Traffic Signal and ITS Standard Specifications

City of Glendale Transportation Department
5850 West Glendale Avenue, Glendale, Arizona 85301

Approved by: Signature on File _____ _____
Transportation Director Date

Approved by: Signature on File _____ _____
City Traffic Engineer Date

Introduction

The following document contains standard details and specifications for the design and construction of traffic signals and intelligent transportation systems (ITS) within the City of Glendale, Arizona. Signed copies of the included drawings are available at the City of Glendale Transportation Department, 5800 W. Glenn Dr. Suite 315, Glendale, Arizona, 85301; 623-930-2940.

All projects that contain Traffic Signal or ITS elements should conform to these details and specifications. In the event that these specifications or details contradict herein or with another document, the designer or contractor shall seek clarification from the City. The Traffic Signal and ITS elements of any plan set must be approved by the Transportation Department. Three sets of plans shall be provided to the Transportation Department for review by Traffic Engineering, Traffic Signals and Intelligent Transportation Systems.

Periodically, these standards and specifications will be revised to reflect the City's most up to date practices. The designer or contractor shall ensure that they are working from the most current version of the standards. The most up to date standards and specifications are available on the City's website.

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Introduction

This document serves as a guide to the engineering design standards, specifications, and practices for the design of City of Glendale (COG) traffic signals and intelligent transportation system (ITS) infrastructure. The purpose of this document is to provide a consistent set of guidelines, practices, and standards used by designers, contractors, and City of Glendale staff.

This document provides guidance developed by the City of Glendale regarding typical traffic signal design and ITS operations and construction. It is designed to expedite the production and review of plans by providing equipment specifications, placement guidelines, plan formatting instructions, drafting guidance, and standard notes.

Engineers designing commercial developments are advised to contact the corresponding departments concerning requirements not covered by this document that apply to their design or project.

The *City of Glendale Traffic Signals and ITS Standards and Specifications* is hereafter referred to as COG Standards and Specifications. This document supersedes the 2003 City of Glendale Traffic Signal Standards.

Abbreviations

The following abbreviations are used in these standards and specifications and are listed here for convenience.

AC	Asphaltic Concrete
ABC	Aggregate Base Course
APS	Arizona Public Service
APWA	American Public Works Association
ASTM	American Society for Testing and Materials
AWG	American Wire Gauge
BC	Bolt Circle
C	Conduit
CC	Control Cable
CCTV	Closed Circuit Television
CCSDU	CCTV Control Signal Distribution Unit
CD	Compact Disc
CL	Centerline
COG	City of Glendale
dB	Decibel
DB-25	25-Pin Connector
DET	Detector

EIA	Electronics Industry Association
EOC	Emergency Operations Center
EOP	Edge of Pavement
EVPE	Emergency Vehicle Pre-Emption
EX	Existing
FDM	Frequency Division Multiplexer
FODC	Fiber Optic Distribution Center
FP	Full Penetrating
FT	Foot
HD	Head
HDPE	High Density Polyethylene
ID	Inside Diameter
IISNS	Internally Illuminated Street Name Sign
IMSA	International Municipal Signal Association
IT	Information Technology
ITS	Intelligent Transportation Systems
KM	Kilometer
KVA	Kilo-Volt-Amperes
LED	Light Emitting Diode
LI	Loop Lead-in Cable
MAG	Maricopa Association of Governments
MDPE	Medium Density Polyethylene
ML	Match Line
NEC	National Electric Code
NEMA	National Electrical Manufacturer's Association
NIC	Not In Contract
NM	Nanometer
NTSC	National Television Systems Committee
OD	Outside Diameter
OTDR	Optical Time Domain Reflectometer
FOTR	Fiber Optic Transceiver
PB	Pull Box
PC	Personal Computer
PCCP	Portland Cement Concrete Pavement
PRI	Primary
PVC	Polyvinyl Chloride
R	Radius
RAM	Random Access Memory
REA	Rural Electrification Administration
RGB	Red Green Blue

RMC	Rigid Metal Conduit
ROW	Right-of-Way
RS-232	EIA Revised Standard 232
RS-422	EIA Revised Standard 422
SDR	Standard Diameter Ratio
SMFO	Single Mode Fiber Optic Cable
SMFO(XX)	Single Mode Fiber Optic Cable (Number of Fibers)
SONET	Synchronous Optical Network
SRP	Salt River Project
ST	Fiber Optic Connector Type
TIA	Telecommunications Industry Association
TMC	Traffic Management Center
TS	Traffic Signal
TSC	Traffic Signal Controller
TYP	Typical
UPS	Uninterruptible Power Supply
UV	Ultra Violet
VAC	Volts Alternating Current
VID	Video Image Detection

ITEM 2-1 PULL BOXES (NO. 1, 1.5, 3.5, 5 AND 7)

1.0 Description:

The contractor shall furnish and install No. 1, 1.5, 3.5, 5, or 7 Pull Boxes as shown in the project plans, special provisions, and these specifications.

2.0 Materials:

The pull box, extension, and lid shall meet the requirements of the COG Standards and Specifications for the type of pull boxes specified in the project plans.

Acceptable pull boxes to be installed by contractor are:

Manufacturer	Enclosure Style
Quazite	PC or PG
Christy	Fibrelyte, FL

The specific part numbers/order numbers are identified in each pull box detail shown in the COG Standards.

The lid shall be supplied with all bolts and washers required to secure the lid.

3.0 Construction Requirements:

Pull box locations shown on the plans are approximate. Minor adjustments may be made to improve ease of constructability, to avoid utility conflicts, maintenance purposes, and other factors. Relocated pull boxes should be approved by the field inspector.

For interconnect/fiber optic applications, the pull box spacing shall not exceed 880 feet from measured from center to center. The minimum pull box spacing (if applicable) shall not be violated due to moving the pull box.

Pull boxes shall be installed flush with adjacent grade, roadway or sidewalk. Pull boxes shall not be installed in roadways, driveways, parking areas, ditches, or sidewalk ramps unless otherwise noted on the plans or directed by the Engineer.

Pull boxes may be installed on slopes no greater than 3:1. The contractor shall install appropriate extension and grade area around pull box to prevent material or debris from entering the pull box.

The pull box shall be backfilled with select excavated material and thoroughly compacted to within two inches of original grade. The compaction around the box shall not cause the sides to deflect or any part of the box or lid to crack. The contractor shall replace any cracked, broken, chipped or damaged pull boxes or lids at no additional cost to the City.

The contractor shall be responsible for restoring the surrounding surface conditions back to their original state, including concreted areas.

All pull boxes shall be left in a clean condition, free of dirt and debris upon completion of work.

4.0 Method of Measurement:

New pull box installations will be measured as a unit for each pull box, extension, and lid, which includes any excavating, backfilling, grading, and area restoration necessary to complete the work.

The hold down bolts are considered incidental and shall not be measured or paid separately.

5.0 Basis of Payment:

The accepted quantities of each type of new pull box, measured as provided above, will be paid for at the contract unit price each, which price shall be full compensation for the work, complete in place.

