel shall incorporate a relay, designated as K1, to remove +24 VDC from the common side of the load switches when the intersection is placed into mechanical flash. The relay shall have a momentary pushbutton to apply power to the load switch inputs for ease of troubleshooting.

All pedestrian push button inputs from the field to the controller shall be opto-isolated through the BIU and operate at 12 VAC.

All wire (size 16 AWG or smaller) at solder joints shall be hooked or looped around the eyelet or terminal block post prior to soldering to ensure circuit integrity. Lap joint soldering is not acceptable.

A load resistor panel consisting of eight (8) 2.2K ohm, 10Watt resistors. The common side terminator to AC\_ Neutral and the load side to each odd phase red (1-3-5-7) and all OLAP red (A-B-C-D). No peds shall utilize the load resistor circuits.

Power Panel Design and Construction

The power panel shall be integrated with the main panel and be located on the lower right portion of the cabinet. The power panel shall be wired to provide the necessary filtered power to the load switches, flasher(s), and power bus assembly. The power components shall be equipped with a removable plastic front cover for technician protection. The design will allow a technician to access the main and auxiliary breakers without removing the protective front cover.

The power panel portion of the main panel shall include the following components:

- a. A 40-amp main cabinet circuit breaker. This breaker shall supply power to the controller, MMU, signals, cabinet power supply and auxiliary panels. Breakers shall be at minimum, a thermal magnetic type, U.L. listed for HACR service, with a minimum of 10,000 amp inter-rupting capacity.
- b. A 15-amp auxiliary breaker. This breaker shall supply power to the fan, light and GFI utility outlet.
- c. An EDCO model SHA-1210 or exact approved equivalent surge arrester.
- d. A 50 amp, 125 VAC radio interference line filter.

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TRAFFIC SIGNAL CONTROLLER CABINET**

- e. A normally-open, 75-amp, Solid State Signal buss relay. The SSR shall be a Crydom Model # HA4875H or approved equal.
- f. A minimum of one (1) 8-position neutral bus bar capable of connecting three #12 wires per position. Additional neutral bus bars may be mounted on the cabinet rails directly below the power auxiliary panel.
- g. A minimum of one (1) 6-position ground bus bar capable of connecting three #12 wires per position. Additional ground bus bars may be mounted on the cabinet rails directly below the power auxiliary panel.
- h. A minimum of one (1) NEMA type 5-15R GFI utility outlet.

Power Bus Assembly

The power bus assembly shall be manufactured from 0.090", 5052-H32 aluminum. It shall provide filtered power for the controller, malfunction management unit, cabinet power supply, and all auxiliary equipment. It shall include the SDLC Bus connecting cables wired into a surface-mounted terminal block. As an alternate SDLC Bus connections may be made via an SDLC Hub Assembly.

The Power Bus Assembly shall house the following components:

- a. A minimum of three and a maximum of six power connectors.
- b. Two terminal strips to hardwire the power connections.
- c. SDLC terminal block with pre-wired cables or SDLC Hub Assembly

All cabinet equipment requiring filtered power to operate shall be connected to the power bus assembly by a 16 pin circular connector.

An SDLC Hub Assembly shall include a minimum of three and maximum of eight D-Subminiature Female 15 pin (DB15) connectors that are wired in series.

Auxiliary Cabinet Equipment

The cabinet shall be provided with two (2) thermostatically controlled (adjustable between 55-160 degrees Fahrenheit) ventilation fans in the top of the cabinet plenum. The fan plate shall be removable with the use of simple hand tools for serviceability. The fans shall be a ball bearing type fan and shall be capable of drawing a minimum of 100 cubic feet of air per minute each. The Fan/Thermostat assembly shall be connected to the Power panel by means of a 4 position plug-in cable.

Two (2) LED light assemblies shall be mounted on the fan panel plenum so as to sufficiently illuminate the top portion of the cabinet. There shall also be two (2) LED light assemblies mounted under the bottom shelf to illuminate the field terminals in the lower portion of the cabinet. The LED light system shall be connected to a door-activated switch and appropriate power supply.

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

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A minimum of two sets of complete and accurate cabinet drawings shall be supplied with each cabinet.

Vehicle Detection

One (1) Loop Detector Rack shall be provided in each cabinet. The detector shall be available in the following configuration.

Configuration #2 - Shall support up to 16 channels of loop detection (either eight 2 channel detectors or four 4 channel detectors), two 2-channel preemption devices and one BIU. This configuration shall be included as a standard on the 12 or 16 position main panel assembly.

Detector rack BIU mounting shall be an integral part of the detector rack.

All BIU rack connectors shall have jumper address pins corresponding to the requirements of the TS2 specification. The jumpers may be moved to change the address of any individual rack. The address pins shall control the BIU mode of operation. BIUs shall be capable of being interchanged with no additional programming.

Each cabinet shall contain detector interface panels for the purpose of connecting field loops and Loop Detector Racks. The panels shall be manufactured from FR4 G10 fiberglass, 0.062 inches thick, with a minimum of 2 oz. of copper for all traces.

One 8-position interface panel shall be provided for an 8-channel rack cabinet and one 16-position interface panel shall be provided for a 16-channel rack cabinet. The interface panel shall be secured to a mounting plate and attached to the left wall of the cabinet.

Each interface panel shall allow for the connection of eight or sixteen independent field loops. A ground bus terminal shall be provided between each loop pair terminal to provide a termination for the loop lead-in cable ground wire.

Each interface panel shall provide a 10-position terminal block to terminate the field wires for up to two 2-channel preemption devices.

Lightning protection device mounting holes shall be provided to accommodate an Edco SRA-16C, or Edco SRA-6, or Edco LCA-6, or a varistor lightning protection device. Lightning protection devices shall not be provided unless specifically called for in the special provisions of this specification.

A cable consisting of 20 AWG twisted pair wires shall be provided to enable connection to and from the panel to a detector rack. The twisted pair wires shall be color coded red and white wire.

All termination points shall be identified by a unique number and silk screened on the panel.

Each detector rack shall accommodate rack mountable preemption devices such as EMTRAC or Opticom.

Each detector rack shall be powered by the cabinet power supply and be connected to the power bus assembly by means of a 16 pin circular connector.

Cabinet Test Switches and Police Panel

A test switch panel shall be mounted on the inside of the main door. The test switch panel shall provide as a minimum the following:

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- a. AUTO/FLASH SWITCH - When in the flash position, power shall be maintained to the controller and the intersection shall be placed in flash. The controller shall not be stop timed when in flash. Wired according to NEMA-TS2-2016 the MMU forces the controller to initiate the start-up sequence when exiting flash.
- b. STOP TIME SWITCH - When applied, the controller shall be stop timed in the current interval.
- c. CONTROL EQUIPMENT POWER ON/OFF - This switch shall control the controller, MMU, and cabinet power supply AC power.

Momentary test push buttons for all vehicle and pedestrian inputs to the controller are not required. The ATC controller to be provided with the cabinet assembly shall provide vehicular and pedestrian call inputs from its keyboard while in the standard status display.

The police door switch panel shall contain the following:

- a. SIGNALS ON/OFF SWITCH - In the OFF position, power shall be removed from signal heads in the intersection. The controller shall continue to operate. When in the OFF position, the MMU shall not conflict or require reset.
- b. AUTO/FLASH SWITCH – When in the flash position, power shall be maintained to the controller and the intersection shall be placed in flash. The controller shall be stop timed when in flash. Wired according to NEMA-TS2-1998 the MMU forces the controller to initiate the start-up sequence when exiting flash.
- c. AUTO/MANUAL SWITCH - Cabinet wiring shall include provisions for an AUTO/MANUAL switch and a momentary push button or hand cord.

All toggle type switches shall be heavy duty and rated 15 amps minimum. Single- or double-pole switches may be provided, as required.

Any exposed terminals or switch solder points shall be covered with a non-flexible shield to prevent accidental contact.

All switch functions must be permanently and clearly labeled.

All wire routed to the police door-in-door and test switch push button panel shall be adequately protected against damage from repetitive opening and closing of the main door.

All test switch panel wiring shall be connected to the main panel via a 37 pin circular connector.

Wiring from the main panel to the test switch panel shall be connected to the switch panel via a 24 pin circular connector.

Controller Telemetry Interface Panel

Two telemetry interface panels and harnesses shall be supplied with each cabinet assembly, one for local and one for master operation.

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The harness shall be a minimum of 6 feet long and shall consist of two twisted shielded pairs, 22 AWG wire with drain wire in an overall jacket, terminated to a 9-pin "D" type connector at one end. The pin out of the 9-pin connector shall be in exact accordance with the NEMA TS2 Standard. The opposite end of the harness shall be terminated on a 10-position EDCO PCB-1B or exact equal lightning protection socket base.

All terminal block designations and peripheral board-mounted components shall be labeled as to their number and function and shall correspond to the cabinet wiring diagrams.

The following signals shall be accessible from the telemetry interface panel:

- Local controller command lines 1 & 2
- Local controller read back lines 1 & 2
- Master controller command lines 1 & 2
- Master controller read back lines 1 & 2
- Earth grounds

A socket mounted communication line transient protection device shall be supplied with the telemetry interface panel. The device shall be an EDCO model PC642C-008D or exact approved equivalent. The transient protection device shall be wired in series with the telemetry communication circuit.

Communication line impedance shall be matched to the transmitter output impedance to minimize noise on the communication lines. The panel shall allow connection of a 620 ohm resistor across the command and read back lines, where necessary.

Additional Cabinet Equipment Required

- 10 (ten) Red Jumpers for unused phases.
- 1 – CCA2 Controller Power Cable
- 1 – extra 15 pin Neutral buss bar mounted vertically on the rail under the power panel assembly
- 1 – extra 8 pin Earth buss bar mounted vertically on the rail under the power panel assembly.
- 1 – Document/computer drawer mounted under the center lower shelf.
- 1 – 6 position power outlet strip mounted horizontally on the upper left side rail.
- 1 – Modem outlet assembly for the Master Modem power.

Auxiliary Devices

Load Switches

- Load switches shall be solid state and shall conform to the requirements of Section 6.2 of the NEMA TS2 Standard.
- Signal load switches shall have a minimum rating of 10 amperes at 120 VAC for an incandescent lamp load.
- The front of the load switch shall be provided with three indicators to show the input signal from the controller to the load switch.
- Load switches shall be dedicated per phase. The use of load switches for other partial phases is not acceptable.

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- The full complement of load switches shall be supplied with each cabinet to allow for maximum phase utilization for which the cabinet is designed if called for in special provisions.

**Flashers**

- The flasher shall be solid state and shall conform to the requirements of section 6.3 of the NEMA TS2 Standard.
- Flashing of field circuits for the purpose of intersection flash shall be accomplished by a separate flasher.
- The flasher shall be rated at 15 amperes, double pole with a nominal flash rate of 60 FPM.
- Flasher will be supplied if called for in special provisions.

**Flash Transfer Relays**

- All flash transfer relays shall meet the requirements of Section 6.4 of the NEMA TS2 Standard.
- The coil of the flash transfer relay must be de-energized for flash operation.
- The full complement of relays shall be supplied with each cabinet to allow for maximum phase utilization for which the cabinet is designed if called for in special provisions.

**Malfunction Management Units (MMU)**

- Each cabinet assembly shall be supplied with one MMU as defined by the requirements of Section 4 of the NEMA TS2 Standard.
- Malfunction Management Units shall be a Type 16. The MMU shall be Econolite Control Products, Inc. Model MMU2-16LEIP (EDI Model MMU2-16LEIP) or approved equal.
- MMU shall be supplied if called for in special provisions.

**Bus Interface Units (BIU)**

- All BIUs shall meet the requirements of Section 8 of the NEMA TS2 Standard.
- The full complement of Econolite Control Products, Inc. Model 160-1003-501, Bus Interface Units shall be supplied with each cabinet to allow for maximum phase and function utilization for which the cabinet is designed.
- Each Bus Interface Unit shall include power on, transmit and valid data indicators. All indicators shall be LEDs.

**Cabinet Power Supply**

- The cabinet power supply shall meet the requirements of Section 5.3.5 of the NEMA TS2 Standard.
- The cabinet power supply shall provide LED indicators for the line frequency, 12 VDC, 12 VAC, and 24 VDC outputs.
- The cabinet power supply shall provide (on the front panel) jack plugs for access to the +24 VDC for test purposes.

One Econolite Control Products, Inc. Model 1084-003 cabinet power supply or equivalent shall be supplied with each cabinet assembly and shall be wired directly to the Power Bus Assembly via a 16 pin circular connector.

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**REVISION OF SECTION 614**  
**TRAFFIC SIGNAL CONTROLLER CABINET**

4        Testing and Warranty

5        Testing

- 6            • Each controller and cabinet assembly shall be tested as a complete entity under signal  
7            load for a minimum of 48 hours.  
8            • Each assembly shall be delivered with a signed document detailing the cabinet final tests  
9            performed.  
10           • The cabinet shall be assembled and tested by the controller manufacturer or authorized  
11           local distributor to ensure proper component integration and operation.

12       Warranty

- 13           • The controller and Malfunction Management Unit shall be warranted by the manufacturer  
14           against mechanical and electrical defects for a period of two years from date of shipment.  
15           The manufacturer's warranty shall be supplied in writing with each cabinet and controller.  
16           Second party extended warranties are not acceptable.  
17           • The cabinet assembly and all other components shall be warranted for a period of one  
18           year from date of shipment.  
19           • Any defects shall be corrected by the manufacturer or supplier at no cost to the Owner.

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**END REVISION OF SECTION 614**



1 **REVISION OF SECTION 614**  
2 **TRAFFIC SIGNAL POLES**

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

4 Subsection 614.08 (g) shall include the following:

5 Traffic signal poles, mast arms, and luminaire arms shall follow all of the requirements outlined in  
6 the Colorado Department of Transportation (CDOT) Standard Plans. Unless otherwise noted,  
7 traffic signal poles, mast arms and foundation design shall adhere to requirements as follows:

- 8 • Except as noted on the plans, traffic signal poles with mast arms up to and including 55  
9 feet shall use CDOT Standard Plan No. S-614-40A, Sheets 1 through 5.
- 10 • Traffic signal poles with mast arms exceeding 55 feet shall follow the requirements of  
11 CDOT Standard Plan No. S-614-40, Sheets 2 through 7.
- 12 • Traffic signal span wire poles and traffic signal pedestal poles shall follow the  
13 requirements shown in the Adams County Standard Signal Details.
- 14 • Traffic signal poles with school flasher assemblies shall follow the requirements shown in  
15 the Adams County Standard Signal Details.

16 Traffic signal poles, mast arms, luminaire arms, pedestal poles, and span wire poles shall be  
17 wrapped for shipping from the factory in heavy duty paper or plastic to protect them from  
18 scratches and abrasions in transit. Poles shall be handled in a manner that will preserve the  
19 overall appearance and prevent damage to the coating. The use of chains or cables for loading,  
20 unloading, or installing is prohibited. Only 3/4 inch diameter or larger nonabrasive nylon rope or  
21 equivalent nylon belting will be used. Adequate hold-downs and appropriate blocking shall be  
22 utilized for shipping to prevent load movement and damage to the outer coating in transit.

23 Traffic signal poles, mast arms, luminaire arms, pedestal poles, and span wire poles shall be  
24 galvanized as per ASTM A123 and A153. Prior to the installation of traffic poles, mast arms,  
25 and/or luminaire arms, the Contractor shall wipe clean the outer surfaces. All accessible interior  
26 surfaces of signal poles shall also be galvanized per ASTM A123 and A153.