ITEM 2-2 PULL BOX (NO. 8)

1.0 Description:

The contractor shall furnish and install No. 8 pull boxes as shown in the project plans, special provisions, and these specifications.

2.0 Materials:

Acceptable pull box to be installed by contractor is:

Manufacturer	Enclosure Style
Christy	Synertech Polymer Box

The specific part numbers/order numbers are identified in each pull box detail shown in the COG Standards.

Lids shall be marked “COG Communications” with two inch letters as shown in the standard drawing.

Lid shall have a minimum coefficient of friction of 0.5 skid resistance surface.

The lid shall be supplied with all bolts and washers required to secure the lid.

3.0 Construction Requirements:

Pull box locations shown on the plans are approximate. Minor adjustments may be made to improve ease of constructability, to avoid utility conflicts, maintenance purposes, and other factors. Relocated pull boxes should be approved by the field inspector. The minimum pull box spacing (if applicable) shall not be violated due to moving the pull box.

Pull boxes shall be installed flush with adjacent grade, roadway or sidewalk. Pull boxes shall not be installed in roadways, driveways, parking areas, ditches, or sidewalk ramps unless otherwise noted on the plans or directed by the Engineer.

Pull boxes may be installed on slopes no greater than 3:1. The contractor shall install appropriate extension and grade area around pull box to prevent material from entering the pull box.

The pull box shall be backfilled with select excavated material and thoroughly compacted to within two inches of original grade. The compaction around the box shall not cause the sides to deflect or any part of the box or lid to crack. The contractor shall replace any cracked, broken, chipped or damaged pull boxes or lids at no additional cost to the City.

The contractor shall be responsible for restoring the surrounding surface conditions back to their original state, including concreted areas.

All pull boxes shall be left in a clean condition, free of dirt and debris upon completion of work.

4.0 Method of Measurement:

New No. 8 pull box will be measured as a unit for each pull box and lid, which includes any excavating, backfilling, grading, and area restoration necessary to complete the work.

The hold down bolts are considered incidental and shall not be measured or paid separately.

5.0 Basis of Payment:

The accepted quantities of each type of No. 8 pull box, measured as provided above, will be paid for at the contract unit price each, which price shall be full compensation for the work, complete in place.

ITEM 2-3 PULL BOX (NO. 9)

1.0 Description:

The contractor shall furnish and install No. 9 pull boxes as shown in the plans, specifications, and the special provisions. The contractor shall furnish and install racks and hooks in all new No. 9 pull boxes.

2.0 Materials:

The pull box and lid shall meet structural requirements for AASHTO Specification HS20-44 loads and as shown on the Plans. A certificate of compliance, in accordance with Section 106.05 of the ADOT Standard Specifications shall be supplied for structural capabilities and materials used in manufacture.

(A) Covers:

The pull box cover shall have a square, hinged lid that opens a full 180 degrees. Opening of the lid shall be assisted from both the open and closed positions via a torsion bar lift system. The lid shall lock down with at least one stainless steel penta-head bolt that shall be captive to the lid. The lid shall also have provisions for an externally mounted padlock for extra security. The padlock shall mount in a cavity in the pull box cover so no part of the padlock is exposed.

Lids shall be marked “COG Communications” with two inch letters as shown in the standard drawing.

(B) Cable Mounting Hardware:

Each pull box shall be supplied with six P-4000 unistruts embedded in the concrete walls of the pull box, with a 18-hole rack mounted to each unistrut with two ½"-spring nuts and bolts, as shown on the standards. Four 7.5" hooks that mount in the 18-hole racks shall be supplied.

3.0 Construction Requirements:

The construction requirements shall be in accordance with these specifications and per the details shown in the Plans.

Prior to any trenching, the contractor shall verify, with utility as-builts, the existence of any cathodic protection in all existing utilities and take all possible precautions to maintain existing cathodic protection.

After Blue Staking has been accomplished, the contractor shall mark the proposed pull box location with white paint prior to excavation. Above ground pull box locations shall be marked with tape. The pull box locations must then be approved by the Engineer before installation begins.

If pull box is replacing existing pull box, the contractor shall remove the existing pull box, bricks, and stone sump and dispose of properly. The new No. 9 pull box shall be placed where the existing pull box was removed unless otherwise directed by the Engineer.

When installing the No. 9 pull box and pull box covers, the contractor shall only lift the pull box and covers using the lifting hardware installed for that purpose. The cover shall be oriented such that the lid hinge lies along the side of the pull box with no conduit openings farthest from the roadway.

At locations where the contractor is required to remove an existing pull box and replace it with a new No. 9 pull box, the contractor shall remove the existing pull box, stone sump, and bricks and dispose of properly. The contractor shall be responsible for the protection of, and/or extension of lighting and communication circuits where existing.

The contractor shall be responsible for restoring the surrounding surface conditions back to their original state, including concrete and roadway areas. Where the removal of concrete is required for pull box installation, the contractor shall remove and replace (in kind) the entire concrete slab(s).

For interconnect/fiber optic applications, the pull box spacing shall not exceed 880 feet from measured from center to center. The minimum pull box spacing (if applicable) shall not be violated due to moving the pull box.

4.0 Method of Measurement:

New No. 9 pull boxes will be measured as a unit for each pull box and cover. Racks and hooks for cable mounting, excavating, backfilling, area restoration necessary to complete the work, and one penta head socket for each pull box installed shall be considered incidental and shall not be measured or paid.

5.0 Basis of Payment:

The accepted quantities of each No. 9 pull box, measured as provided above, will be paid for at the contract unit price each, which price shall be full compensation for the work, complete in place.

ITEM 2-4 ELECTRICAL CONDUIT

1.0 Description:

The work under these items shall consist of furnishing and installing electrical conduit as shown on the Plans. The work shall include excavation, installation of conduit, removal of spoils, backfill, compaction of directional drilling pits, warning tape, warning signs and posts, locator wire, connectors and fittings, locating existing conduit when new is to be intercepted with existing, and restoration of the surface to existing condition, including decomposed granite and other landscaping items.

2.0 Materials:

Unless otherwise specified in the Plans, the contractor has the option of using PVC or HDPE conduit at his/her discretion for ITS projects. Traffic signal conduit shall be Schedule 40 PVC for all projects. The conduit and locator wire supplied shall meet the following criteria:

(A) PVC Conduit:

PVC Conduit and materials shall be in accordance with Section 732-2.02, paragraph one of the ADOT Standard Specifications.

(B) HDPE Conduit:

Should the contractor choose to substitute HDPE conduit in place of the installation of direct buried PVC conduit, the HDPE conduit must meet the requirements for HDPE conduit listed below, and the contractor shall provide original data sheets or a Certification of Compliance letter from the HDPE conduit manufacturer to the Engineer stating that the product meets these specifications and obtain the written approval from the Engineer prior to procuring and installing the HDPE conduit.

The contractor shall use a HDPE conduit with a Standard Dimensional Ratio (SDR) of SDR 11 or better. The HDPE formulations used by the manufacturer must be

specifically for conduit applications in accordance with ASTM F 2160: Solid Wall High Density Polyethylene (HDPE) Conduit Based on Controlled Outside Diameter (OD) and ASTM 3035 Polyethylene (PE) Plastic Pipe (SDR) Based on Controlled Outside Diameter. It shall have a cell classification of PE334470C (for black conduit) and PE334470E (for colored conduit) per ASTM 3350: Standard Specification for Polyethylene Pipe and Fittings Materials.