27 Any surface areas damaged during handling or installation shall be touched up immediately.  
28 Nicks and abrasions greater than 1/8 inch deep shall be spray painted with zinc rich paint (greater  
29 than 90%) that matches the galvanized finish, such as Brite Products Brite Zinc Galvanizing  
30 Compound. The manufacturer's application instructions shall be followed.

31 All ferrous mounting hardware and weatherheads shall be either galvanized, cadmium plated, or  
32 made of stainless steel to resist corrosion. Payment for these items shall be incidental to the pay  
33 item to which the miscellaneous hardware item is attached.

34 Specialty traffic signal poles, of nostalgia design or other, and which do not meet these  
35 specifications, shall only be installed with approval from the Engineer.

36 SPAN WIRE POLE

37 Span wire poles and cables shall be designated to meet the structural requirements given in the  
38 latest edition of "Standard Specifications for Structural Support for Highway Signs, Luminaires  
39 and Traffic Signals", published by AASHTO, for a wind velocity of 90 MPH. The minimum pole  
40 weights and span wire cable rating given in the standard details shall be increased as necessary  
41 in accordance with the AASHTO requirements. All span wire poles shall be steel.

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**REVISION OF SECTION 614  
TRAFFIC SIGNAL POLES**

Span wire poles may be seamless, or may be fabricated as one piece without transverse joints or welds and with only one longitudinal seam which shall be either continuously welded and ground, or rolled flush.

Span wire cable shall be seven wire stranded, common galvanized, and utilities grade. The cable shall have a minimum wire diameter of 3/8 inch, and shall be rated at 13,000 pounds minimum. Tether cable shall have a maximum diameter of 1/4 inch and shall be stranded, galvanized steel. Both span wire cable and tether cable shall be incidental to the span wire pay item.

**PEDESTAL POLE**

Pedestal poles shall be designed to meet the structural requirement given in the latest edition of "Standard Specifications for Structural Support for Highway Signs, Luminaires and Traffic Signals", published by AASHTO, for a wind velocity of 90 MPH. Unless modified by a structural analysis, the pole shall be Schedule 40 galvanized steel. The pole base shall be frangible. The pedestal pole shall be hot dipped galvanized per ASTM A123 and A153, equivalent to 2 oz. per square foot, inside and out.

Subsection 614.13 shall include the following:

Traffic signal pole (steel), traffic signal-light pole (steel), traffic signal span wire pole, and traffic signal pedestal pole shall be measured and paid for per unit count and shall include all labor, equipment, and materials necessary to install the item complete-in-place. Unless otherwise noted in the plans, the cost of the traffic signal mast arm shall be incidental to the traffic signal pole, or traffic signal-light pole as appropriate.

Span wire cable shall be measured and paid for per unit count and shall include all labor, equipment, and materials necessary to install both the span wire cable and tether cable complete-in- place. Span wire cable shall be paid for under the "Span Wire Cable" pay item.

Traffic signal pole and traffic signal-light pole foundations shall be paid for separately as "Drilled Caissons", and meet all of the requirements outlined in the CDOT Standard Plans No. S-614-40, or CDOT Standard Plans No. S-614-40A, as applicable, and Section 503. Traffic signal poles and traffic signal-light poles with school flasher assemblies shall follow the requirements of the Adams County Standard Details. Traffic signal pole and traffic signal-light pole foundations with school flasher assemblies shall be paid for separately as "Drilled Caissons", and meet all of the requirements outlined in the Adams County Standard Details. Traffic Signal Pedestal Pole foundations and Traffic Signal Span Wire Pole foundations shall be included in the cost of the pole.

Subsection 614.14 shall include the following:

<b>Pay Item</b>	<b>Pay Unit</b>
Traffic Signal Pole (Steel)	Each
Traffic Signal-Light Pole (Steel),	Each
Traffic Signal Span Wire Pole	Each
Traffic Signal Pedestal Pole Steel	Each
Span Wire Cable	Each

Payment includes all labor, equipment and materials necessary to complete the work.

**END REVISION OF SECTION 614**

**REVISION OF SECTION 614  
TRAFFIC SIGNAL FACE**

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

Subsection 614.08 (h) Delete the third paragraph and replace with the following:

All vehicular traffic signal heads shall be 100% polycarbonate, colored black, with black, detachable, tunnel visors. Standard signal heads shall be Eagle Signal Corporation, McCain, or approved equal.

LED indications shall be furnished for all indications unless defined otherwise in the plans and shall include red ball, yellow ball, green ball, and arrow indications. All LED indications shall be warranted for a minimum of seven years by the manufacturer. Traffic LED indications shall be Gelcore, Series DR6 (RX11), or approved equal, with a 12" diameter displays unless otherwise noted.

When incandescent bulbs are defined in the plans, traffic signal bulbs shall be General Electric, Durotest, Phillips, or Engineer approved alternate. They shall be 116 watt, 130 volt for all 12-inch indications. Bulbs shall be 69 watt, 130 volt, for all 8-inch and pedestrian indications.

All signal head locations shall be approved by the Engineer in the field.

All back plates shall be installed on all mast arm mounted and/or span wire mounted traffic signal heads, black in color, and of the louvered design to allow wind passage. Back plates shall not be mounted on side-of-pole mounted traffic signal heads.

Astro-brac or Sky-brac type mounting hardware shall be used to attach all traffic signal heads mounted on mast arms.

Industry standard span wire mounting hardware shall be used to attach the signal heads to both the span wire cable and messenger cable on a span wire type installation.

Side of pole traffic signal heads shall use industry standard side of pole hardware on both the top and bottom traffic signal head sections for mounting.

All Band-it material, including buckles, shall be 3/4" stainless steel.

During construction, traffic signal heads that have been installed but are not ready for actual electrical connection shall be bagged with a dark opaque material.

Subsection 614.13 shall include the following:

Traffic Signal Heads shall be paid for as Traffic Signal Face, with the number of indications as specified on the plans, and on a unit price basis that shall include all labor, equipment and materials necessary to install the item complete-in-place.

Subsection 614.14 shall include the following:

<b>Pay Item Pay</b>	<b>Unit</b>
Traffic Signal Face	Each

**END REVISION OF SECTION 614**

1 **REVISION OF SECTION 614**  
2 **PEDESTRIAN SIGNAL FACE**

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

4 Subsection 614.08 (h) Delete the third paragraph and replace with the following:

5 All pedestrian signal heads shall be single section, black, symbolized messages, and clam shell  
6 mounting. Standard pedestrian signal heads shall be as manufactured by Indicator Controls  
7 Corporation, or approved equal.

8 LED indications shall be furnished for all indications unless defined otherwise in the plans and  
9 shall include countdown pedestrian hand and walk-man indications. Pedestrian indications shall be  
10 of the "filled" type. Outlined hand and walk-man indications shall not be permitted. All LED  
11 indications shall be warranted for a minimum of seven years by the manufacturer. Pedestrian  
12 countdown LED indications shall be Gelcore Model PS7-CFF1-01A-18<sub>2</sub>, or approved equal, with  
13 16" displays, unless otherwise noted.

14 All pedestrian head locations shall be approved by the Engineer.

15 Industry standard span wire mounting hardware shall be used to attach the signal heads to both  
16 the span wire cable and messenger cable on a span wire type installation.

17 All Band-it material, including buckles, shall be 3/4" stainless steel.

18 Subsection 614.13 shall include the following:

19 Pedestrian signal heads shall be paid for as Pedestrian Signal Face (16), and Pedestrian Signal  
20 Face (16) (Countdown), and on a unit price basis that shall include all labor, equipment and  
21 materials necessary to install the item complete-in-place.

22 Subsection 614.14 shall include the following:

23 <b>Pay Item</b>	23 <b>Pay</b>	23 <b>Unit</b>
24 Traffic Pedestrian Signal Face (16)		24 Each
25 Traffic Pedestrian Signal Face (16) (Countdown)		25 Each

26 **END REVISION OF SECTION 614**

1 **REVISION OF SECTION 614**  
2 **PEDESTRIAN PUSH BUTTON**

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

4 Subsection 614.08 (f) shall include the following:

5 Pedestrian push button assemblies shall be Pelco model SE-2005-08 (ADA pedestrian push  
6 button), or approved equal. The button housing shall be black in color. A separate 9" W x 12" H  
7 decal sign, MUTCD Reference # R10-3b or R10-3d as applicable or approved equal shall be  
8 installed with each pedestrian push button or as directed by the Engineer. For countdown  
9 pedestrian signal heads, A separate 9" W x 15" H decal sign, MUTCD Reference # R10-3e or  
10 approved equal shall be installed with each pedestrian push button.

11 Push button locators shall only be used where specified in the plans, and may be considered by  
12 the Engineer on a per project basis. When push button locators are requested, this function shall  
13 be integrated as part of the pedestrian push button, the pedestrian push button shall be of the  
14 manufacturer and model number specified, and shall conform to Manual on Uniform Traffic  
15 Control Devices (MUTCD) requirements and all current ADA accessibility requirements.

16 Audible pedestrian indications shall only be used where specified in the plans, and may be  
17 considered by the Engineer on a per project basis. When audible pedestrian indications are  
18 requested, they may be of the manufacturer and model number specified, and shall conform to  
19 latest edition of the MUTCD requirements.

20 PEDESTRIAN PUSH BUTTON POLE

21 Pedestrian push button pole shall be as illustrated in the Adams County standard details,  
22 constructed of Schedule 40 galvanized steel. Pole base shall be frangible.

23 Subsection 614.13 shall include the following:

24 Pedestrian push buttons shall be paid for on a unit price basis and shall include all labor,  
25 equipment and materials necessary to install the item complete-in-place. Pedestrian push buttons  
26 shall be paid for under the "pedestrian push button" pay item.

27 Pedestrian push button poles shall be measured and paid for per unit count and shall include all  
28 labor, equipment, and materials necessary to install the item complete-in-place. Pedestrian push  
29 button poles shall be paid for under the "pedestrian push button pole" pay item.

30 When an audible pedestrian indication is requested and where this function is integrated within  
31 the pedestrian push button, the audible pedestrian indication costs shall be included in, as part of,  
32 the unit price of the "pedestrian push button" pay item.

33 Where the audible pedestrian indication function is not integrated within the pedestrian push  
34 button, audible pedestrian indications shall be paid for on a unit price basis and shall include all  
35 labor, equipment, and materials necessary to install the item complete-in-place. Audible  
36 pedestrian indications shall be paid for under the "audible pedestrian indication" pay item.

37 The cost of separate decal signs installed with each pedestrian push button shall be included in,  
38 as part of, the unit price of the "pedestrian push button", or "audible pedestrian indication" pay  
39 item, as applicable.

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**REVISION OF SECTION 614  
PEDESTRIAN PUSH BUTTON**

Subsection 614.14 shall include the following:

<b>Pay Item</b>	<b>Pay</b>	<b>Unit</b>
Pedestrian Push Button		Each
Pedestrian Push Button Pole		Each
Audible Pedestrian Push Button		Each

Payment includes all labor, equipment and materials necessary to complete the work.

**END REVISION OF SECTION 614**

**REVISION OF SECTION 614  
TRAFFIC SIGNAL VEHICLE DETECTOR AMPLIFIER**

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

Subsection 614.08 (l) shall hereby include the following:

This specification defines the minimum design, operational, and performance requirements for a multiple channel, digital, self tuning inductive vehicle detector. Inductive vehicle detectors shall be card rack mounted, plug in type, and shall operate from an external 12-24 VDC power supply.

Inductance Vehicle Detectors shall be capable of operating within a TS1 or TS2-Type 1 cabinet.

Inductive vehicle detectors shall include a power indicator.

Inductive vehicle detectors shall have built-in protection against lightning induced and other transients.

Inductive vehicle detectors shall have all user programmed settings and vehicle detector gathered data stored in non-volatile memory.

Each inductive vehicle detector shall include two or four complete detector channels.

Each channel of the sensor unit shall automatically self tune to any loop and lead-in inductance from 20 to 2500 microhenries within 10 seconds after application or interruption of supply voltage. Units shall also track changes in loop/lead-in electrical characteristics, as might reasonably be expected to occur in undamaged loops properly installed in sound pavement, without producing false indications or changes in sensitivity.

Each channel shall have both detect and fault indicators.

All vehicle detection parameters shall be programmable separately for each channel. This includes the sensitivity, background adapt rate, recovery method, wash delay time, and wash adapt time.

Each channel at minimum shall be capable of a minimum of eight (8) pulse mode sensitivity levels, seven (7) presence mode sensitivity levels, off mode, and four (4) frequency settings.

Inductance vehicle detectors shall be hot-swappable.

Inductance vehicle detectors shall operate in temperatures between -29 degrees Fahrenheit and +165 degrees Fahrenheit with a humidity level of 0% to 95% (non-condensing).

When data storage capability is required per project plans and/or special provisions, inductance vehicle detectors shall meet these specifications, and all stored data shall be recoverable via built in RS232/RS485 communication ports.

Subsection 614.13 shall hereby be replaced with the following:

Inductance vehicle detectors shall be measured by the units installed and shall include all labor, equipment, and materials necessary to install the item complete-in-place. Inductance vehicle detectors shall be paid for under the pay item "Traffic Signal Vehicle Detector Amplifier (Loop Type)".

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**REVISION OF SECTION 614  
TRAFFIC SIGNAL VEHICLE DETECTOR AMPLIFIER**

Subsection 614.14 shall include the following:

<b>Pay Item</b>	<b>Pay</b>	<b>Unit</b>
Traffic Signal Vehicle Detector Amplifier (Loop Type)		Each

**END REVISION OF SECTION 614**



**REVISION OF SECTION 614  
LOOP DETECTOR WIRE**

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

Subsection 614.08 (k) shall hereby include the following:

Detector loops shall be installed in accordance with these specifications, the construction plans, and the County Standard Details.

Each individual detector loop is to be spliced to a lead-in cable within a pull box as specified on the plans, and each loop shall consist of one continuous wire, without splicing, to this point. Any required series or parallel connections are to be completed in the pull box.

All detector loops shall have a tag attached to the leading clockwise lead of the loop. This tag shall be marked to indicate the relative location of the loop. This marking shall correspond directly to the phase designations in the Plans.

Detector loop roadway cuts, when required, shall be 3/8-inch in width and of sufficient depth to provide a minimum of 2-inch of sealant above the wire.

Detector loop roadway cuts where required shall be sealed to the surface level of the original roadway with "Gold Label Flex," "3-M Brand model Black 5000", "Bondo No. E-709", or approved equal. ("Bondo No. P-606" is not approved). This sealer is to be used whether or not the roadway is to be overlaid.

Detector loop installations larger than 6-foot x 6-foot shall be of a quadrapole (2-4-2) design, according to the Plans. Duct type loop wire, IMSA 51-5-1984, shall be used for all loops.

Where the detector loop lead enters or resides in a pull box or conduit, the two associated loop lead wires shall be twisted together in a clockwise direction with a twist rate of 10-12 twists per foot.

At a minimum, three (3) feet of twisted loop lead shall be left in the pull box where splicing is to occur.

Subsection 614.13 shall hereby be replaced with the following:

Detector loops shall be paid for on a unit price basis including loop wire, saw cutting, and sealant for a complete installation to the splice point pull box. Detector loops shall be paid for under the pay item "loop detector wire".

Subsection 614.14 shall include the following:

<b>Pay Item</b>	<b>Pay</b>	<b>Unit</b>
Loop Detector Wire		Each

**END REVISION OF SECTION 614**

1 **REVISION OF SECTION 614**  
2 **FIRE PREEMPTION UNIT AND TIMER**

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

4 Subsection 614.08 shall include the following:

5 *Fire Preemption Unit.* The Fire Preemption Unit shall consist of Global Traffic Technologies (GTT)  
6 Opticom phase selectors and detectors shall be of the most current model, or as specified herein.  
7 Opticom Detectors shall be installed as specified in the plans and may include model numbers  
8 711, 721, and/or 722. Opticom Phase Selectors shall be model number 752.

9 Subsection 614.13 shall include the following:

10 Fire preemption units shall include both the Opticom phase selectors and detectors, and shall  
11 include all labor, equipment and materials necessary to install the items complete-in-place. Fire  
12 Preemption Unit and Timer shall be measured and paid by the number of intersections at which  
13 the system is installed. The item shall include all labor, materials, and ancillary hardware required  
14 to provide a fully functioning system to the satisfaction of the Engineer.

15 Subsection 614.14 shall include the following:

16 <b>Pay Item</b>	16 <b>Pay</b>	16 <b>Unit</b>
17 Fire Preemption Unit and Timer		17 Each

18 **END REVISION OF SECTION 614**  
19

1 **REVISION OF SECTION 614**  
2 **INTERSECTION DETECTOR SYSTEM (CAMERA)**

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

4 Subsection 614.08 (l) shall hereby include the following:

5 **Video Detection – General Requirements**

6 This specification sets forth minimum requirements for a system to monitor vehicles on a roadway  
7 by processing of video images. The detection of vehicles passing through the field-of-view of an  
8 image sensor shall be made available to a large variety of end user applications as simple  
9 contact closure outputs that reflect the current real-time detector or alarm states (on/off) or as  
10 summary traffic statistics that are reported locally or remotely. The contact closure outputs shall  
11 be provided to a traffic signal controller and comply with the National Electrical Manufacturers  
12 Association (NEMA) Type C or C detector rack or 170 input file rack standards.

13 The system architecture shall fully support Ethernet networking of system components through a  
14 variety of industry standard and commercially available infrastructures that are used in the traffic  
15 industry. The data communications shall support direct connect, modem, and multi-drop  
16 interconnects. Simple, standard Ethernet wiring shall be supported to minimize overall system  
17 cost and improve reliability, utilizing existing infrastructure and ease of system installation and  
18 maintenance. Both streaming video and data communications shall optionally be interconnected  
19 over long distances through fiber optic, microwave, or other commonly used digital  
20 communications transport configurations.

21 On the software application side of the network, the system shall be integrated through a client-  
22 server relationship. A communications server application shall provide the data communications  
23 interface between as few as one to as many as hundreds of Machine Vision Processor (MVP)  
24 sensors and a number of client applications. The client applications shall either be hosted on the  
25 same PC as the communications server or may be distributed over a local area network of PC's  
26 using the industry standard TCP/IP network protocol. Multiple client applications shall execute  
27 simultaneously on the same host or multiple hosts, depending on the network configuration.  
28 Additionally, a web-browser interface shall allow use of industry standard internet web browsers  
29 to connect to MVP sensors for setup, maintenance, and playing digital streaming video.

30 **Video Detection – Hardware Requirements**

31 The video detection system shall include a video sensor that integrates a high-definition (HD)  
32 camera with an embedded processor for analyzing the video and performing detection. The  
33 system shall detect vehicles on a roadway using only video images of vehicle traffic and shall be  
34 an Econolite Autoscope<sup>®</sup> Vision, or an approved equivalent.

35 The camera shall be a color Complementary Metal-Oxide-Semiconductor (CMOS) imaging array  
36 with HD resolution of at least 720p (1280x720 pixels). The camera shall include a minimum 10X  
37 optical zoom with the functionality to zoom the lens as required to satisfy across-the-intersection  
38 detection objectives, including stop line and advance detection. It shall be possible to zoom the  
39 lens remotely from the TMC for temporary traffic surveillance operations or to inspect the  
40 cleanliness of the faceplate.

41 The camera shall have direct, real-time iris and shutter speed control by the integrated processor.  
42 The processor shall support H.264 video compression for streaming output.

43 The camera and processor shall be housed in a sealed IP-67 enclosure. The faceplate of the  
44 enclosure shall be glass and shall have hydrophilic coating on the exterior surface to reduce  
45 debris accumulation and maintenance. The faceplate shall have a thermostatically-controlled  
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**REVISION OF SECTION 614  
INTERSECTION DETECTOR SYSTEM (CAMERA)**

indium tin oxide (ITO) heater applied directly on the interior surface to keep the faceplate clear of condensation, snow, ice and frost.

An adjustable aluminum visor shall shield the faceplate from the sun and extraneous light sources.

An integral aiming sight shall assist in aiming the camera for the detection objectives.

A removable rear cap and cable strain relief shall seal the power connection. The rear cap shall be tethered to the enclosure to avoid dropping the cap during installation. The rear cap shall be fastened to the body of the video sensor with a single, captive bolt. The rear cap and enclosure shall include Gore breathers to equalize internal and external pressure.

The sensor shall be self-supporting on manufacturer's mounting brackets for easier fastening during installation.

It shall be possible to rotate the field-of-view 360° without changing the angle of the visor.

**Video Detection – Power and Communications**

Power and communications for the video sensor shall be carried over a single three-conductor cable. Termination of the three-conductor cable shall be inside the rear cap of the enclosure on a three-position, removable Phoenix terminal block. Each conductor shall be attached to the Phoenix plug via a screw connection.

The video sensor shall operate normally over an input voltage range of 89 to 265 VAC at 50 or 60 Hz. Power consumption shall be no more than 16 watts typical.

No supplemental surge suppression shall be required outside the cabinet.

All communications to the video sensor shall be broadband-over-power via the same three-conductor cable that powers the unit. Coaxial cable shall not be required.

The video detection system shall include an interface panel in the traffic cabinet that manages communications between the video sensors, the traffic management center, a maintenance technician, and the traffic cabinet itself.

The communications interface panel shall provide connection points for four video sensors. Each sensor connection shall be a 3-pole terminal block, which supplies power and broadband-over-power communications to the sensor. The broadband-over-power communications shall provide a throughput of 70 to 90 Mbps. The broadband-over-power connection shall support at least 1,000 feet of cabling to the video sensor.

Each video sensor connection shall include a power switch. There shall be an LED for each video sensor to indicate the state of the power to the sensor and an LED for each video sensor to indicate the status of communications.

Each video sensor connection shall contain a resettable fuse.

Each video sensor connection shall provide high-energy transient protection.

A wired Ethernet port shall be provided to connect the technician at the cabinet to the video detection system for setup and maintenance purposes. The maintenance port shall support 10/100/1000 Mbps Ethernet communication. All communications to the video detection system

**REVISION OF SECTION 614  
INTERSECTION DETECTOR SYSTEM (CAMERA)**

through the maintenance port shall be to a single IP address. The maintenance port shall support DHCP to automatically assign an IP address to the user's computer, if desired.

An 802.11g Wi-Fi access point shall allow wireless connection to the video detection system at the cabinet for setup and maintenance purposes. All communications to the video detection system through the Wi-Fi access point shall be to a single IP Address. The Wi-Fi access point shall support DHCP to automatically assign an IP Address to the user's computer. The Wi-Fi access point shall include a dipole, omnidirectional antenna.

A momentary pushbutton shall allow the user to turn the Wi-Fi access point on or off. The Wi-Fi access point shall turn itself off automatically after a period of inactivity from connected devices. An LED shall indicate when the Wi-Fi access point is enabled. The Wi-Fi access point shall operate simultaneously with the wired maintenance port and with the TMC connection.

The communications interface panel shall provide one connection to communicate to the traffic controller through the cabinet.

The traffic controller connection shall support a TS2 Type 1 compatible SDLC interface. The traffic controller connector shall be a 15-pin female metal shell D sub-miniature type connector to support a standard NEMA TS2 or TEES SDLC cable. The traffic controller connection shall support a protocol interface to SDLC-capable traffic controllers (NEMA or TEES). The traffic controller connection shall support the NEMA TS2 SDLC protocol to include up to 64 detector outputs and 32 inputs.

The traffic controller connection shall be able to connect to a wired input/output card, which supports wired I/O in cabinets without a SDLC-capable controller. The wired I/O data communications link shall support at least 24 outputs and 16 inputs. It shall be possible to connect and use both SDLC communications and communication to the wired input/output card simultaneously.

The communications interface panel shall include two USB 2.0 ports. If a communications interface panel fails to start and run due to a software or operating system failure, it shall be possible to reinstall all system and application software from a USB memory stick without necessitating removal of the communications interface panel from the cabinet.

The communications interface panel shall accept input voltage in the range of 89-265 VAC, 50/60 Hz power from the transient-protected side of the cabinet.

The communications interface panel shall be protected by two slow blow fuses. Spares shall be attached to the panel.

The video detection system shall support a wired input/output card that communicates with the communications interface panel for real-time detection states and other I/O to the traffic controller. The card may reside in a standard detector rack or shelf-mount enclosure with power module.

The wired input/output card shall comply with the form factor and electrical characteristics to plug directly into a NEMA type C or D detector rack or Caltrans TEES Input File. The card shall occupy two slots of the detector rack. The card shall provide four detector outputs on its rear-edge connector.

A front connector shall provide communication to the communications interface panel. A front connector shall allow 16 inputs and 24 contact-closure detector outputs for wiring into the cabinet.

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INTERSECTION DETECTOR SYSTEM (CAMERA)**

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A front panel LED for each of the 16 inputs and 24 outputs shall indicate the state of the input or output.

The wired input/output card shall support expansion cards in other slots. Each expansion card shall support 4 outputs to the back edge of the card.

The wired input/output card shall support optional harnesses for connection to Input Files.

**Video Detection – Software**

The video detection system shall include management software for configuration, monitoring and data collection purposes.

Management software shall be a Windows-based application. The software shall be compatible with Windows 7 and Windows 10 operating systems. The software shall communicate with the video detection system via Ethernet.

The management software shall automatically determine all video sensors and communications interface panels available on the local network and populate a list of all devices.

The management software shall provide the user a means to name individual video sensors and communications interface panels.

The management software shall provide a means for the user to zoom the camera optics while viewing a live video stream.

The management software shall provide a means for the user to calibrate distances in the field of view.

The management software shall show the length and width of the detection zone

The management software shall allow user defined size and specific distance of advanced zones

The management software shall provide the user a means to create 4-sided detection zones in the field of view using either a still snapshot or live video.

The management software will overlay an outline of each detection zone over the background image. It shall be possible for the user to place detection zones anywhere in the field of view for stop line detection and/or advance detection. It shall be possible for the user to set the desired color of both the on and off states of the detection zone overlay. It shall be possible for the user to alter the size and shape of any previously created zone. It shall be possible for the user to overlap zones, either partially or fully.

It shall be possible for the user to name each zone uniquely.

It shall be possible for the user to assign each zone to detect vehicles, to detect bicycles, or to detect both, and to specify different outputs for each type.

It shall be possible for the user to assign the same output to multiple zones such that the output will be on if any of the zones are detecting a vehicle or bicycle.

It shall be possible for the user to assign a single zone to more than one output such that if a vehicle or bicycle is detected, all the assigned outputs shall be turned on.

**REVISION OF SECTION 614  
INTERSECTION DETECTOR SYSTEM (CAMERA)**

The management software shall be capable of creating at least 99 detection zones per video sensor.

It shall be possible for the management software to retrieve all configuration parameters from video sensors or communications interface panels. It shall be possible for the user to save all the settings for a video sensor or a communications interface panel to a laptop file. The management software shall provide a means to read or import all the settings from a previously saved configuration file for a video sensor or a communications interface panel.

The management software shall be able to download a new version of the application software into a communications interface panel and its attached video sensors locally and remotely.

The management software shall provide a screen to monitor operation of a video sensor. The monitoring screen shall include a live video stream from the video sensor with at least HD 1280x720 pixel resolution. The monitoring screen shall show indications of detection in real time by changing the color of the detection zone. It shall be possible for the user to configure different indications for vehicle detections vs. bicycle detections when both are configured for the same zone. The monitoring screen shall include the following optional, configurable objects:

- It shall be possible for the user to size and position them anywhere on the screen and to change the color and size of text.
- An indication of when an output is on or off, along with a user-configurable name for that indicator.
- The current time in the video sensor.
- A user-configurable title or name.
- The version number of the video sensor software.
- A signal head definable by phase

It shall be possible for the user to turn the overlay graphics on or off with a single setting.

The management software shall provide a screen to monitor operation of the intersection with a quad-view video stream from the communications interface panel. The quad-view video stream shall have a resolution of at least HD 1280x720 pixels, where each of the sensor videos comprising the quad-view shall be at least 640x360 pixels. It shall be possible for the user to configure the order that the sensor videos appear in the quad-view. The real-time quad-view video stream shall be capable of displaying the overlay graphics for all four sensors simultaneously.

While monitoring the video of a single video sensor or of the quad-view, it shall be possible for the user to request a "snapshot" or single-frame image to save to a named file on a laptop.

While monitoring the video of a single video sensor or of the quad-view, it shall be possible for the user to record a period of the video to save to a named file on a laptop.

**Video Detection – Functionality**

The video detection system shall provide the following features and functionality.

The video detection system shall detect the presence of vehicles in defined zones and turn on the assigned output when the vehicle is present in the zone.

For detection zones placed at the stop line, the probability of not detecting the presence of a vehicle shall be 1% or less under all operating conditions when the video sensor is installed

**REVISION OF SECTION 614  
INTERSECTION DETECTOR SYSTEM (CAMERA)**

and configured properly. For detection zones placed at the stop line, the probability of falsely detecting a vehicle that is not present shall be 3% or less under all operating conditions when the video sensor is installed and configured properly.

It shall be possible to place advance detector zones such that the farthest point of the zone is up to 600 feet from the video sensor. Advance detector zone placement shall include 2-3 car lengths of field-of-view beyond the farthest point of the zone.

To ensure statistical significance for the above detection performance specifications, the data shall be collected over 24-hour time intervals (so as to avoid a single lighting condition) and will contain a minimum of one hundred (100) vehicles per lane. The calculations of detection performance will not include turning movements where vehicles do not pass through the detectors, vehicle lane-change anomalies, or where they stop short or stop beyond the combined detection zones.

The video detection system shall provide a failsafe mode for each video sensor. If the failsafe mode is enabled, all programmed presence detection outputs for the video sensor shall be turned on, thus placing constant calls to the controller. When failsafe mode is disabled, all outputs revert to normal on/off operations.

The video sensor shall continuously monitor the overall contrast in the video. If the overall contrast falls below a preset level (such as caused by dirty faceplate, severe glare, extreme fog, or temporary ice/snow on the faceplate), the sensor shall enable the failsafe mode. When sufficient contrast is restored in the video, the sensor will disable the failsafe mode.

The communications interface panel shall continuously monitor the connectivity status of the attached video sensors. If any video sensor goes offline due to either electrical failure or internal software failure, the communications interface panel shall enable the failsafe mode for that video sensor. If the video sensor comes back online, failsafe mode shall be disabled.

The video detection system shall automatically collect and store traffic flow data in non-volatile memory for later retrieval and analysis. No additional hardware or software shall be necessary. The data shall include:

- Vehicle counts.
- Vehicle average speeds.

The management software shall be able to retrieve collected data for a specified period of time or for all currently stored data and save into a standard CSV file.