The polyethylene base resin shall meet the density requirement and melt index properties described herein. The density shall not be less than 0.940 and not more than 0.955 g/CM3 in accordance with ASTM D 1505: Standard Test Method for Density of Plastics by the Density-Gradient Technique. The range for the melt index shall be between 0.05 to 0.5g/10 minutes in accordance with ASTM D 1238: Standard Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer. The HDPE conduit shall have a minimum Flexural Modulus, MPa (PSI) of 80,000 per ASTM D 790 and a minimum tensile strength at yield (PSI) of 3,000 per ASTM D-638.

Additives to the base resin shall be included to provide heat stabilization, oxidation prevention and ultraviolet (UV) protection. It shall also utilize carbon black in the range of 2-3% for long term protection against UV degradation. The minimum protection period shall be one year from date of manufacture in unprotected, outdoor storage in accordance with ASTM D 1603: Standard Test Method for Carbon Black in Olefin Plastics.

(C) RMC Conduit:

RMC and materials shall be in accordance with Section 732-2.02 paragraph two of the ADOT Standard Specifications.

(D) Locator Wire:

Locator wire shall be 12 AWG solid copper locator wire for ITS applications and traffic signal applications, as indicated in the standard drawings.

3.0 Construction Requirements:

The construction requirements shall be in accordance with Section 732-3 of the ADOT Standard Specifications, and as specified herein. Where conduit is placed in an open trench, it shall not deviate more than one inch per foot in either the horizontal or vertical planes for fiber optic applications.

Prior to any trenching, the contractor shall verify, with utility as-builts, the existence of any cathodic protection in all existing utilities and take all possible precautions to maintain existing cathodic protection.

After Blue Staking has been accomplished, the contractor shall mark the proposed conduit path with white paint (similar to Blue Stake marking) prior to any boring or

trenching. The conduit path must then be approved by the City's Construction Manager before installation begins.

Where no conduit installation method is specified in the Plans, the contractor may open trench or directional drill, however if drilling is used he does so at his own risk, no change of conditions can be claimed.

Conduit depths shall be a minimum of 30 inches, or as shown on the Plans.

Unless otherwise shown on the Plans, bends, conduit fittings, expansion joints, 36" sweeps and other conduit accessories not specifically mentioned shall be from a material similar to the connecting conduit.

Conduit shall be placed in accordance with the lines, grades, details and dimensions as shown on the Plans or as otherwise approved by the Engineer. All PVC and rigid metal conduit shall be installed in accordance with Section 732-3.01 of the ADOT Standard Specifications, unless noted otherwise on the Plans.

For all Directional Drill (DD) conduit installations the contractor shall use HDPE conduits along the prescribed bore path from the surface with minimal impact to the surrounding area. The pulling tension for installing the HDPE conduit shall not exceed 75% of the manufacturer's tensile strength rating for each size and configuration of conduit(s) to prevent the conduit(s) from elongation or "necking down" during installation.

The proposed DD profile shall be submitted to the Engineer after the contractor has completed the necessary potholing and approved prior to beginning the DD operation at each location.

The contractor's DD operations shall utilize the "walkover" locating system or other Engineer approved equivalent for determining the location of the bore head. A sonde, behind the bore head shall register the depth, angle, rotation and directional data. At the surface, a receiver compatible with the sonde shall be used to gather the data and relay the information to the DD equipment operator.

When joining segments of HDPE conduit, the contractor shall utilize non-corrosive, sit-tight, water-tight couplings. Heat fusion, electrofusion fittings and mechanical connections shall be permitted if the HDPE conduit and joining device manufactures recommendations are observed and the internal diameter of the HDPE conduit is not reduced. Extrusion welding and hot gas welding to join HDPE conduits is not permitted.

Upon completion of joining HDPE conduit sections and setting the pull boxes, the contractor shall clean the HDPE conduit with compressed air. The contractor shall demonstrate by pulling a cleaning mandrel or ball mandrel, correctly sized for the conduit, that the conduit was not deformed during installation. If the mandrel passes through the HDPE the contractor shall install the pull tape in each unused conduit. Jetline is not acceptable. If the mandrel encounters a deformity in the HDPE conduit,

the contractor shall replace the entire segment of HDPE between pull boxes with new HDPE at no cost to the City.

No more than one week prior to installation of any cable, all new and existing conduit runs in which cable is to be installed shall be cleared/cleaned by pulling through a metal-disc mandrel with a diameter of 90% of the conduit diameter, or a ball mandrel with a diameter of 80% of the conduit diameter. The conduit may be brushed or swabbed, if deemed necessary, prior to pulling the mandrel through the conduit. No measurement or payment shall be made for this activity, as it is considered incidental.

Where the removal of concrete is required for conduit installation, the contractor shall remove and replace (in kind) the entire concrete slab(s).

Underground RMC shall be wrapped with an approved PVC protective tape. The tape shall extend at least 12 inches past where the RMC surfaces.

Conduits containing fiber optic cable shall follow NEC guidelines for power conduits.

All spoilage shall be removed from the project within 48 hours.

4.0 Method of Measurement:

Conduit will be measured by the linear foot by each diameter size combination, and method of installation (trenching or directional drilling), from center to center of pull boxes, or center of pull box to center of foundation, or center of pull box to edge of building. Vertical conduits and conduit sweeps, conduit in pull boxes, conduit in foundations, clearing and grubbing, and replacement of any landscape vegetation damaged during trenching activities are not measured or paid. The contractor shall account for these conditions in the unit prices bid for these bid items. The contractor is alerted to the fact that hand digging may be required in the installation of trenches and pull boxes. No extra payments will be made for hand digging.

12 AWG bare locator wire shall be considered incidental to the conduit bid item and shall not be measured or paid.

No measurement or payment will be made for locating existing conduit, couplings, expansion fittings, clearing the conduit prior to cable installation, removal of spoilage, and all other materials, the cost being considered as included in the price of the conduit.

Removal and replacement of concrete slabs (if required) shall be considered incidental to the conduit installation and shall not be measured or paid. The use of ABC slurry to meet utility company requirements (if required) shall be considered incidental to the conduit installation and shall not be measured or paid.

Rigid metal electrical conduit used to cross existing bridge structures shall include all conduit, couplings, expansion fittings, hangers, labor and expenses of x-raying and core drilling concrete structures, attaching conduit to structures, painting conduit to match the

existing structure color, and all other materials and necessary hardware to complete the installation of the conduit shall be incidental to the conduit.

The use of ABC slurry to meet utility company requirements (if required) shall be considered incidental to the conduit installation

5.0 Basis of Payment:

The accepted quantities of each diameter size measured as provided above will be paid for at the contract unit price per linear foot, which price shall be full compensation for the work, complete in place including any labor, materials, restoration of landscaping vegetation and irrigation systems, excavating, hand digging, backfilling, removal of spoilage and incidentals required to complete the work.