The communications interface panel and each video sensor shall maintain a time-stamped operations log of routine and special events in non-volatile memory for later retrieval and analysis.

The video detection system and management software shall provide three methods to synchronize the time of day clocks in the communication interface panel and the video sensors, as follows:

- Manual time synchronization operation by the user, which sets the time to the current time on the laptop where the management software is running.
- A configuration setting to allow the communications interface panel to automatically obtain time from the NEMA TS2 protocol on the SDLC channel and broadcast it to



**REVISION OF SECTION 614  
INTERSECTION DETECTOR SYSTEM (CAMERA)**

the video sensors.

- A configuration setting to allow the communications interface panel to automatically obtain time from up to five Network Time Protocol (NTP) sources and broadcast it to the video sensors.

In addition to the ability to view video streams in the management software, it shall be possible to view video from individual sensors or to view the quad-view from the communications interface panel using a third-party video player application on a tablet, smart phone or laptop computer.

The video detection system hardware shall be designed for flexible, fast and easy installation and setup. It shall be possible to mount the video sensor on an intersection pole, mast arm, or luminaire arm. No special tools or extra equipment, other than a laptop for configuration, will be required.

Once all hardware is installed, connected and functional, it shall be possible to configure the video detection system for a typical 4-approach, 8-phase intersection.

The video detection system shall be provided with the following warranty, service and support options. The manufacturer shall warrant the video detection system for a minimum of three (3) years. Ongoing software support by the manufacturer will include software updates of the video sensor, communications interface panel, and management software. These updates will be provided free of charge during the warranty period. The manufacturer will maintain a program for technical support.

Subsection 614.13 shall hereby include the following:

The video detection system shall be paid for on the basis of each intersection the system is installed, and shall include all labor, equipment and materials necessary to complete-in-place. The video detection system shall be paid for under the "Intersection Detection System (Camera)" pay item.

Subsection 614.14 shall include the following:

<b>Pay Item Pay</b>	<b>Unit</b>
Intersection Detection System (Camera)	Each

**END REVISION OF SECTION 614**

1 **REVISION OF SECTION 614**  
2 **FLASHING BEACON**

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

4 Subsection 614.08 (f) shall include the following:

5 SCHOOL FLASHING BEACON ASSEMBLY

6 A school flashing beacon assembly shall be either solar or 120V as shown in the County standard  
7 details and as specified in the plans.

8 LED indications shall be furnished for all indications. For 120VAC installations, LED indications  
9 shall be warranted for a minimum of seven years by the manufacturer, shall be Gelcore series  
10 DR6 (RX11), or approved equal for 12" indications, and shall be Gelcore, Series DR4, or  
11 approved equal for 8" back mounted indications. For solar installations, LED indications shall be  
12 warranted for a minimum of five years by the manufacturer and LED indications shall be Leotek  
13 12V, or approved equal.

14 Front mount school flashing beacon assembly signal heads shall flash alternately.

15 Each school flasher beacon assembly shall include a NEMA Type 4 enclosure for housing the  
16 associated time clock unit and electrical connections. When solar power is used in conjunction  
17 with the school flashing beacon assembly, the NEMA Type 4 enclosure shall be of sufficient size  
18 to house all associated solar power equipment, including the battery(s).

19 The NEMA Type 4 enclosure shall be lockable and provided with a treasury type lock Corbin  
20 number R357SGS, or exact equivalent A time clock, RTC model number AP21T, or approved  
21 equal shall be incorporated in the school flashing beacon assembly NEMA Type 4 enclosure.

22 Terminal blocks shall be molded, phenolic, barrier type rated at 15 ampere, 1000 V. No wiring  
23 splices will be permitted within the school flasher beacon assembly or NEMA Type 4 enclosure  
24 without the permission of the Engineer.

25 Signs shall be provided by the County and shall be installed by the Contractor as an integral part  
26 of the flashing assembly.

27 For 120VAC installations, a main circuit breaker shall be installed in the NEMA Type 4 enclosure  
28 between the service feed and school flashing beacon assembly electronics. Fuse(s) in place of  
29 the circuit breaker shall not be permitted. A main circuit breaker shall not be required for solar  
30 type installations.

31 For 120VAC installations, a 120VAC receptacle shall be installed within the NEMA Type 4  
32 enclosure.

33 WARNING OR REGULATORY SIGN FLASHING BEACON ASSEMBLY

34 A warning or regulatory sign flashing beacon assembly shall either solar or 120V as shown in the  
35 County standard details and as specified in the plans.

36 LED indications shall be furnished for all indications. For 120VAC installations, LED indications  
37 shall be warranted for a minimum of seven years by the manufacturer and LED indications shall  
38 be Gelcore, Series DR6 (RX11), or approved equal. For solar installations, LED indications shall  
39 be warranted for a minimum of five years by the manufacturer and LED indications shall be  
40 Leotek 12V, or approved equal.

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**REVISION OF SECTION 614  
FLASHING BEACON**

Front mount warning or regulatory sign flashing beacon assembly signal heads shall flash simultaneously.

All terminations shall be made on a terminal block located within the signal head. Terminal blocks shall be molded, phenolic, barrier type rated at 15 ampere, 1000 V. No wiring splices will be permitted within the warning or regulatory sign flashing beacon assembly without the permission of the Engineer.

Signs shall be provided by the County and shall be installed by the Contractor as an integral part of the flashing assembly.

Subsection 614.13 shall include the following:

School flashing beacon assemblies shall be paid for on a unit price basis and shall include all labor, equipment, materials, and electrical service connections necessary to install a school flashing beacon assembly, complete-in-place, on a single pole. School flashing beacon assemblies shall be paid for under the "school flashing beacon assembly" pay item.

Warning or regulatory sign flashing beacon assemblies shall be paid for on a unit price basis and shall include all labor, equipment, materials, and electrical service connections necessary to install a warning or regulatory sign flashing beacon assembly, complete-in-place, on a single pole. Warning or regulatory sign flashing beacon assemblies shall be paid for under the "warning/regulatory sign flashing beacon assembly" pay item.

Subsection 614.14 shall include the following:

<b>Pay Item Pay</b>	<b>Unit</b>
Warning/Regulatory Sign Flashing Beacon Assembly	Each
School Flashing Beacon Assembly	Each

**END REVISION OF SECTION 614**

1 **REVISION OF SECTION 614**  
2 **UNINTERRUPTED POWER SUPPLY**

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

4 Subsection 614.08 (b) shall include the following:

5 **Uninterrupted Power Supply – General Requirements**

6 An Uninterrupted Power Supply (UPS) shall be installed where specified in the plans and may be  
7 considered by the Engineer on a per project basis.

8 The UPS shall be compatible with the Adams County traffic controller cabinets, controller and  
9 cabinet components, including the safety monitor, for full time operation. The UPS shall include  
10 all necessary cables to connect Inverter/Controller and battery panel(s).

11 **Uninterrupted Power Supply – Functional Requirements**

12 The UPS shall provide a 2-amp cabinet load a minimum run-time of four (4) hours. UPS must  
13 provide a minimum of 1000W @ +74°C, continuous active output capacity, with a 90% minimum  
14 inverter efficiency while running in battery backup mode. When under battery power, the UPS  
15 output voltage shall be 120 VAC, pure sine wave output,  $\pm 3\%$ , 60 Hz  $\pm 0.1\%$ .

16 The maximum transfer time allowed, from disruption of utility line voltage to stabilized inverter line  
17 voltage from batteries shall be eight (8) milliseconds. The maximum transfer time when switching  
18 from inverter line voltage to utility line voltage after the line-qualifying period shall be ten (10)  
19 milliseconds. The UPS shall be capable of allowing the user to change the transfer time in eight  
20 (8) millisecond increments up to 200 milliseconds if needed by the cabinet equipment.

21 Operating temperature for the Inverter/Controller and battery panel(s) shall be -35°F to +165°F.

22 The UPS transient protection shall be able to handle a minimum of 480 joules of energy and 39kA  
23 peak current. In addition, the input circuit shall contain an RF filter, which provides attenuation of  
24 line noise of 25 dB at 10 KHz, 65 dB at 100 KHz and 100 dB at 1 MHz.

25 The UPS shall have the capability to be replaced with ease utilizing single connectors for AC  
26 input, AC output and the battery panel(s).

- 27
- 28 • The AC input and output shall be separate panel mounted plug/receptacles that allow no  
29 possibility of accidental exposure to dangerous voltages. The plug/receptacles shall  
30 utilize some form of locking mechanism to prevent accidental disconnect.
  - 31 • The battery panel shall utilize a single circular barrel type connector for connecting to the  
Inverter/Controller with ease.

32 The UPS must recharge to full charge capacity within four (4) hours of complete discharge when  
33 AC utility line voltage is available. The number of battery panels connected to the  
34 Inverter/Controller shall not have an effect on the four (4) hour recharge time. Temperatures  
35 below 65°C shall not have any effect on the ability to recharge or the recharge time. The UPS  
36 must not require trickle/float charging.

37 The UPS shall have a fail-safe utility tie feature that automatically cuts back to the utility line in the  
38 event of an Inverter/Controller failure, battery panel(s) failure or complete battery panel(s)  
39 discharge.

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**REVISION OF SECTION 614  
UNINTERRUPTED POWER SUPPLY**

**Uninterrupted Power Supply – Battery Requirements**

- The batteries shall utilize a Sealed Nickel-Zinc (NiZn) battery technology.
- The battery panel(s) must be capable of installation in existing controller cabinet without the need for a dedicated secondary or piggy back enclosure.
- The charging/battery monitoring circuitry shall be incorporated within the battery panel.
- The system shall allow the user to ‘Hot Swap’ the batteries while on utility power or battery backup power.
- The Inverter/Controller must allow the connection of four (4) batteries directly to the Inverter/Controller.
- The Inverter/Controller must be capable of accepting battery panel(s) of different capacities giving the user the ability to utilize different battery sizes to achieve required run-times.
- The Inverter/Controller shall accept up to sixteen (16) battery panels when utilizing a battery HUB(s).

**Uninterrupted Power Supply – Operational Requirements**

The UPS Inverter/Controller shall have a 4 line by 20-character LCD display with an LED back light. From the main screen, the LCD display shall provide the following information;

- Utility line voltage
- UPS status
- Cabinet power consumption
- Battery charge percentage
- Available backup time in hours and minutes

The LCD Display Menu shall provide the user the ability to program and monitor the following parameters;

- Voltage threshold parameters
- Programmable relays
- Depth of Discharge (high and normal)
- Event log

The UPS Inverter/Controller shall include a navigational keypad to allow users the ability to operate the menu and program user set parameters.

- The UPS shall allow the user to set high and low AC line voltage thresholds to determine parameters to transfer from utility line power to battery backup power.
- The UPS shall bypass utility line power if the utility line voltage is outside of the set high and low voltage parameters.
- The UPS shall qualify the utility line power for a minimum of three (3) minutes from the moment the utility line voltage is within the set high and low voltage parameters.

The UPS Inverter/Controller shall include eight (8) programmable relays, which are controlled by power line conditions, and user selected settings. These relay contacts shall be rated for 2 amps at 120 VAC. Each relay shall have the ability to trigger by multiple conditions simultaneously. The programming options are as follows;

- Loss of utility line voltage
- Low battery

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**REVISION OF SECTION 614  
UNINTERRUPTED POWER SUPPLY**

- Time of day
- Temperature
- Time delay (for red flash)

The UPS shall allow the user to control the depth of discharge of the batter panel(s) by choosing a “High” or “Normal” capacity mode in the menu setting of the Inverter/Controller.

The UPS shall provide an event log, which will allow the user to view the date, time and duration of a given event. The event log shall provide the user with an image of the utility power sine waveform from the given event. The data shall be recorded in a FIFO format, so the oldest event is purged as the newest is entered.

The UPS Inverter / Controller must include a Manual Bypass switch to allow the user to manually bypass the inverter while allowing the utility line voltage through to the cabinet.

The UPS Inverter / Controller must be equipped with two (2) 20A circuit breakers, one (1) each for the AC Input and Output.

The UPS shall be equipped with “Force On” capabilities, which provides the user the ability to turn the UPS on and supply backup power when no utility line voltage is available. This allows the user the ability to install a UPS and provide backup AC power at an intersection that has no utility line voltage available.

The UPS must have the capability to provide Ethernet and IP addressing communications with the capability for remote monitoring and programming. This capability must be provided through a desktop application.

The UPS shall be equipped with an Ethernet port. The Ethernet port shall be an RJ45, EIA 568B pin out type connector. The data rate shall be 100mbps.

The Graphical User Interface (GUI) shall be password protected and require a user ID, password and the UPS IP address to access.

The GUI shall have a status area that details the UPS status, location, available run-time in hours and minutes, AC line voltage status and real-time cabinet power consumption. The status area must be displayed on every page.

The GUI shall have a Home screen with clickable icons and tabs, which will allow the user to navigate the GUI with ease. The home screen shall allow the user to view real-time graphical charts of the cabinet power consumption and AC line voltage status. The home screen must allow the user the ability to view a live waveform from the AC utility line in the cabinet.

The GUI shall have an Event Log page to allow the user to view the time, date and duration of a given event. The GUI must provide the user the capability of viewing the waveform of the given event.

The GUI shall have a relay Configuration page to allow the user to program the relay contacts.

The GUI shall have a System Configuration page that allows the user to configure the following; UPS location, depth of discharge, AC line voltage high and low thresholds, AC switch delay, time and date, network settings (IP address, gateway address and subnet), user ID / password and SNMP settings.

**REVISION OF SECTION 614  
UNINTERRUPTED POWER SUPPLY**

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The GUI shall communicate notification and alerts through SNMP traps. Triggers that generate notifications shall be; absence of utility line voltage, battery capacity, remaining run-time and UPS heartbeat status.

Subsection 614.13 shall include the following:

UPS shall be measured by the units installed and shall include all labor, equipment, and materials necessary to install a UPS, complete-in-place. UPS shall be paid for under the pay item "Uninterrupted Power Supply".

Subsection 614.14 shall include the following:

<b>Pay Item Pay</b>	<b>Unit</b>
Uninterrupted Power Supply	Each

**END REVISION OF SECTION 614**

1 **REVISION OF SECTION 614**  
2 **INTERCONNECT WIRE**

3 Section 614 of the Standard Specifications is hereby revised for this project as follows.

4 Subsection 614.06, shall contain the following:

5 HARDWIRE/COPPER INTERCONNECT

6 Where Hardwire/Copper telemetry cable is required, telemetry cable shall be solid conductor  
7 wire, 22 gauge, with a minimum of six (6) pairs. Telemetry cable shall be rated appropriately for  
8 the type of installation.

9 Subsection 614.13 shall include the following:

10 Hardwire/copper interconnect shall be measured by the linear feet installed and shall include all  
11 labor, equipment and materials necessary to install the item complete-in-place. Hardwire/copper  
12 interconnect shall be paid for under the pay item "interconnect wire".

13 Subsection 614.14 shall include the following:

14 Payment will be made under:

15 <b>Pay Item Pay</b>	<b>Unit</b>
16 Interconnect Wire Linear	Feet

17 **END REVISION OF SECTION 614**  
18



**REVISION OF SECTION 614  
FIBER OPTIC CABLE - GENERAL**

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

Subsection 614.01 shall include the following:

This work provides for the installation of fiber optic communications cable to be installed in conduit or duct as specified in the plans. All fiber cable shall be of Non-Armored, All-Dielectric, Single Jacketed, Loose Tube Gel-Filled or Loose Tube Dry Block Construction for outside plant installation. All labor and materials required to fan-out, terminate, splice or otherwise connect fiber optic cables at individual controller cabinets, will be paid separately under the Telemetry (Field) pay item. The contractor shall be required to demonstrate successful signal system communications to the Engineer as a requirement of acceptance of this item.

Subsection 614.10 shall include the following:

All fiber-optic interconnect cable shall be furnished by the Contractor, and installed, spliced (if required and only as approved by the Engineer), terminated, connected and tested by the Contractor.

A 14 AWG locate wire shall be installed for the complete length of all new conduit runs containing fiber optic cable. Where joint trenching is used, only one locate wire need be installed for each joint trench. Cable installations with a length greater than 400' between pull boxes shall be equipped with a pull tape. The pull tape shall have a minimum tensile strength of 1250 lbs. and be of a design and manufacture that prevents cutting or burning into the conduit during cable installation.

Cable ends shall be stored in pull boxes or splice closures at locations indicated in the plans or as directed by the Engineer. Fibers to be spliced and/or connected in any manner shall be limited to those identified in the plans, and only in designated controller cabinets or splice closures. All other fibers shall be left uncut or sealed as appropriate in a manner recommended by the cable manufacturer.

Fiber optic cable shall be installed in a continuous run between all controller cabinets and splice closures as shown in the plans. Lateral cables shall be spliced only in splice closures and routed to the controllers as shown in the plans. Under no conditions shall the fiber cable be cut out or spliced at intermediate points without the express written direction of the Engineer.

Cable shall be installed in new conduit or existing conduit as specified in the plans. The Contractor shall be required to leave a minimum of 10 feet of cable slack in the equipment controller cabinet. The Contractor shall leave a minimum of 50 feet of cable slack in the pull box adjacent to the controller and shall leave a minimum of 50 feet of slack in all other communication pull boxes.

**Cable Tags and Labels**

Fiber optic cable shall be neatly coiled and clearly tagged and labeled at each communication pull box and at all locations where the fiber is exposed. Cable tags and Labels shall be as follows:

Materials: Metal or heavy plastic identification tags with cable type and number, copper pair or optic number assignments, and destination shall be provided on both ends of all cables (except station cables) and all splice cases. All cables shall be clearly labeled with cable number (County to determine) and size at each end of the cable, when it enters or leaves a conduit and at 30-foot intervals when run in accessible areas such as tunnels, manholes, ceilings, etc.

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**REVISION OF SECTION 614**  
**FIBER OPTIC CABLE - GENERAL**

Manufacturer: Tags shall be 3M, Panduit or an approved equivalent.

Controller cabinets to be connected under this project will connect directly to the appropriate controller as shown in the plans. This connection will be paid under Telemetry (Field).

*General Requirements:* The Contractor shall provide the Engineer with two copies of the cable manufacturer's cable specifications and installation instructions for fiber optic cable in conduit. All installation shall be in accordance with these practices except as otherwise directed by the Engineer.

Additional cable costs due to damage caused by the Contractor's neglect of recommended procedures shall be Contractor's responsibility. The main cable shall be installed in continuous runs except where cable type changes or where maximum pull lengths govern. The manufacturer's recommended limits for cable pull tensions shall not be exceeded. Cable ends shall be stored in controller cabinets or pull boxes immediately adjacent to cabinets or as directed by the City.

Lateral and Branch cables shall be installed using appropriate strain relief in the cabinet (through cable ties) at a minimum of three locations.

All fiber optic cables to be installed shall be checked with an OTDR before and after installation. Documentation of fiber performance shall be provided to the City within 30 days of test. All optical fibers shall be within the manufacturer's recommended tolerances. In addition, any other acceptance testing recommended by the manufacturer shall be provided. Data shall be supplied to the City prior to completion of the project.

Fiber optic cable shall be transported to site using cable reel trailers. Care shall be taken at all times to avoid scraping, denting, twisting, or otherwise damaging the cable before, during and after installation. Damaged cable shall be replaced by the Contractor without additional compensation.

Cable shall be installed in conduit or duct in the field in accordance with the contract drawings. The conduit and duct ends shall have all rough edges smoothed to prevent scraping the cable. All existing or suspected dirt and debris within the conduit shall be cleaned with compressed air before installing cable. A manufacturer recommended lubricant shall be applied to the cable to reduce friction between the cable and duct or conduit. Where fiber optic cables are to be installed in inner duct, the Contractor shall secure each section of the conduit to prevent it from being pulled without the cables.

A cable grip shall be attached to the cables so that no direct force is applied to the optical fiber. The cable grip shall have a ball-bearing swivel to prevent the cable from twisting during pulling. Cable rollers and feeders and winch cable blocks shall be used to guide the cable freely into the duct and at maintenance hole locations. Mechanical aids and pulling cable or ropes shall be used as required. The maximum pulling tension as defined by the cable manufacturer shall not be exceeded. The cable shall be taken up at intermediate pulling points with an intermediate cable take-up device as approved by the Engineer to prevent over-tension on the cable. Cable pulls shall be continuous and steady between pull points and shall not be interrupted until the entire run of cable has been pulled. Personnel equipped with two-way radios shall be stationed at each maintenance hole, cabinet, pedestal, communications box, and junction box through which the cable is to be pulled to observe and lubricate the cable. Intermediate splices between pull boxes shall not be allowed. The cable shall be securely fastened in place within pull boxes, pedestals, manholes and cabinets.

**REVISION OF SECTION 614  
FIBER OPTIC CABLE - GENERAL**

The contractor shall ensure cable length is sufficient to allow for connection between the communications equipment and the splice equipment and the splice enclosures including provision for slack, vertical runs, cable necessary for splicing, wastage and cable to allow for the removal of the splice enclosure for future splicing.

*Lateral and Branch Fiber Optic Cable:* Lateral/Branch fiber optic cable shall be installed in new or existing conduit, or along existing span wire, as depicted in the plans. Cables shall be provided with appropriate strain relief in the cabinet, consisting of cable ties in at least three interior cabinet locations. Lateral and Branch fiber optic cable shall be clearly tagged and labeled as such at pull boxes and all other locations where it is exposed. At any location where the cable is brought into or out of a span wire pole, the Contractor shall install a new weather-head to accommodate the bending radius of the cable.

Subsection 614.13 shall include the following:

Fiber Optic Cable will be measured by the linear feet for the main (backbone), lateral and branch cables, and shall include all labor and materials required to install the main, lateral, branch, and start cables through conduits to all pull boxes, cabinets and closures specified in the plans. Installation of all internal field cabinet telemetry, splicing, fan-out and termination of the cable at individual controller cabinets is paid for separately under the "Telemetry (Field)" pay item.

Subsection 614.14 shall include the following:

Payment will be made under:

<b>Pay Item Pay</b>	<b>Unit</b>
Fiber Optic Cable (Special)	Linear Feet

**END OF REVISION OF SECTION 614**

1 **REVISION OF SECTION 614**  
2 **LOOSE TUBE FIBER OPTIC CABLE**

3 Section 614 of the Standard Specifications is hereby revised for this project as follows.

4 Subsection 614.01 shall include the following:

5 When called for in the project plans or special provisions, fiber optic cable shall be installed of the  
6 fiber type, count, and configuration specified. Unless other wise directed, all fiber shall be Single  
7 Mode type and shall conform to these specifications.

8 Fiber optic cable shall comply with industry standards such as Telcordia Technologies GR-20  
9 (formerly Bellcore), Electronic Industries Association (EIA), Telecommunications Industry  
10 Association (TIA), International Telecommunications Union (ITU), International Electrotechnical  
11 Commission (IEC), and American Society for Testing and Materials (ASTM).

12 Fiber optic cable shall meet all requirements stated in this specification. The cable shall be an  
13 accepted product of the United States Department of Agriculture Rural Electrification  
14 Administration (REA) as meeting requirements of 7CFR1755.900.

15 The cable shall be new, unused, and of current design and manufacture.

16 All fiber cable shall be of Non-Armored, All-Dielectric, Single Jacketed, Loose Tube Gel-Filled or  
17 Loose Tube Dry Block Construction for outside plant installation.

18 When fiber cable installation includes cable transition into a building, and where the termination  
19 point is greater than 50' from the building's fiber cable entry point, fiber cable shall be converted to  
20 the appropriate cable type for the structure. Conversion shall be made via a fiber splice panel to  
21 minimize losses.

22 All fibers in the cable must be usable fibers and meet these specifications.

23 All optical fibers shall be sufficiently free of surface imperfections and inclusions to meet the  
24 optical, mechanical and environmental requirements of this specification.

25 Each optical fiber shall consist of a germania-doped silica core surrounded by a concentric glass  
26 cladding. The fiber shall be a matched clad design.

27 Each optical fiber shall be proof tested by the fiber manufacturer at a minimum of 100 kpsi (0.7  
28 GN/m<sup>2</sup>).

29 The fiber shall be coated with a dual layer acrylate protective coating. The protective coating shall  
30 be in physical contact with the cladding surface.

31 The attenuation specification shall be a maximum value for each cabled fiber at 23 + 5 degrees C  
32 on the original shipping reel.

33 COLOR CODE

34 The individual colors for fibers and buffer tube cable cores shall comply with EIA/TIA-598.  
35

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**REVISION OF SECTION 614  
LOOSE TUBE FIBER OPTIC CABLE**

CENTRAL STRENGTH MEMBER

The central strength member functions as an anti-buckling element, and shall be a glass/epoxy composite dielectric rod. A polyethylene overcoat may be applied to the central member to provide the proper spacing between buffer tubes during stranding.

CABLE BUFFER TUBES

Optical fibers are enclosed within buffer tubes that have a diameter several times larger than the diameter of the fibers. The optical fibers are loose within the buffer tubes allowing the fibers to move freely. The loose buffer tubes should have a 2.5 mm diameter, with a nominal wall thickness of 0.4 mm.

For composite cable design, in which both multi-mode and single mode fiber occupy the same cable, all of the Single Mode fibers will be contained in the first buffer tubes. The Multi-mode fibers will be contained in subsequent buffer tubes.

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 contain 12 fibers.

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

The buffer tubes (and filler rods, if necessary) shall be stranded in a reverse oscillation lay (ROL) technique around the central strength member to allow for easy mid-span access. The core of buffer tubes shall be wrapped with two counter helically applied threads to bind together the cable core.

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.

Tensile strength shall be provided by high tensile strength aramid yarns, fiberglass yarns, or both. Water blocking of the core outside, and around the buffer tubes, shall be accomplished via gel or dry block elements. In addition, water-blocking inside the buffer tubes shall be accomplished via gel or dry block elements.

In buffer tubes containing multiple fibers, the colors or numbers shall be stable during temperature cycling and not subject to fading or smearing onto each other or into the gel filling material. Colors shall not cause fibers to stick together.

For ease of jacket removal, one clearly identifiable polyester ripcord shall be provided directly under the cable sheath.

CABLE OUTER JACKET CHARACTERISTICS

All-Dielectric cables shall be sheathed with minimum or heavy density polyethylene. The minimal nominal jacket thickness shall be 1.4 mm.

**REVISION OF SECTION 614  
LOOSE TUBE FIBER OPTIC CABLE**

Jacketing material shall be applied directly over the tensile strength members and water block flooding compound. The polyethylene shall contain carbon black to provide ultraviolet light protection and shall not promote the growth of fungus.

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

CABLE OUTER JACKET MARKINGS

For standard outer jackets, printed characters shall be indent printed with white characters for black jackets, and black characters for non-black jackets.

The characters shall be of proper height and space to produce good legibility. Character height of 2 mm should facilitate adequate readability. An occasional illegible marking is permitted if there is a legible marking on either side.

The cable shall be sequentially marked at two feet intervals. The length intervals shall not be reset to zero on any length of the cable. The actual length of the cable shall be within -0/+1% of the length markings.

Each length of the cable shall be marked with manufacturer's name, manufacturer's part number, month and year cable was manufactured (MM-YY), telephone symbol (indicating fiber is of communications grade), fiber counts, fiber type (SM, MM, SM/MM), and manufacturer's serial number.

CABLE PACKAGING

The manufacturer shall supply the product using their standard reel sizes, methods, apparatus, and reel wood lagging.

Reels are assumed to be in good working condition, firm, and able to support the product through shipping and final installation. Reels shall be clean, dry, and free of excessive dirt. All reels shall be checked for high nails, stave fit, and proper stenciling.

Each wood reel shall be permanently marked with the manufacturer's name, "OPTICAL CABLE", an arrow with the words "CABLE END" to indicate the position of the outer cable end, an arrow with the words "ROLL THIS WAY" to indicate direction reel should be rolled to prevent loosening, and reel number.

Outer layers of the reel shall be covered with a protective wrap to limit the solar heating of the cable.

Each end of the cable shall have end seals, either end caps or KELLEMS pulling grips, in order to prevent moisture ingress into the cable during shipping, storage, or installation.

The top end of the cable shall be securely fastened to the inside of the reel flange to prevent the cable from becoming loose in transit or during handling. The bottom end, "test tail", shall be approximately three meters in length and easily accessible. The end shall be protected within a cable slot and be securely fastened to the outside of the reel flange with wire ties or walkout straps.

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LOOSE TUBE FIBER OPTIC CABLE**

Each cable shall have certified test data securely fastened to the reel in a waterproof wrapping. The certified test data shall include the following information:

- Cable Number
- Date
- Customer Name
- Ordered Length
- Customer Order Number
- Ship Length
- Customer Cable Code
- Customer Reel Number
- Customer Attenuation Specifications
- Number of Fibers
- Cable Construction
- Fiber Transmission Data
- Bandwidth Data (Multimode Fiber Only)
- Authorized Signature

Each cable shall have a reel tag securely fastened to the reel in a waterproof wrapping. The reel tag (Cut Length Data Sheet) shall include the following information:

- Cable Number
- Date
- Customer Name
- Ordered Length
- Customer Order Number
- Ship Length
- Customer Cable Code
- Customer Reel Number
- Customer Attenuation Specifications
- Number of Fibers
- Beginning and Ending Sequential Length Markings
- Gross Weight
- Net Weight
- Inspected By Signature

SINGLE MODE FIBER SPECIFICATIONS

The dispersion un-shifted Single Mode fiber utilized in the cable specified herein shall conform to the following specifications:

- a. Typical Core Diameter: 8.3 micrometer;
- b. Cladding Diameter: 125.0 + 1.0 micrometer;
- c. Core-to-Cladding Offset: < 0.6 micrometer;
- d. Cladding Non-Circularity: < 1.0 %, defined as  $[|(\text{minimum Cladding diameter} / \text{maximum Cladding diameter}) - 1|] \times 100$
- e. Coating diameter: 245 + 10 micrometer;
- f. Colored Fiber Diameter: nominal 250 micrometer;
- g. Attenuation Uniformity: No point discontinuity > 0.10 dB at either 1310 nm or 1550 nm;

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LOOSE TUBE FIBER OPTIC CABLE**

- h. Attenuation at the Water Peak: The attenuation at 1383 + 3 nm shall not exceed 2.1 dB/km;
- i. Cutoff Wavelength: The cabled fiber cutoff wavelength shall be < 1260 nm;
- j. Mode-field Diameter (Petermann II): 9.30 + 0.50 nm at 1310 nm;
- k. Mode-field Diameter (Petermann II): 10.50 + 1.00 micrometer at 1550 nm;
- l. Zero Dispersion Wavelength (ZDW): 1301.5 nm < 1321.5 nm;
- m. Zero Dispersion Slope (ZDS):  $ZDS < 0.092 \text{ ps} / (\text{km} \times \text{nm}^2)$ ;
- n. Fiber Polarization Mode Dispersion (PMD):  $0.5 \text{ ps} / \sqrt{\text{km}}$ ;
- o. Fiber Curl: > 4.0 m radius of curvature;
- p. Maximum Tensile Loads: Short-Term 2700 N (600 lbs);
- q. Maximum Tensile Loads: Long-Term 890 N (200 lbs);
- r. Shipping, Storage, and Operating Temperature Range of the Cable: -40 Degrees C to +70 Degrees C.