ITEM 2-5 CABLE INNERDUCT

1.0 Description:

The contractor shall furnish and install innerduct in conduit as shown on the Plans. Fiber optic cable and 12 AWG bare locator wire is typically installed in the conduit along with the inner duct.

2.0 Materials:

(A) 1 ¼" Innerduct:

The innerduct shall be 1 ¼" I.D. designed for outdoor, underground, in-conduit application. The innerduct shall be made of HDPE with a smooth interior wall and have a Standard Diameter Ratio (SDR) of 13.5 or less. Ribbed or corrugated will not be accepted. The innerduct shall have pre-installed pull tapes with a minimum tensile strength of 1,250 pounds. The innerduct shall be free of pinholes, voids or other imperfections. The innerduct shall be furnished in one continuous length with no factory installed splices or couplings of lengths sufficient enough to complete each run without splicing.

(B) Fabric Innerduct:

The innerduct shall be MaxCell® 4" 3-cell fabric innerduct with pre-installed color coded pull tapes, or approved equal.

(C) Documentation:

The contractor shall provide certification that the innerduct furnished and installed is in conformance with the manufacturer standards and these specifications.

(D) Warranty:

The innerduct shall be warranted by the contractor against all defects in material and workmanship in accordance with Subsection 106.13 of the ADOT Standard Specifications.

3.0 Construction Requirements:

The innerduct shall be furnished on reels. Each reel shall have a continuous innerduct of sufficient length to permit a run to be made without splices.

Installation of innerduct shall be continuous and without splices between pull boxes. The contractor shall perform all final length measurements and order innerduct accordingly.

The innerduct shall be installed in the conduit at the same time as the SMFO cable and 12 AWG bare locator wire. The SMFO cable and 12 AWG bare locator wire shall be installed in the conduit alongside the innerduct.

Innerduct and cables shall be pulled in the conduit with a split mesh cable grip or pulling eyes designed to provide a firm hold on the innerduct and cables. The innerduct or cables shall not drag on the ground or pavement during installation. The contractor shall ensure that the tensile load on the innerduct or cables does not exceed the allowed maximum by using a break-away tension limiter set below the recommended tensile limit of the innerduct or cables, or a system that includes a means of alerting the installer when the pulling tension approaches the limit and displays the actual tension on the innerduct or cables.

Innerduct shall be pulled in new and existing conduit, as shown on the plans. Innerduct shall be pulled with a minimum of dragging on the ground or pavement. The contractor shall ensure that the tensile load on the innerduct does not exceed the allowed maximum by using a break-away technique and/or a pulley system with numeric readout which includes a means of alerting the installer when the pulling tension approaches the manufacturer's maximum pulling tension.

The contractor shall ensure that the innerduct is protected from sharp edges and excessive bends. The contractor shall not cause the innerduct to violate the minimum bending radius for which the innerduct was designed. The contractor shall be responsible for all damages caused from violations and shall remove and install new innerduct at no expense to COG in such cases.

During pulling, the innerduct shall be lubricated adequately as it enters the conduit. Prelubrication may be necessary. The lubricant used shall be compatible with the innerduct material. The manufacturer's recommended pulling speed and pulling tension shall not be exceeded. Innerduct used within pullboxes to separate cable types shall extend a minimum of 12 inches into the conduits on each side of the pull box.

Fabric innerduct shall only be installed by the cable/conductor installer.

All unused innerduct shall contain a detectable pull tape from pull box to pull box and shall be sealed with an innerduct plug. The pull tape shall be attached to the plug and the innerduct sealed to prevent foreign material from entering the innerduct.

4.0 Method of Measurement:

The cable innerduct will be measured by the linear foot furnished and installed. It will be measured horizontally along the route from center of pull box to center of pull box, center of pull box to center of foundation, or center of pull box to edge of building. No payment will be made for innerduct that is below ground in vertical conduit stub-ups or for slack cable in pull boxes. Use of equipment required to install innerduct will be incidental to these items and will not be measured or paid. This installation equipment will remain the property of the contractor.

5.0 Basis of Payment:

The cable innerduct measured as provided above, will be paid for at the contract unit price, which price shall be full compensation for the work, complete in place.

ITEM 4-1 TRAFFIC SIGNAL CABINET

1.0 Description:

The Contractor shall furnish and install TS2 Type 1 traffic control modular cabinet assemblies as shown in the plans, specifications, and the special provisions.

2.0 Materials:

The cabinet assembly shall meet, as a minimum, all applicable sections of the NEMA Standard Publication No. TS2-1998 except where modified herein.

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

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

A rain channel shall be incorporated into the design of the main door opening to prevent liquids from entering the enclosure. The cabinet door opening must be a minimum of 80 percent of the front surface of the cabinet. A stiffener plate shall be welded across the inside of the main door to prevent flexing. The top of the cabinet shall incorporate a 1-inch slope toward the rear to prevent rain accumulation.

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

All seams shall be sealed with RTV sealant or equivalent material on the interior of 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 sides of the cabinet near the top shall be drilled and tapped to be capable of receiving a standard hanger during the installation of the cabinet. The hanger shall be capable of being removed once the cabinet is installed.

The cabinet size will be specified on the plans.

(A) Shelves:

All cabinets shall be supplied with a minimum of one removable shelf manufactured from 5052-H32 aluminum. Shelf shall be a minimum of 10 inches deep.

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

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

The cabinet shall have a minimum of one roll-out or otherwise concealable shelf that can be used as a shelf for a laptop computer or other tools when the cabinet door is opened.

(B) Component Mountings:

A minimum of one set of vertical “C” channels shall be mounted on each interior wall of the cabinet for the purpose of mounting the cabinet components. 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.

(C) Doors:

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 main door shall be equipped with a three-point latching mechanism. The handle on the main door shall utilize a shank of 5/8 inches minimum diameter. 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, 125, and 150 degrees under windy conditions. Manual placement of the mechanism shall not be required by field personnel. The main door shall be equipped with a lock. 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 a minimum of one key. The lock shall be modified to work with a ‘Glendale’ No. 2 key. Contact the COG traffic signal supervisor at (623) 930-2762 for more information.

(D) Anchor Bolts:

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.

(E) Main Panel, Terminals, and Facilities:

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.

All main panels are provided with a mounting mechanism which allows easy access to all wiring on the rear of the panel without the removal of any cabinet shelves. 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 as a minimum be available in the following configuration:

Sixteen load switch sockets, six flash transfer relay sockets, one flasher socket, two (2) BIU sockets, two (2) 16-channel detector racks each with one BIU and one (1) spare SDLC cable.

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.

The main panels shall have all field wires contained on two rows of horizontally mounted terminal blocks. One row shall be wired for the pedestrian and overlap field terminations. The other 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 alphanumerical labels. All labels shall use standard nomenclature per the NEMA TS2 specification.

It shall be possible to flash either the yellow or red indication on any vehicle movement and to change from one color indication to the other by use of a screwdriver.

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

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.