MULTI-MODE FIBER SPECIFICATIONS

- a. Typical Core Diameter: 62.5 + 3 micrometer;
- b. Core Non-Circularity: < 5%
- c. Cladding Diameter: 125.0 + 2.0 micrometer;
- d. Core-to-Cladding Concentricity: < 3.0 micrometer;
- e. Cladding Non-Circularity: < 2%, defined as  $[|(\text{minimum Cladding diameter} / \text{maximum Cladding diameter}) - 1|] \times 100$
- f. Coating diameter: 245 + 5 micrometer;
- g. Cable Fiber Attenuation: < 3.5 dB/km at 850 nm;
- h. Cable Fiber Attenuation: < 1.0 dB/km at 1300 nm;
- i. Point Discontinuity: < 0.2 dB at either 850 nm or 1300 nm;
- j. IEEE 802.3 GbE Distance: up to 500 m at 850 nm; up to 1000 m at 1300 nm;
- k. Maximum Tensile Loads: Short-Term 2700 N (600 lbs);
- l. Maximum Tensile Loads: Long-Term 890 N (200 lbs);
- m. Shipping, Storage, and Operating Temperature Range of the Cable: -40 Degrees C to +70 Degrees C.

GENERAL CABLE PERFORMANCE SPECIFICATIONS

The un-aged cable shall withstand water penetration when tested with a one meter static head or equivalent continuous pressure applied at one end of a one meter length of filled cable for 24 hours. No water shall *leak* through the open cable end. When a one meter static head or equivalent continuous pressure is applied at one end of a one meter length of aged cable for one hour, no water shall leak through the open cable end. Testing shall be done in accordance with FOTP-82, "Fluid Penetration Test for Filled Fiber Optic Cable".

When tested in accordance with FOTP-81, "Compound Flow (Drip) Test for Filled Fiber Optic Cable", Method A, the cable shall exhibit no flow (drip or leak) of filling or flooding compound at 80oC. If material flow is detected, the weight of any compound that drips from the sample shall be less than 0.05 grams (0.002 ounce).

The cable shall withstand a minimum compressive load of 220 N/cm (125 lbf/in) for non-armored cables applied uniformly over the length of the compression plate. The cable shall be tested in accordance with FOTP-41 "Compressive Loading Resistance of Fiber Optic Cables", except that the load shall be applied at the rate of 3 mm to 20 mm per minute and maintained for 10 minutes. The magnitude of the attenuation change shall be within the repeatability of the measurement system for 90% of the test fibers.



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The remaining 10% of the fibers shall not experience an attenuation change greater than 0.1 dB at 1550 nm (single-mode). The average increase in attenuation for the fibers shall be < 0.02 dB at 1300 nm (multimode). The repeatability of the measurement system is typically + 0.05 dB or less. No fibers shall exhibit a measurable change in attenuation after load removal.

When tested in accordance with FOTP-104, "Fiber Optic Cable Cyclic Flexing Test", the cable shall withstand 25 mechanical flexing cycles at a rate of 30 + 1 cycles per minute, with a sheave diameter not greater than 20 times the cable diameter. The magnitude of the attenuation change shall be within the repeatability of the measurement system for 90% of the test fibers. The remaining 10% of the fibers shall not experience an attenuation change greater than 0.1 dB at 1550 nm (single-mode). The repeatability of the measurement system is typically + 0.05 dB or less. The cable jacket shall exhibit no cracking or splitting when observed under 5X magnification.

When tested in accordance with FOTP-25, "Repeated Impact Testing of Fiber Optic Cables and Cable Assemblies", the cable shall withstand 25 impact cycles. The magnitude of the attenuation change shall be within the repeatability of the measurement system for 90% of the test fibers. The remaining 10% of the fibers shall not experience an attenuation change greater than 0.1 dB at 1550 nm (single-mode). The repeatability of the measurement system is typically + 0.05 dB or less. The average increase in attenuation for fibers shall be < 0.04 dB at 1300 nm (multimode). The cable jacket shall not exhibit evidence of cracking or splitting at the completion of the test. When tested in accordance with FOTP-33, "Fiber Optic Cable Tensile Loading and Bending Test", using maximum mandrel and sheave diameter of 560 mm, the cable shall withstand a tensile load of 2700 N (608 lbf) applied for one hour (using "Test Condition II" of the procedure). In addition, the cable sample, while subjected to a minimum load of 2660 N (600 lbf), shall be

able to withstand a twist of 360 degrees in a length of less than 3 meters. The magnitude of the attenuation change shall be within the repeatability of the measurement system of 90% of the test fibers. The remaining 10% of the fibers shall not experience an attenuation change greater than 0.1 dB at 1550 nm. The repeatability of the measurement system is typically + 0.05 dB or less. The average increase in attenuation for fibers shall be < 0.40 dB at 1300 nm (multimode). The cable shall not experience a measurable increase in attenuation when subjected to the rated residual tensile load, 890 N (200 lbf).

When tested in accordance with FOTP-85, "Fiber Optic Cable Twist Test", a length of cable no greater than 2 meters will withstand 10 cycles of mechanical twisting. The magnitude of the attenuation change will be within the repeatability of the measurement system for 90% of the test fibers. The remaining 10% of the fibers will not experience an attenuation change greater than 0.1 dB at 1550 nm. The repeatability of the measurement system is typically + 0.05 dB or less. The average increase in attenuation for fibers shall be < 0.40 dB at 1300 nm (multimode). The cable jacket will exhibit no cracking or splitting when observed under 5X magnification after completion of the test.

When tested in accordance with the proposed FOP-181, "Lighting Damage Susceptibility Test for Fiber Optic Cables with Metallic Components", the cable shall withstand a simulated lighting strike with a peak value of the current pulse > 105 kA. The test current used shall be damped oscillatory with a maximum time-to-peak value of 15 microseconds (which corresponds to a minimum frequency of 16.7 kHz) and a maximum frequency of 30 kHz. The time of half-value of the waveform envelope (t<sub>2</sub>) shall be from 40 - 70 microseconds. In addition to the analysis criterion set forth in FOTP-181, the integrity of the buffer tubes (or analogous loose tube, i.e., core tube) and strength members must be intact after removal of the cable specimens from the test box.

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**REVISION OF SECTION 614  
LOOSE TUBE FIBER OPTIC CABLE**

QUALITY ASSURANCE PROVISIONS

All optical fibers shall be proof tested by the fiber manufacturer at a minimum load of 100 ksi.

All optical fibers shall be 100% attenuation tested. The attenuation of each fiber shall be provided with each cable reel.

Subsection 614.13 shall include the following:

All performance and material requirements outlined herein for loose tube fiber optic cable shall be paid for under the "Fiber Optic Cable (Special)" pay item.

**END REVISION OF SECTION 614**

1 **REVISION OF SECTION 614**  
2 **TEST FIBER OPTIC CABLE**

3 Section 614 of the Standard Specifications is hereby revised for this project as follows.

4 Subsection 614.06, shall contain the following:

5 REQUIREMENTS

6 When fiber optic cable is installed, the fiber optic cable test shall consist of the testing for both  
7 multi-mode and single mode fiber optic cable as installed. The testing procedures involve an  
8 OTDR test and an Optical Power Meter Test.

9 The standards for fiber optic cable testing include:

10 Test jumpers and patch cords must be of the same fiber core size and connector type as the  
11 cable system:

- 12 a. Multi-mode fiber 62.5/125  $\mu$ m  
13 b. Single Mode fiber 8.3/125  $\mu$ m  
14

15 The light source and OTDR must operate within the range of 850+30 nm or 1300+20 nm for  
16 multi-mode testing in accordance with ANSI/EIA/TIA-526-14.

17 The light source and OTDR must operate with the range of 1310+10 nm or 1550+20 nm for single  
18 mode testing in accordance with ANSI/EIA/TIA-526-7.

19 The power meter and the light source must be set to the same wavelength during testing. The  
20 power meter must be calibrated and traceable to the National Institute of Standards and  
21 Technology (NIST).

22 All system connectors, adapters and jumpers must be cleaned as per manufacturer's instructions  
23 before measurements are taken.

24 MATERIALS

25 The following fiber optic test equipment is required to perform fiber optic cable tests:

- 26 a. An OTDR;  
27 b. A test reel, of at least 900 feet;  
28 c. A light source at the appropriate wavelength;  
29 d. Optical Power Measurement Equipment;  
30 e. Test Jumpers as specified  
31

Multi-mode Fiber Test Jumpers

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

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

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**REVISION OF SECTION 614  
TEST FIBER OPTIC CABLE**

Single Mode Fiber Test Jumpers

- a. 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.

FIBER TESTING WITH OTDR

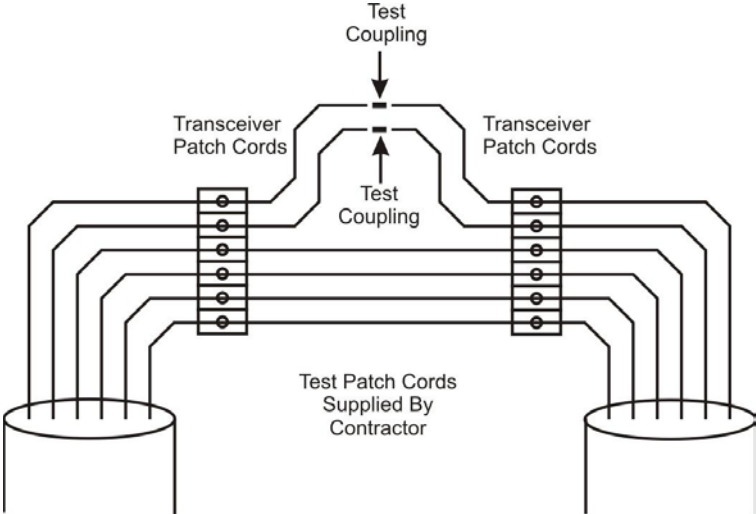
The Contractor shall perform an OTDR test of all fibers in all tubes on the reel, prior to installation of the fiber. The test results shall be supplied to the Engineer prior to installation of the cable.

If the fiber is specified as "Install Only", the Contractor shall test the fiber on the reel and provide the test results to the Engineer prior to accepting the cable. After installation, if there are unused portions of cable remaining on the reel, the Engineer may request the Contractor or other qualified technician to perform a reel test. The Contractor shall provide the Engineer the test results prior to delivering the cable to the Engineer. Any cable damaged while in the Contractor's possession shall be replaced at the Contractor's expense.

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 nm and 1300 nm for multi-mode fibers and 1310 nm and 1550 nm for single mode fibers.

Segmented end-to-end testing shall not be less than 1 kilometer (1 mile). Patches for testing shall not exceed five (5).

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:

- a. Names of personnel conducting the test.
- b. Type of test equipment used (manufacturer, model, serial number, calibration date).
- c. Date test is being performed.
- d. Optical source wavelength and spectral width.
- e. Fiber identification.
- f. Start and end point locations.
- g. Launch conditions
- h. Method of calculation for the attenuation or attenuation coefficient.
- i. Acceptable link attenuation.

**FIBER TESTING WITH OPTICAL POWER METER**

The Contractor shall conduct an Optical Power Meter Test for each fiber installed.

Multi-mode segments shall be tested in one direction at both the 850 nm and the 1300 nm wavelengths.

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

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:

- a. Names of personnel conducting the test.
- b. Type of test equipment used (manufacturer, model, serial number, calibration date).
- c. Date test is being performed.
- d. Optical source wavelength, spectral width, and for multimode, the coupled power ratio (CPR).
- e. Fiber identification.

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TEST FIBER OPTIC CABLE**

- f. Start and end point locations.
- g. Test direction.
- h. Reference power measurement (when not using a power meter with a Relative Power Measurement Mode).
- i. Measured attenuation of the link segment.
- j. 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.

ACCEPTABLE ATTENUATION VALUES

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

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

Multi-mode Fiber - The general attenuation equation for any multi-mode link is as follows:

- a. Acceptable Link Attenuation = Cable Attenuation + Connection Attenuation + Splice Attenuation + CPR Adjustment
- b. 62.5 nm multimode attenuation coefficients:
  - i. Cable Attenuation = Cable Length (km) x (0.34 dB/km@850 nm or 1.00 dB/km@1300 nm)
  - ii. Connection Attenuation (ST or SC connectors) = (# of Connections x 0.39 dB) + 0.42 dB
  - iii. Connection Attenuation (LC connectors) = (# of Connections x 0.14 dB) + 0.24 dB
  - iv. Splice Attenuation (Mechanical or Fusion) = Splices x 0.30 dB
  - v. CPR Adjustment = See table below.

MM 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 SC Connections	+0.25	0.00	-0.10	-0.20	-0.30

- c. The Coupled Power Ratio (CPR) of a light source is a measure of the modal power distribution launched into a multi-mode fiber. A light source that launches a higher percentage of its power into the higher order modes of a multi-mode 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.

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TEST FIBER OPTIC CABLE**

Single Mode Fiber - The general attenuation equation for any single mode link segment is as follows:

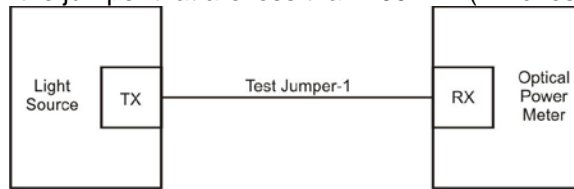
- a. Acceptable Link Attenuation = Cable Attenuation + Connection Attenuation + Splice Attenuation
- b. 8.3 nm single mode attenuation coefficients:
  - i. Cable Attenuation = Cable Length (km) x (0.34 dB/km@1310 nm or 0.25 dB/km@1550 nm)
  - ii. Connection Attenuation (ST or SC connectors) = (# of Connections x 0.39 dB). No more than 0.75 dB per connector.
  - iii. Splice Attenuation (Mechanical or Fusion) = Splices x 0.10 dB

TEST PROCEDURES

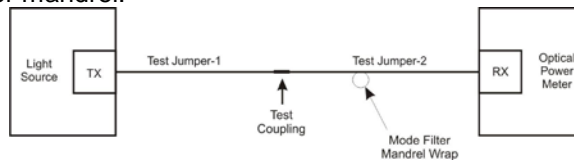
All fiber testing shall be performed on all fibers in the completed end-to-end system.

Multi-mode Fiber - The multi-mode fiber cable test shall be conducted as follows:

- a. Clean the test jumper connectors and the test coupling per manufacturer's instructions.
- b. Follow the test equipment manufacturer's initial adjustment instructions.
- c. 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.



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



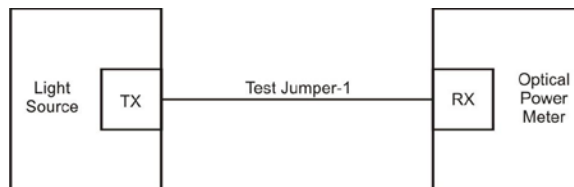
- g. Record the Power Measurement (P sum). If the power meter is in Relative Power Measurement Mode, the meter reading represents the CPR value. If the meter does not have a Relative Power Measurement Mode, perform the following calculation:
  - i. If P sum and P ref are in the same logarithmic units:  $CPR (dB) = P_{sum} - P_{ref}$
  - ii. If P sum and P ref are in watts:  $CPR (dB) = 10 \times \log_{10} [P_{sum}/P_{ref}]$

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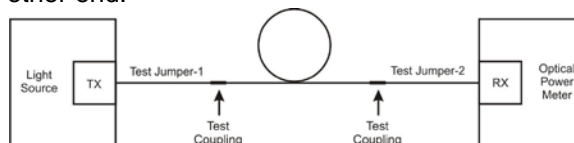
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**REVISION OF SECTION 614  
TEST FIBER OPTIC CABLE**

Single Mode Fiber - The single mode fiber cable test shall be conducted as follows:

- a. Clean the test jumper connectors and the test coupling per manufacturer's instructions.
- b. Follow the test equipment manufacturer's initial adjustment instructions.
- c. 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.



- d. 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.
- e. Disconnect Test Jumper-1 from the power meter. Do NOT disconnect the test jumper from the light source.
- f. 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:  $CPR (dB) = P_{sum} - P_{ref}$
- If P sum and P ref are in watts:  $CPR (dB) = 10 \times \log_{10} [P_{sum}/P_{ref}]$

**TEST ACCEPTANCE**

The Contractor shall demonstrate and provide written certification 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.

**SUBMITTALS**

The Contractor shall submit test results documentation as both a hard copy and electronic copy. After each reel test, the Contractor shall submit one hard copy of the OTDR trace for every fiber on the reel.

After installation, the Contractor shall submit one hard copy of the OTDR trace for every spliced fiber.



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**REVISION OF SECTION 614  
TEST FIBER OPTIC CABLE**

Hard copy traces shall be organized and bound in logical order in an 8 1/2" x 11" hard cover binder in addition to other documentation listed in the project Special Provisions package.

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

Subsection 614.13 shall include the following:

Fiber optic cable testing shall include all labor equipment, and materials necessary to complete end-to-end, bidirectional testing of all fiber installed as part of the project, complete-in-place.

Subsection 614.14 shall include the following:

No separate measurement or payment will be made for fiber optic cable testing. All cable (system) testing shall be considered incidental to the Fiber Optic Cable (Special) pay item.

**END REVISION OF SECTION 614**

1 **REVISION OF SECTION 614**  
2 **TELEMETRY (FIELD)**

3 Section 614 of the Standard Specifications is hereby revised for this project as follows.

4 Subsection 614.01 shall include the following:

5 This work consists of fan-out and termination of fiber optic (interconnect) cable at each controller  
6 cabinet location identified in the plans. It is also to include installation and connection of all  
7 necessary telemetry equipment including: ethernet switches, fiber optic transceivers, computer  
8 stations, patch panels, splice organizers, interface panels, optical splice closures, serial cables  
9 and pigtails. The Contractor shall be responsible for properly making all fiber optic cable  
10 connections to each modem within each controller cabinet, and as described in the plans.

11 **ETHERNET MANAGED SWITCH**

12 An Ethernet Managed Switch shall only be used where specified in the plans and project special  
13 provisions, and may be considered by the Engineer on a per project basis. When specified in the  
14 project plans and project specials, the Ethernet Managed Switch shall be of the manufacturer and  
15 model number specified.

16 An Ethernet Managed Switch shall include all labor, equipment, and materials necessary to install  
17 the item complete-in-place, including, but not limited to, power supplies, Ethernet cables, serial  
18 cables, and fiber patch cords.

19 Unless otherwise specified, the Contractor shall be responsible for proper programming, setup,  
20 and testing of the Ethernet Managed Switch. At the County's discretion, the County may opt to  
21 have their Maintenance Contractor or other third party complete Ethernet Managed Switch, setup,  
22 and/or testing. When the County's Maintenance Contractor or other third party is enlisted for  
23 programming, setup, and/or testing of the Ethernet Managed Switch, associated costs for the  
24 Maintenance Contractor or third party labor shall be the responsibility of the County.

25 **FIBER OPTIC TRANSCEIVERS**

26 Fiber Optic Transceivers shall only be used where specified in the plans and project specials, and  
27 may be considered by the Engineer on a per project basis. When specified in the project plans  
28 and project specials, Fiber Optic Transceivers shall be of the manufacturer and model number  
29 specified.

30 Fiber Optic Transceivers shall include all labor, equipment, and materials necessary to install the  
31 item complete-in-place, including, but not limited to, fiber optic transceiver card racks, power  
32 supplies, serial cables, and fiber patch cords.

33 Unless otherwise specified, the Contractor shall be responsible for proper programming, setup,  
34 and testing of the Fiber Optic Transceivers. At the County's discretion, the County may opt to  
35 have their Maintenance Contractor or other third party complete Fiber Optic Transceivers  
36 programming, setup, and/or testing. When the County's Maintenance Contractor or other third  
37 party is enlisted for programming, setup, and/or testing of the Fiber Optic Transceivers,  
38 associated costs for the Maintenance Contractor or third party labor shall be the responsibility of  
39 County.

40 **OPTICAL SPLICES AND OPTICAL SPLICE CLOSURES**

41 Splices are not allowed without the authorization of the Engineer. If splices are authorized or  
42 specified on the plans, each such splice shall occur in a pull box of adequate size to house the  
43 splice closure and fiber optic cable slack without exceeding the fiber cable minimum bend radius.  
44 All splices shall be enclosed in a splice closure. Following successful splicing, said splice  
45 enclosure and fiber optic cable slack shall be placed inside the pull box.

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

When fiber splicing is specified in the plans, splicing diagrams shall be provided by the County. Splicing diagrams shall define fiber cables to be spliced in part or whole and shall provide buffer tube designation, fiber designation, and routing information of each fiber to be spliced.

The Contractor shall accomplish the fiber splicing work using industry standard splicing tools and hardware.

Splice closures shall be used for splicing lateral fiber optic cable runs to the main fiber optic cable (backbone) at pull box locations that are identified in the plans. All closures shall include a 1-inch future port kit. The size of the splice closure at specific locations shall be governed by the number of cables and splices required.

**BUFFER TUBE FAN-OUT**

Fiber fan-outs shall be completed as defined in the plans and/or special provisions. Only those buffer tubes defined shall be fanned out. When additional buffer tubes are present, but are not to be fanned out, a termination panel shall be required. Buffer tubes which have not been fanned out shall be loosely coiled and secured within a termination panel.

Fiber fan-outs shall only be completed within a building or NEMA 4 rated cabinet and shall be of the count and type as defined in the plans and/or special provisions.

Industry standard fan-out kit tools and tool kit consumables shall be used.

During installation, and at no time, shall the fiber fan-out, in part or whole, be reduced to a length shorter than 36 inches. Fiber fan-outs shorter than 36 inches shall be replaced by the Contractor. Fees associated with replacement of fiber fan-outs which were installed by the Contractor, but which do not meet specifications, including terminations and testing, shall be borne by the Contractor and shall not be chargeable to the County.

**TERMINATIONS**

Only those fibers defined shall be terminated. All other fibers shall remain uncut.

Connectors shall be "ST" type unless otherwise specified. The connectors shall have a ceramic ferrule with nickel-plated nut and body. The connectors shall be compatible with a physical contact (PC) finish.

All connectors shall be polished to a PC finish such that the return loss per mated pair of connectors is less than -25 dB.

The return loss when the connector is mated with a previously installed connector shall be less than - 18 dB.

The connector's insertion loss shall not be greater than 0.20 dB (typical). The connector's loss shall not vary more than 0.20 dB after 1000 repeated matings. Tensile strength shall withstand an axial load of 20 lbs with less than 0.20 dB change.

Index matching fluids or gels shall not be used. The connectors shall be compatible with the optical fiber surrounding jacket and shall be installed on one end of the optical fiber in accordance with the manufacturer's recommended materials, equipment, and practices. The connectors shall be suitable for the intended environment and shall meet, or exceed, the following environmental conditions.

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

- Operating Temperature: -40 degrees C to +80 degrees C
- Storage Temperature: -40 degrees C to +85 degrees C

The connector loss shall not vary more than 0.20 dB over the operating temperature range. Connectors shall be protected by a suitably installed waterproof protective cap.

Subsection 614.13 shall include the following:

Telemetry (Field) shall be measured by the total number of terminals (i.e. cabinets and/or computer stations) at which the interconnect cable is fanned out, terminated, connected, patch panels and fiber-optic interfaces installed. All labor and materials required to perform panel installations, provide in-cabinet strain relief, fan-out, cable termination and connection to the controller is considered included in the unit price for this item. This item, therefore, includes the following:

1. All required in-cabinet cable ties and strain relief (including ancillary hardware and labor to complete);
2. All required fan-out kits, kit tools, ancillary hardware and labor to accomplish the fan-out at the cabinet;
3. All required pigtails and harness cables;
4. All required interconnect transceivers and switches, and fiber optic interface panels in individual controller cabinets as shown in the plans;
  - a. All required termination enclosures (including specified features), connectors, adapters, jumpers, pigtails, patch cord cables, ancillary hardware and labor required to accomplish the cabinet termination;
  - b. All required optical splice closures;
  - c. All other labor and material necessary to complete the item.

All labor, materials and testing necessary to complete this item to the satisfaction of the engineer shall be considered included in the unit price and will not be paid separately.

Subsection 614.14 shall include the following:

Payment will be made under:

<b>Pay Item Pay</b>	<b>Unit</b>
Telemetry (Field)	Each

**END REVISION OF SECTION 614**

1 **REVISION OF SECTION 614**  
2 **SPREAD SPECTRUM RADIO**

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

4 Subsection 614.08 shall include the following:

5 **Radio Communication – General Requirements**

6 Where specified in the plans, radio communications shall be included on the project. The radio  
7 communication system shall be compatible with the existing Adams County spread spectrum  
8 radio system. Communication hardware and software shall be compatible with the Adams County  
9 traffic signal system software (Econolite Centracs).

10 A radio frequency analysis (wireless survey), network model, and communication link study report  
11 shall be included as part of the wireless communication solution programming software. At a  
12 minimum, the radio frequency analysis shall address the following: anticipated Effective Isotropic  
13 Radiated Power (EIRP) of the proposed antenna, expected environmental effects on the wireless  
14 link, existence of path obstacles (fixed or seasonal), probable fade margin, and predicted Fresnel  
15 zone size and potential blockage. Technical manuals shall be supplied with the radio system and  
16 shall become the property of the County at the completion of the project.

17 The radio communication system shall include all labor, equipment, and materials necessary to  
18 install the item complete-in-place, including, but not limited to, antenna(s), coax cable(s), surge  
19 suppression unit(s), power supply, serial cable(s), and/or Ethernet cable(s).

20 All radios must meet FCC part 15 rules/regulations.

21 Radios shall support the IEEE 802.11a (Orthogonal Frequency Division Multiplexing) protocol.

22 Radios shall be available as an Integrated Panel Antenna, Access Point Cluster (3 and 4 radio  
23 modules), Dual (2 radio modules) or Stand-Alone Enclosure (1 or 2 radio modules).

24 Radios must be configurable as an Access Point, Remote Station, Repeater or Mesh Node.

25 Integrated and stand-alone radios must consume less than 8 watts of power per unit.

26 Radios must be configurable using network monitoring software. Software must include a  
27 complete toolset to assist in advanced network monitoring and radio configuration. Radio  
28 software must be capable of monitoring real time bi-directional data. The software must utilize  
29 drag and drop radio programming for managing radio and wireless network information.

30 Radios must include Adaptive Modulation; Dynamic Frequency Selection must be user selectable  
31 and when enabled must continually adapt to avoid interference; and Manual Transmit Power  
32 Control – RF link must adjust the data rate to optimize the maximum link performance.

33 Radios shall meet IP67 and exceed NEMA environmental specifications with performance testing  
34 over operating temperatures of -40° to +85 C.

35 Radios will be powered by an IEEE 802.3 af/at Power-over-Ethernet (PoE) Injector with surge  
36 protection or a certified IEEE 802.3 af/at PoE Switch. This will include 160ft of outdoor-rated  
37 Ethernet cable. Suppliers and product manufacturing must be located in the United States of  
38 America.

39 **Radio Communication – Functional Requirements**

- 40
- Operating Frequency: 5.150 – 5.825 GHz
  - RF Data Rate:
- 41

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**REVISION OF SECTION 614  
SPREAD SPECTRUM RADIO**

- Up to 300 Mbps (per radio module) for 802.11n (2X2 MIMO) units
- Up to 108 Mbps (per radio module) for 802.11a units. Receiver Sensitivity: -94 to -74 dBm
- Radio Output Power:
  - Up to 27dBm – 500mW for 802.11n units
  - Up to 28dBm – 600mW for 802.11a units
- Channel Width:
  - 5, 10, 20, 20/40MHz Above and Below for 802.11n units
  - 5, 10, 20, 40MHz for 802.11a units Typical Range: Range at 54Mbps – up to 20 miles – Line Of Sight (LOS)
- Power-over-Ethernet (PoE) Injector: Surge Protection included in the injector
- Antenna Type:
  - Type N(F) – stand-alone solution
  - 23dBi – integrated panel solution
  - 19-21dBi – adjustable beam width sector antenna solution
- Network Operating Modes:
  - Point to Point
  - Point to Multipoint
  - Mesh

23 The radio communication system shall support the following IEEE Networking Features:

- 802.11e (WMM & QoS)
- 802.11h (DFS & TPC)
- 802.1d (Ethernet Bridging)
- 802.1p (Traffic Prioritization)
- 802.1q (VLAN)
- 802.1s (Multiple Spanning Tree Protocol (MSTP))
- 802.1w (Rapid Spanning Tree)
- 802.3ab (Gigabit Ethernet – AP Cluster Radios)
- 802.3ac (802.1q & 802p support)
- 802.3ad (Link Aggregation)
- 802.3i (10Mbps Ethernet)
- 802.3u (100Mbps Ethernet & Auto-Negotiation)
- 802.3x (Full Duplex and Flow Control)
- 802.3z (1Gb Ethernet & Auto Negotiation)

38 The radio communication system shall comply with FCC Part 15.

39 **Radio Communication – Software Requirements**

- Software must utilize drag and drop programming
- Software must monitor and display real-time, bi-directional data on map
- Software must have a Configurable network topology view
- Software must evaluate the overall network health
- Software must maintain a minimum 72 hour event log for network errors
- Software must allow for role-based security
- Software display must include network health on map by RSSI, signal to noise ratio, CCQ (transmit and receive), throughput (transmit and receive), and ping latency
- Software must be capable of producing separate data and wireless statistics graphing (in real-time and bi-directional)

**REVISION OF SECTION 614  
SPREAD SPECTRUM RADIO**

- Software must be able to generate configuration reports on an individual unit, or the entire wireless network
- Software must be able to generate broken links reports
- Software must be capable of network and individual unit wireless statistics reporting
- Software must allow for alarm email notification
- Software must generate alarm monitoring by RSSI, signal to noise ratio, CCQ (transmit and receive), throughput (transmit and receive), and ping latency

**Radio Communication – Testing & Integration**

Unless otherwise specified, the Contractor shall be responsible for proper programming, setup, and testing of the radio communication system. At the County’s discretion, the County may opt to have their Maintenance Contractor or other third party complete the radio communication system programming, setup, and/or testing. When the County’s Maintenance Contractor or other third party is enlisted for programming, setup, and/or testing of the radio communication system, associated costs for the Maintenance Contractor or third party labor shall be the responsibility of the County.