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 size and color:

Output	Wire Color	Wire Size (AWG)
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 to – black wire main panel)	Black	8/10
AC Line (main panel)	Black	10
AC Line (power panel to – black wire main panel)	Black	8/10
AC Line (main panel)	Black	10
AC Neutral (power panel to – white wire main panel)	White	8/10
AC Neutral (main panel)	White	10
Earth ground (power panel)	Green	8
Logic ground	Gray	22
Flash programming- orange wire flasher terminal	Black wire 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 tiewraps or interwoven cables is unacceptable.

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

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 metallized plastic 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 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 (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.

(F) Power Panel:

The power panel shall consist of a separate module, securely fastened to the right side wall 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. It shall be manufactured from 0.090-inch, 5052-H32 aluminum with a removable plastic front cover. The panel shall be of such design so as to allow a technician to access the main and auxiliary breakers without removing the front cover.

The power panel shall house the following components:

1. A minimum of a 30-amp main 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 interrupting capacity.
2. A minimum of a 15-amp auxiliary breaker. This breaker shall supply power to the fan, light and GFI utility outlet.
3. An EDCO model SHP-300-10 or approved equivalent surge arrester.
4. A 50 amp, 125 VAC radio interference line filter.
5. A normally-open, 60-amp, mercury contactor Durakool model BBC-7032 or exact equivalent.
6. A minimum of 8-position neutral bus bar capable of connecting three #12 wires per position.

7. A minimum of 6-position ground bus bar capable of connecting three #12 wires per position.
8. A NEMA type 5-15R GFI utility outlet.
9. A 4 position plug-in connector for wiring to the power bus assembly.

(G) 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.

Two spare filtered 110 V power outlets shall be provided.

It shall include the SDLC Bus connecting cables wired into a surface mounted compression terminal block.

The Power Bus Assembly shall house the following components:

1. A minimum of three and a maximum of six power connectors.
2. Two terminal strips to hardwire the power connections.
3. SDLC terminal block with pre-wired cables.

All cabinet equipment requiring filtered power to operate, shall be connected to the power bus assembly by a Burndy connector # SMS12PDH1 or exact equivalent, or hardwired directly to the supplied terminal blocks.

(H) Vehicle Detection Rack:

A minimum of one vehicle detector amplifier rack shall be provided in each cabinet in the following configuration:

Supports up to sixteen channels of loop detection (eight 2 channel detectors), two 2-channel preemption devices, and one BIU.

If design plans call for a second detector rack then a second detector rack should be added.

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

All BIU 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 vehicle detector amplifiers. 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 sidewalk 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 leading 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.

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.

Each detector rack shall be powered by the cabinet power supply and be connected to the power bus assembly by means of Burndy connector # SMS12PDH1.

Each detector rack shall be supplied with a full array of two (2) channel detector cards unless otherwise specified. The detector cards shall be EDI Oracle 2E or Reno C-1000.

(l) Cabinet Test Switch 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:

1. 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-TS2-1998 the MMU forces the controller to initiate the start-up sequence when exiting flash.
2. STOP TIME SWITCH – When applied, the controller shall be stop timed in the current interval.
3. CONTROL EQUIPMENT POWER ON/OFF – This switch shall control the controller, MMU, and cabinet power supply AC power.

Momentary test push buttons for vehicle and pedestrian inputs are not required.

The police door switch panel shall contain the following:

1. 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.
2. 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.
3. AUTO/MANUAL SWITCH – Cabinet wiring shall include an AUTO/MANUAL switch and a hand cord with a police push button.

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 36-pin Burndy connector #SMS36R1, or exact equivalent.

All wiring from the main panel to the test switch panel shall be connected to the switch panel via a 24-pin Burndy connector #SMS24R1 or exact equivalent.

(J) Resistor Panel:

An odd phase red resistor panel shall be included in each cabinet

(K) Auxiliary Devices:

1. Load Switches

   Load switches shall be solid state and shall conform to the requirements of Section 6.2 of the NEMA TS2 Standard and the most recent City of Glendale specification. See Item 4-4.

2. 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.

3. 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.

4. Malfunction Management Units
   Each traffic signal cabinet assembly shall be supplied with one Malfunction Management Unit as defined by the requirements of Section 4 of the NEMA TS2-2003 Standard and the most recent City of Glendale specification. See Item 4-3.

5. Bus Interface Units
   All Bus Interface Units (BIUs) shall meet the requirements of Section 8 of the NEMA TS2 Standard.

   The full complement of 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.

6. 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.

7. Load Switch Jumpers
   10 load switch jumpers shall be provided with each cabinet.

(L) Auxiliary Cabinet Equipment:

The cabinet shall be provided with two (2) thermostatically controlled (adjustable between 80-150 degrees Fahrenheit) ventilation fans in the top of the cabinet plenum.

The fanplate shall be removable with the use of simple hand tools for serviceability. A minimum of two exhaust fans shall be provided. The fan shall be a ball bearing type fan and shall be capable of drawing a minimum of 100 cubic feet of air per minute. Each Fan/Thermostat assembly shall be connected to the Power panel by means of a 4 position plug-in cable.

A 25-watt incandescent lamp mounted on a 14-inch flexible arm shall be included. The flexible arm shall be permanently mounted to the middle of the cabinet door. The lamp shall be wired to either a 15-amp ON/OFF toggle switch mounted on the power panel or to a door activated switch mounted near the top of the door.

A fluorescent lighting fixture shall be mounted on the inside top of the cabinet near the front edge. The fixture shall be rated to accommodate at minimum a F15T8 lamp operated from a normal power factor UL or ETL listed ballast. The lamp shall be wired to either a 15-amp ON/OFF toggle switch mounted on the power panel or to a door activated switch mounted near the top of the door.

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 cabinet prints.

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

A minimum of one set of manuals for the controller, Malfunction Management Unit and vehicle detector amplifiers shall be supplied with each cabinet.

At a minimum, an additional electrical outlet shall be provided in the cabinet. The outlet shall be wired through a fuse to protect equipment using the outlet from surges. The outlet shall be placed in a manner such that devices can be plugged in while still allowing the cabinet door to close.

3.0 Construction Requirements:

The construction requirements shall be in accordance with the COG Standards and Specifications and per the details shown in the Plans.

(A) Testing and Warranty:

Each cabinet assembly shall be tested as a complete entity under signal load for a minimum of 48 hours.

Each assembly shall be delivered with a signed document detailing the cabinet final tests performed.

The cabinet shall be assembled and tested by the controller manufacturer or authorized local distributor to ensure proper component integration and operation.

The cabinet assembly and all other components shall be warranted for a period of one year from date of shipment. The manufacturer's warranty shall be supplied in writing with each component. Second party extended warranties are not acceptable.

Any defects shall be corrected by the manufacturer or supplier at no cost to the owner.

(B) Replacement Coverage:

If a malfunction occurs during the warranty period, the supplier shall, within two (2) weeks after notification furnish a like unit, module, or auxiliary equipment, for use while the warranted unit is being repaired.

(C) Reliability Clause:

While under warranty, the isolation and repair of any unit malfunction shall be the responsibility of the supplier. Any unit experiencing a total of three failures that has twice been returned to the supplier for repair shall be replaced with a new unit of the same type at no charge to the City. The replacement unit's warranty shall be that of a new unit.

NOTE: Malfunctions do not include damage caused by lightning, power surges, negligence, acts of God, or use of equipment in a manner not originally intended by its manufacturer.

4.0 Method of Measurement:

New Traffic Signal Cabinets will be measured as a unit for each cabinet. The cabinet components described in section 2 of this Specification shall be considered incidental to the cabinet and shall not be measured or paid.

5.0 Basis of Payment:

The accepted quantities of each Traffic Signal Cabinet, measured as provided above, will be paid for at the contract unit price each, which price shall be full compensation for the work, complete in place.

ITEM 4-2 TRAFFIC SIGNAL CONTROLLER

1.0 Description:

The contractor shall furnish and install a shelf mounted, two through sixteen phase, fully-actuated digital, solid state traffic controller. The controller shall meet, as a minimum all applicable sections of the NEMA Standards Publications for TS2 and NTCIP. Where differences occur, this specification shall govern. Controller shall be compatible with both NEMA TS2 Types 1 and 2 cabinets.

2.0 Materials:

The controller shall be compact so as to fit in limited cabinet space.

(A) Hardware:

1. Electronics: A microprocessor shall be used for all timing and control functions. Continuing operation of the microprocessor shall be verified by an independent monitor circuit, which shall set an output and indicate an error message if a pulse is not received from the microprocessor within a defined period.

   A built-in, high-efficiency switching power supply shall generate all required internal voltages as well as 24 VDC for external use. All voltages shall be regulated and shall be monitored with control signals. Fuses shall be mounted on the front of the controller for 120 VAC input and 24 VDC output.

   Timing of the controller shall be derived from the 120 VAC power line. User-programmed settings and intersection configuration data shall be stored in Flash Memory. Memory requiring an energy storage device (battery or capacitor) to maintain user data shall not be acceptable. To facilitate the transfer of user-programmed data from one controller to another, a data transfer module (data key) using a separate serial flash memory device shall be included. This data transfer module shall be easily removable and directly accessible from the front of the controller. The controller will not require this module to be present for proper operation.

   The timing parameters shall be capable of being downloaded from a Windows based computer. The controller manufacturer shall provide a software program which stores the timing database and allows them to be downloaded directly to the controller.

   All controller software shall be stored in Flash Memory devices. The controller software shall be easily updated without the removal of any memory device from the controller. The use of removable PROMS or EPROMS from the controller shall not be acceptable. The controller shall include an option that allows updating software using a Windows based computer. This option shall allow updating the controller software via a serial or Ethernet port from the front of the controller. Updating the controller software shall require the intersection to be in flash for no more than ten seconds using Ethernet file transfer.

   All printed circuit boards shall meet the requirements of the NEMA Standard plus the following requirements to enhance reliability:

   - All plated-through holes and exposed circuit traces shall be plated with solder.

- Both sides of the printed circuit board shall be covered with a solder mask material.
- The circuit reference designation for all components and the polarity of all capacitors and diodes shall be clearly marked adjacent to the component. Pin 1 for all integrated circuit packages shall be designated on both sides of all printed circuit boards.
- All printed circuit board assemblies, except power supplies, shall be coated on both sides with a clear moisture-proof and fungus-proof sealant.

2. Front Panel: The front of the controller shall consist of a panel for the display, keyboard and connectors for all necessary user connections. It shall only be necessary to open the front panel during option installation and maintenance of the electronic circuits.

   An alphanumeric liquid crystal display (LCD) shall be used to show program and status information. For ease of viewing, backlighting and multiple levels of contrast adjustment shall be provided.

   Front-panel operator inputs shall be via clearly labeled and environmentally-sealed electrometric keys.

3. Data Key: A data key shall be available for use as a database storage device (backup) or as a database transfer module. It shall be capable of storing a minimum 256KB of data.

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

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

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

4. Computer Database: A Windows computer software program shall be available for use as a database storage device and database transfer. The software program shall be capable of storing timing data from multiple controllers.

   The software shall be able to upload and download while the controller is in operation.

5. Connectors: All interface connectors shall be accessible from the front of the controller. Controller model shall be offered to accommodate both NEMA TS2 Type 1 and NEMA TS2 Type 2 cabinets.

   To facilitate special applications the controller shall have the capability of assignment of any input or output function to any input or output pin

respectively on the interface connectors, with the exception of Flashing Monitor, Controller Voltage Monitor, AC+, AC-, Chassis Ground, 24VDC, Logic Ground and TS2 Mode bits.

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

   The controller layout shall allow the removal and replacement of any circuit board without unplugging or removing other circuit boards, except for the power supply. No more than two boards shall be attached together to form a circuit assembly.

   The controller enclosure shall be designed so that one side of any circuit board is accessible for troubleshooting and testing while the controller is still in operation. This capability shall be accomplished without the use of extender cards or card pullers.

(B) Displays:

1. Dynamic Displays: Dynamic displays listed below shall be provided to show the operational status of the controller. Additional displays shall be offered for programming. It shall be possible to place vehicle, pedestrian and preemption calls from the keyboard while displaying status information.

   Intersection status display shall indicate a summary of ring, phase, coordination, preemption and time-based control status.

   Controller status display shall indicate current interval, pedestrian, density, maximum, and maximum extension timing by phase and ring. The status of vehicle and pedestrian signal outputs shall be displayed in combination with vehicle and pedestrian calls.

   Coordinator status display shall indicate the command source, current coordination pattern information, local and system cycle count, commanded/actual offset, offset correction, time-based control status, hold, force-off, vehicle permissive, split count down, split extension, offset from ring 1 and green band indications.

   Preemptor status display shall indicate priority (railroad, fire, emergency) preemptors and bus preemptors with calls, preemptor active, inhibit, and delay status. When a preemptor is active, the display shall also indicate preemptor interval, timing, duration, and hold status. A portion of the display shall indicate the controller status during preemption including current status, interval, and timing by phase and ring and the status of vehicle and pedestrian signals for each phase.

Time base status display shall indicate the current time and date, the current day and week program, the active program step for both coordination pattern and time-of-day functions, the start time of the next program step, and the highest step used. The programmed selections of the active coordination pattern and time-of-day pattern shall also be displayed.

There shall be communications status displays for Port 1 (SDLC), Port 2 (terminal) Port 3, Ethernet and NTCIP.

Port 1 (SDLC) status display shall indicate the frame responses from the MMU, the terminal and facilities BIUs and the detector BIUs.

Ports 2 and 3 status display shall indicate the interconnect format, transmit, valid data, data error, carrier detect and the last valid command.

An Ethernet status display shall indicate the line speed, the line status, the total number of transmit and receive counts and the number of transmit and receive error counts.

An NTCIP status display shall indicate the total number of SNMP and STMP transmit and receive counts.

A detector status display shall indicate activity for up to 64 detectors. The display shall show detector calls as they are processed by the controller.

Flash/malfunction management unit (MMU) status display shall indicate flash status plus MMU channel, conflict, and monitoring function status. A separate display shall indicate the results of the controller's comparison of its MMU programming to the programming in the controller.

An input and output status display shall indicate the activity of all of the logic level inputs and outputs to the controller.

2. Programming Displays: Programming displays in the form of menus shall aid the operator in entering data from the front-panel keyboard.