Subsection 614.13 shall include the following:

The radio communication system shall be measured by the number of intersections or relay points the system is installed. The radio communication system shall include all labor, equipment, and materials necessary to install the item complete-in-place and the on-site wireless survey and resulting documentation. The radio communication system shall be paid for under the pay item “Spread Spectrum Radio”.

Subsection 614.14 shall include the following:

Payment will be made under:

<b>Pay Item Pay</b>	<b>Unit</b>
Spread Spectrum Radio	Each

**END REVISION OF SECTION 614**

1 **REVISION OF SECTION 625**  
2 **CONSTRUCTION SURVEYING**

3 Section 625 of the Standard Specifications is hereby revised as follows:

4 Subsection 625.11 shall hereby include the following:

5 The Contractor shall submit construction surveying in the form of "as-built" drawings showing in  
6 detail all construction changes, including, but not limited to wiring, cable, and location and depth  
7 of conduit, and all other installations and equipment that varies from the plans. As-built plans shall  
8 be both electronic CAD revisions of the construction plans, and neatly and clearly drafted onto the  
9 plans in ink. As-Builts shall be submitted at the end of the project and shall be required prior to  
10 final acceptance by the County.

11 Subsection 625.12 and 625.13 shall hereby be replaced with the following:

12 Construction surveying shall not be paid for separately, but shall be included in the cost of the  
13 work performed.

14 **END REVISION OF SECTION 625**



1 **REVISION OF SECTION 630 -**  
2 **CONSTRUCTION ZONE TRAFFIC CONTROL**

3 Section 630 of the Standard Specifications is hereby revised as follows:

4 Subsection 630.02 through 630.08 shall include the following:

5 Traffic control through the construction area is the responsibility of the Contractor. Before starting  
6 construction the Contractor shall submit, in writing, the proposed Method of Handling Traffic  
7 (MHT) for the initial phase of construction. When a different MHT is required for a subsequent  
8 construction phase, it must be submitted two weeks prior to starting that phase. All proposed  
9 MHTs shall be approved, in writing, by the Engineer. No phase of construction shall start until an  
10 acceptable MHT has been received and approved by the Engineer. The proposed methods shall  
11 include, as a minimum, the following:

12 A detailed diagram that shows the location of all sign placements, including advance construction  
13 signs (if not previously approved) and speed limit signs; method, length and time duration for lane  
14 closures; and location of flag persons.

15 A tabulation of all traffic control devices shown in the detailed diagram including, but not limited  
16 to:

- 17 • construction signs,
- 18 • vertical panel;
- 19 • vertical panel with light;
- 20 • Type 1 and Type 2 barricades;
- 21 • cones,
- 22 • drum channelizing devices;
- 23 • concrete barrier (temporary);
- 24 • advance warning flashing or sequencing arrow panel.
- 25 • Certain traffic control devices may be used for more than one operation or phase.

26  
27 However, all devices required for any particular phase must be detailed and tabulated for each  
28 phase. Certain traffic control devices may be used for more than one phase of construction.

- 29 • Number of flag-persons to be used.
- 30 • Number of days a Traffic Control Supervisor is to be required.
- 31 • Number of hours for uniformed traffic control.

32  
33 Subsection 630.09 shall include the following:

34 Traffic Control. All proposed MHT's shall be approved, in writing, by the Engineer. No phase of  
35 construction shall start until an acceptable MHT has been received and approved by the  
36 Engineer.

37 Approval of the proposed MHT is intended to indicate those devices for which payment is to be  
38 made. Such approval does not relieve the Contractor of liability specifically assigned to him  
39 under the contract. The Contractor shall erect and maintain warning lights, signs, barricades, and  
40 sufficient safeguards around all excavations, embankments, and obstructions.

41 Subsection 630.15 shall be revised to include the following:

42 *When the contract includes Traffic Control paid for as a Lump Sum:*

43 Traffic Control devices will not be measured but will be paid for on a lump sum basis.

44 *When the contract does not include pay items for Traffic Control:*

45 Payment for all Traffic Control shall be included in the work.

46 **END OF REVISION OF SECTION 630**

1 **TRAFFIC CONTROL PLAN – GENERAL**

2 The key requirements of the Contractor's method of handling traffic (MHT) are outlined in Subsection  
3 630.09.

4 The components of the TCP for this project are included in the following:

- 5 • Subsection 104.04 and Section 630 of the CDOT *Standard Specifications for Road and*  
6 *Bridge Construction*
- 7 • Current edition of the Colorado Department of Transportation, Standard Plans, Traffic  
8 Controls for Highway Construction, S-630-1, Sheets 1 through 12 as applicable.
- 9 • Manual on Uniform Traffic Control Devices (MUTCD).

10 Traffic Control shall be provided as required by, in descending order of precedence, MUTCD, the  
11 plans and special provisions for this project, Colorado Department of Transportation Standard  
12 Specifications, and Colorado Department of Transportation M and/or S Standards.

13 Special Traffic Control Plan requirements for this project are as follows:

14 Steel drum channelizing devices shall not be used for traffic control.

15 During the construction of this project, traffic shall use the present traveled roadway at all times in  
16 each direction unless otherwise directed by the Engineer.

17 The Contractor shall not have construction equipment or materials in the lanes open to traffic any  
18 time, unless approved by the Engineer.

19 All personal / employee vehicle and construction equipment parking is prohibited when it conflicts  
20 with safety, access, or the flow of traffic.

21 The Contractor will be required to maintain access to all properties throughout the period of  
22 construction for this project. The Contractor shall be required to erect, maintain, and remove all  
23 barricades, traffic control signs and devices necessary for any street closure including detour  
24 signs. Any signs not in use shall be covered and turned away from traffic or removed from the  
25 job site. All traffic control devices shall be in good condition. Signs shall be clean, retro reflective,  
26 and free of scratches and graffiti. The contractor shall also notify local police and fire departments  
27 of work activity impacting traffic.

28 The Contractor shall install construction traffic control devices in locations where they do not  
29 block or impede other existing traffic control devices, or sidewalks for pedestrians, disabled  
30 persons, or bicyclists. When excavations remain open overnight as approved by the Engineer,  
31 they shall be properly marked to warn motorists and/or pedestrians. The excavation shall be  
32 properly barricaded for vehicles and/or pedestrians.

33 Excavations in streets or highways shall be performed in such a manner that, at a minimum, one  
34 (1) lane of traffic in each direction shall be open to public traffic during the approved work hours.  
35 Any street closure must be pre-approved by the Engineer. All such barricades and traffic control  
36 signs and devices shall be in accordance with the latest edition of the "Manual on Uniform Traffic  
37 Control Devices for Streets and Highways" including the "Colorado Supplement". The Contractor  
38 shall prepare and submit traffic control plans to the Engineer for review no later than forty-eight  
39 (48) hours in advance of any work.

40 When excavations remain open overnight as approved by the Engineer, they shall be properly  
41 marked to warn motorists and/or pedestrians. The excavation shall be properly barricaded for  
42 vehicles and/or pedestrians.

43

**TRAFFIC CONTROL PLAN – GENERAL**

The Contractor and subcontractors shall equip their construction vehicles with flashing amber lights. Flashing amber lights on vehicles and equipment shall be visible from all directions.

At the end of each day's work and any other time construction operations are suspended, all construction equipment and other obstructions shall be removed from that portion of the roadway open for use by public traffic. The Contractor shall maintain access to all roadways, side streets, walkways, alleyways, driveways, and hike/bike paths at all times unless otherwise approved by the Engineer. During non-construction periods (evenings, weekends, holidays, etc.), all work shall be adequately protected to insure the safety of vehicular and pedestrian traffic, as detailed in the Contractor's MHT. Excavations or holes shall be filled in or fenced when unattended.

The Contractor shall work only on week days between the hours of 8:30 AM and 4:00 PM, unless otherwise approved by the Engineer. The Contractor, upon approval of the traffic control plan by the Engineer, will be allowed lane closures in the public roadway weekdays only from the hours of 8:30 AM to 4:00 PM. The Contractor must receive written approval from the Engineer for lane closures at any other time; and also, for permission to work weekends or holidays. Lane closures within Colorado Department of Transportation right-of-way shall be consistent with the lane closure policy of the applicable Region of the Colorado Department of Transportation. The policy can be located at:

[http://www.dot.state.co.us/Traffic\\_Manuals\\_Guidelines/Traffic\\_Guidelines\\_and\\_Information.asp](http://www.dot.state.co.us/Traffic_Manuals_Guidelines/Traffic_Guidelines_and_Information.asp)

The Contractor shall be responsible for insuring that all work sites are properly cleaned and barricaded prior to the completion of the day's activities.

All construction vehicles shall remain on paved surfaces at all times.

Time required for changeover from existing signal equipment to new signal equipment shall be kept to a minimum. All new signal equipment shall be installed and tested prior to shut down of the existing signal equipment to the highest extent possible.

The Contractor shall coordinate all of the work on the roadway during any special event with the County.

Contractor shall coordinate with all tenants affected by alley and/or access two weeks prior to construction.

Contact Lorraine Taylor at RTD (303) 299-6440 regarding impacts to bus stop access (pedestrian or vehicular) 48 hours in advance of such impact.

All costs incidental to foregoing requirements shall be included in the original contract prices for the project and will not be measured and paid for separately.

1 **UTILITIES**

2 In order to complete the utility work with minimum delay to the project, the work described in these plans  
3 and specifications requires full cooperation between the Contractor and the utility owners.

4 PART 1 - CONTRACTOR SHALL PERFORM THE WORK LISTED BELOW:

5 Coordinate project construction with the performance by the utility owner of each utility work element  
6 listed in Part 2 below. Perform preparatory work specified in Part 2 for each utility work element. Provide  
7 an accurate construction schedule that includes all utility work elements to the owner of each impacted  
8 utility. Provide each utility owner with periodic updates to the schedule. Conduct necessary utility  
9 coordination meetings, and provide other necessary accommodations as directed by the Engineer. Notify  
10 each utility owner in writing, with a copy to the Engineer, prior to the time each utility work element is to  
11 be performed by the utility owner. Provide the notice the number of days specified in Part 2 immediately  
12 prior to the time the utility work must be begun to meet the project schedule.

13 Prior to excavating, the Contractor shall positively locate all potential conflicts with existing underground  
14 utilities and proposed construction, as determined by the Contractor according to proposed methods and  
15 schedule of construction. The Contractor shall modify construction plans to avoid existing underground  
16 facilities as needed, and as approved by the Engineer. Please note that UNCC marks only its members'  
17 facilities – Other facilities, such as ditches and drainage pipes may exist, and it is the Contractor's  
18 responsibility to investigate, locate and avoid such facilities.

19 It is the responsibility of the contractor to examine the site for evidence of failures of or deficiencies in  
20 existing utilities and to immediately call any such evidence of pre-existing damage to the attention of the  
21 County.

22 Without such evidence of pre-existing damage, the contractor hereby agrees that any and all damages  
23 (direct or indirect) to the utility owner, which may be subsequently discovered within those areas where  
24 construction occurred within six feet of the utility and within a period of three years from the date of  
25 construction, were caused by the construction activities. Furthermore, their repair is agreed to be the sole  
26 responsibility of the contractor.

27 The contractor hereby agrees that the repair of any and all damages (direct or indirect), that may be  
28 subsequently discovered and proven to have been caused by the construction activities, is the sole  
29 responsibility of the contractor.

30 It shall be the contractor's responsibility to protect all utilities within the area of construction. This includes  
31 all steps necessary to prevent subsidence of the soil adjacent to or near the utility. All utility locations and  
32 elevations will require field verification in cooperation with the affected companies and public agencies.  
33 The Contractor shall be responsible for locating all underground utilities, valve boxes, manholes, etc., and  
34 insuring that they are properly protected and adjusted as called for in the plans and/or project specials.  
35 When utility adjustments are required, but have not been called for in the plans and/or project specials,  
36 the Contractor shall notify the County.

37 The Contractor shall provide written notices to each utility owner, with a copy to the Engineer,  
38 immediately prior to each utility work element on the construction schedule that is expected to be  
39 coordinated with construction. The Contractor shall allow the number of work days required for each utility  
40 work element in the construction schedule. The number of days expected for construction and number of  
41 days of prior notice is specified below for each utility owner.

42 Provide traffic control, as directed by the Engineer, for any utility work by the utility owner expected to be  
43 coordinated with construction. However, traffic control for utility work outside of typical project work hours  
44 shall be the responsibility of the utility owner.

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1 -2-  
2 UTILITIES

3 Perform each utility work element for every utility owner affected by the project. The Contractor shall give  
4 notice of not less than forty-eight (48) hours to the Department of the County having charge of any  
5 property or utilities served by the County and to other owner or owners of public or private property or  
6 utilities when they will be affected by the work to be performed under the Contract; and shall make all  
7 necessary arrangements with such departments, owner or owners for the removal, replacement, or  
8 protection of such property or utilities.

9 All Utility Owners:

10 Contractor shall locate and pothole all potential conflicts with existing buried utility facilities with the  
11 proposed construction, as shown on the plans or by field location markings. If a conflict exists, modify  
12 proposed construction plans to avoid all existing buried utility facilities as approved by the Engineer.

13 Contractor shall contact utility owners 5 days prior to potholing to allow their observation of potholing  
14 activities.

15 PART 2 - UTILITY OWNERS SHALL PERFORM THE WORK LISTED BELOW:

16 Although the Contractor shall provide traffic control for utility work expected to be coordinated with  
17 construction, traffic control for utility work outside of typical project work hours shall be the responsibility of  
18 the utility owner. The utility owner shall prepare and submit to the County Engineer a Method of Handling  
19 Traffic for utility work to be performed outside typical project work hours. The utility owner shall obtain  
20 acceptance of the Method of Handling traffic from the County prior to beginning the utility work to be  
21 performed outside typical project work hours.

22 All Utility Owners:

23 Contractor shall locate and pothole all potential conflicts with existing buried utility facilities with the  
24 proposed construction, as shown on the plans or by field location markings. If a conflict exists, modify  
25 proposed construction plans to avoid all existing buried utility facilities as approved by the Engineer.

26 Contractor shall contact utility owners 5 days prior to potholing to allow their observation of potholing  
27 activities.

28 Street Lighting & Electric Distribution:

29 The Contractor shall notify the Engineer a minimum of three (3) weeks prior to the signal turn-on so that  
30 orders may be issued for power connection to the intersection on the specified turn-on date.

31 If necessary, the utility company shall relocate aerial facilities as required to attain minimum required  
32 separation from proposed traffic signals, luminaries, and vertical clearance, and to prevent obstruction of  
33 drivers' view of the proposed traffic signals. Contractor shall construct the proposed traffic signals after  
34 utility company has completed the relocating, raising or under grounding of the existing aerial distribution  
35 facilities. This work shall be coordinated with construction and completed within 120 calendar days of the  
36 date of signature of the utility company concurrence letter.

37 The Contractor shall notify the Engineer a minimum of three (3) weeks prior to the signal turn-on so that  
38 orders may be issued for power connection to the intersection on the specified turn-on date.

39 After the Contractor has completed the construction of the proposed traffic signals and they are  
40 operational, the power company shall disconnect the power source to the existing traffic signal controller  
41 and luminaires. This work shall be coordinated with the construction and is expected to take one (1)  
42 working day per intersection to complete.