   A main menu shall allow the user to select a major function of the controller. A submenu shall then be displayed to allow the user to select a sub-function within the major function.

   English language and traffic engineering terminology shall be used throughout to facilitate programming. The display organization shall allow traffic personnel to program the controller without using reference cards or manuals. All data entry and data screens shall be in logical order.

   Programming entries shall consist of alpha-numerical values, YES/NO and ON/OFF entries. During program entry, the new data shall be displayed as it

is entered. Entries shall only be validated and stored when the consistency check is performed for entries that are constrained by other programmed data or when the ENTER or cursor key is pressed when they are not.

An example of constrained data is the sequence of the phases within a ring. They need to be checked with the phase compatibility, phases in the ring and start phases among others.

An example of non-constrained data is the vehicular extension time entry.

The keyboard entry software shall include context sensitive help screens. Help information shall be accessed by placing the cursor on the data entry in question then pressing the HELP key. Help screens shall be provided for all keyboard-entered data and shall include at a minimum range, description, and functional operation information for the data entry.

(C) Programming:

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

   - Manual data entry via the front panel keyboard
   - Downloading via telemetry from a system master connected to a host PC in a closed-loop system.
   - Downloading from a portable PC-compatible computer via an Ethernet or serial cable.
   - Transfer from one controller to another using the Ethernet port on each controller.
   - Transfer from one controller to another, or restoring for a back-up copy, using a data transfer module (data key).

2. Programming Security: A minimum of three access levels shall be available to provide programming security.

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

   The second or data change level shall have access to all programming entries except access codes.

   The third or data display level shall only have access to displayed data. No access code shall be required to display data.

User selectable, four-digit access codes shall be provided for the supervisor and data change access levels. Access codes shall initially be set to provide unrestricted access.

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

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

   The controller unit shall contain a backup data base with user specified values stored in non-volatile memory. A copy function shall permit transferring the backup database to the active database.

   A memory-clear function shall permit the user to clear data entries for the following controller functions, either individually or all at once:

   - Configuration
   - Controller
   - Coordinator
   - Preemptor
   - Time base
   - Detectors
   - Logic Processor

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

   The controller shall have the capability to output a memory image of the user programmed settings and intersection configuration data in binary format. This shall allow transferring the memory image data to a data key.

(D) Actuated Control Functions:

1. Phase Sequence: The phase sequence of the controller shall be programmable in any combination of sixteen phases, eight concurrent groups and four timing rings.

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

The standard phase sequence of the controller shall also be capable of being altered by coordination, time-of-day or external alternate sequence command. The controller shall allow reversing the normal phase sequence of each phase pair as shown below:

- Phases 1 and 2
- Phases 3 and 4
- Phases 5 and 6
- Phases 7 and 8
- Phases 9 and 10
- Phases 11 and 12
- Phases 13 and 14
- Phases 15 and 16

The operator shall be able to select from a library of standard sequences. As a minimum the following shall be provided:

- Standard NTCIP sequence
- Two through eight phase controller
- Sixteen phase quad left turn controller
- Four single ring 4 phase controllers
- Dual TS2 eight phase quad controllers
- TXDOT three phase diamond controller
- TXDOT four phase diamond controller

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

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

   Four independent timing plans shall be provided and selectable on a time-of-day basis or by coordination pattern. Each plan shall contain the following interval timings:

Minimum Green	Maximum 3
Bike Green	Dynamic Maximum
Delay Green	Dynamic Maximum Step
Walk	Yellow Clearance

Walk 2	Red Clearance
Walk Maximum	Red Maximum
Pedestrian Clearance	Red Revert
Pedestrian Clearance 2	Actuations before Reduction
Pedestrian Clearance Maximum	Seconds per Actuation
Pedestrian Carryover	Maximum Initial
Vehicle Extension	Time before Reduction
Vehicle Extension 2	Cars Waiting
Maximum 1	Time to Reduce
Maximum 2	Min Gap

Guaranteed minimum interval values shall be specified at the time of purchase and shall not be changed or overridden from the keyboard. Values shall be provided for the following intervals:

- Minimum green
- Walk
- Pedestrian clearance
- Yellow clearance
- Red clearance
- Red revert
- Overlap Green

A bike green interval shall be provided that will replace the phase minimum green if the interval time is larger than the min green time and if a detector input designated as a bike detector has been activated.

Two Walk and Pedestrian Clearance intervals shall be provided for each phase per timing plan. The second Walk and Pedestrian Clearance shall be activated by a time base action plan.

Two vehicle extension intervals shall be provided for each phase per timing plan. The active vehicle extension interval shall be selected by a time base action plan.

If enabled, a Delay Green timer shall delay the vehicle phase from starting until the timer has expired. This shall provide an additional all red for the vehicles movement until the timing is complete.

The Pedestrian Walk interval shall extend from Walk to the smaller of the Walk Max time or the phase maximum in effect with a constant input from the “Walk Extension detector”.

Volume density intervals shall include actuations before and cars waiting. Actuations before added shall provide a user-specified number of actuations that must occur before adding variable (added) initial time. Cars waiting shall provide a user specified number of actuations, or cars waiting, that must occur before starting gap reduction. Gap reduction shall be initiated by either time before reduction or cars waiting, whichever reaches its maximum value first.

The controller shall be capable of dynamically extending the maximum green time for each phase based on vehicle demand. Three maximum green intervals shall be selectable per phase based on either time-of-day, coordination pattern or external input. The initial interval shall be selectable as Max 1, Max 2, or Max 3. If the phase terminates due to max-out for two successive cycles, then the maximum green time in effect shall automatically be extended by a dynamic max step interval on each successive cycle until it is equal to dynamic maximum. If the phase gaps out for two successive cycles, then the maximum green time shall be reduced by the dynamic max step time until it reaches to the original max value.

Each phase shall have a red maximum timing interval. An input (red extension) shall extend the all red period of the assigned phase as long as the detector input is true. This input must be true within the all red time of the assigned phase to be able to extend the all red period. If this detector fails then the all red extension feature shall be disabled.

3. Overlaps: The controller shall provide sixteen internally-generated overlaps (A – P). These shall be individually programmable as standard, other (see section 5.3.2) or minus green/yellow. The green, yellow and red intervals shall be individually programmable following termination of the parent phase. The overlaps programmed as minus green/yellow overlaps shall provide overlap green when any of the overlap phases are green or when in transition between overlapped phases and a modifier phase is not green. The overlap will be yellow when an overlapped phase is yellow and the modifier phase is not yellow and none of the overlapped phases are next.

   The other overlap option shall provide for protected, pedestrian protected, not overlap, trailing, leading and advance green programming.

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

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

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

- When the controller is in transition between included phases and a pedestrian protected phase is not next
- After servicing an included phase pedestrian demand if there is enough time before max out to service the overlap minimum green

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

Overlap functions shall be programmable from the controller keyboard.

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

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

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

5. Additional Features: The following features shall be programmable for each phase in each of four separate detector plans:

   - Locking/non-locking detector memory
   - Vehicle recall
   - Pedestrian recall
   - Maximum recall
   - Soft recall
   - No-rest phase
   - Enable Added Initial

   Also programmed by phase shall be:

   - Phase in use
   - Exclusive Pedestrian phase

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

   If a phase is designated as a no-rest phase the controller shall not rest in the phase.

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

During a power start condition, the controller shall be capable of timing an all-red or flash interval before the power start phase(s) and interval are displayed.

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

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

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

The controller shall provide the following additional selectable pedestrian functions:

- Actuated phase rest in WALK
- Flashing WALK output
- Pedestrian clearance protection during manual control
- Pedestrian clearance through yellow
- Pedestrian indications remain dark with no call
- Pedestrian timing shall be capable of being carried over from one phase to another

Programming shall be provided to inhibit re-service of odd phases (left turns) within the same concurrent group.

The controller shall provide a programmable simultaneous gap termination feature. When programmed, phases in both rings shall gap out together in order to terminate the green interval and cross the barrier.

The controller shall provide automatic flash selection per the requirements of the MUTCD. Both the flash entrance and exit phases shall be programmable through the keyboard, and flashing shall be controlled by either setting the fault/voltage monitor output to be FALSE or by flashing through the load switch driver outputs. If flash desired through the load switches, both the phase and overlap outputs shall be flashed either yellow or red as selected by the operator. Automatic flash shall be selectable by external input, system command, or time of day action plan.

The controller shall provide dimming for selectable load switch outputs. Dimming shall be accomplished by inhibiting the selected outputs for alternate half cycles of the 120 VAC line. Dimming shall be controllable by time of day and an external input; both functions must be TRUE for dimming to occur. Programming shall permit individual dimming of the Green/Walk, Yellow/Ped Clear, Red/Don't Walk outputs for each load switch.

(E) Coordination:

1. Coordination Patterns: A minimum of 120 coordination patterns shall be provided. Each pattern shall allow selection of an independent cycle length, offset value and split pattern. The coordination patterns shall be selected using telemetry (system), hardwire, or non-interconnected (time base) coordination commands.

   The coordination patterns shall be selected by the coordination command using the following formats:

   - Pattern – This format shall allow selecting the coordination patterns directly, that is, commanding Plan 1 selects Pattern 1. Pattern command shall include 1-120 patterns, pattern 254 shall select free and pattern 255 shall select flash.
   - Standard – This format shall allow selecting the coordination patterns using a pattern number derived from a cycle offset-split command. Each pattern shall be assignable to a specific cycle-offset-split combination. The coordination pattern shall be selected using the formula (((Cycle – 1) * 20) + ((Split – 1) * 5) + Offset)).
   - TS2 – This format shall allow selecting the coordination patterns as a function of Timing Plan and one of three offsets. With this format a minimum of 20 Timing Plans shall be available for selection of one of sixty coordination patterns.

   The following functions shall be programmable in each coordination pattern:

   - Cycle length
   - Split pattern
   - Offset value
   - Alternate-phase sequence
   - Split and offset in seconds or percentage
   - Crossing artery pattern
   - Permissive timing
   - Action plan
   - Coordinated phase split extension
   - Timing plan

- Actuated rest in walk
- Phase re-service
- Ring extension
- Split demand pattern
- Ring displacement
- Directed split preferences
- Special function outputs

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

- Coordinated phase
- Split value by phase
- Omit by phase
- Min recall by phase
- Max recall by phase
- Pedestrian recall
- Max and Pedestrian recall

2. Cycle Length: One cycle length shall be provided for each coordination pattern. The cycle shall be adjustable over a range of 30-255 seconds in 1-second increments.

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

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

   For hardwire systems with multiple sync pulses, the coordinator shall lock onto the correct sync by trying different syncs and checking for reoccurrence during successive cycles.

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

4. Offset: Offset shall normally be defined as the time period from the system sync pulse to the beginning of the leading coordinated phase green (local zero). The coordinator shall also be capable of referencing the offset to the

beginning of the lagging coordinated phase green, coordinated phase yield or start of yellow point.

Offsets shall be programmable using both percent and seconds. The range shall be from 0-99% of the cycle length in 1% increments or 0-254 seconds in 1-second increments. An offset value of 255 shall result in free.

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

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

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

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

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

   All permissive timing shall begin at the lead coordinated phase yield point. A yield point shall be automatically computed for the coordinated phase in each ring. The coordinated phase yield points shall allow the coordinated phases to yield independent of each other. The yield point shall be the point at which the coordinated phase is released to allow the controller to service calls on non-coordinated phases. The computation shall take into account the coordinated phase split interval plus pedestrian and vehicle clearance times.

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

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

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

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

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

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

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

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

9. Crossing Artery Control: The coordinator shall be capable of implementing dual coordination at an intersection where two arterials are under control of separate masters.

   An external input shall enable dual coordination. Once enabled, the coordinator shall place a continuous call on the crossing artery phases so as to ensure that these remain green for their full split interval.

   The coordinator shall output a crossing artery sync signal to indicate the beginning of the crossing artery phase split interval.

   Dual coordination shall force a selectable crossing artery split plan to be used so as to allow a particular split to be optimized for dual coordination in each coordination pattern.

10. Local Split Demand: The coordinator shall provide a minimum of two split demand detector inputs, which shall allow the selection of a preferred split plan based on intersection demand.

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

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

12. Free Mode: The coordinator shall provide a free mode of operation, where all coordination control is removed.

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

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

- Manual control enable
- Stop time
- Automatic flash
- Preemption

The coordinator shall provide an active free mode, where coordination control is removed but the coordinator continues to monitor system sync so as to keep its timing in step with the system master.

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

14. Interconnect Modes: The coordinator shall be capable of operating with any of the following interconnect types:

    - Non-interconnected coordination (time-based)
    - Telemetry
    - Hardwired

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

15. Master Coordinator: The coordinator shall output the coordination command, including sync pulse. This feature shall permit the controller to be used as a time-of-day master in a hardwired interconnected system.

(F) Preemption:

1. Railroad-Fire-Emergency Vehicle Preemption: The ten railroad-fire-emergency vehicle preemptors shall be selectable as a priority or non-priority type. Priority preemptor calls shall override non-priority preemptor calls. Low-numbered priority preemptors shall override higher-numbered priority preemptor calls. Non-priority preemptor calls shall be serviced in the order received.

   Each preemptor shall provide a locking and non-locking memory feature for preemptor calls. If a preemptor is in the non-locking mode and a call is

received and dropped during the delay time, the preemptor shall not be serviced.

Preemptor timing intervals shall be programmable from 0-255 in one-second increments or 0-25.5 in one-tenth second increments, depending on function. Delay, max presence and duration timing intervals shall be programmed from 0 – 65535 seconds in one-second increments.

A programmable delay time interval shall be provided to inhibit the start of the preemption sequence. This interval shall begin timing upon receipt of a preemption call. This time shall be programmable from 0-255 seconds in one second increments.

An inhibit time shall be provided as the last portion of the delay time interval. During this time, phases that are not part of the preempt sequence shall be inhibited from service. This time shall be programmable from 0-65535 seconds in one second increments.

A programmable extend input shall cause the preemptor to remain in the dwell interval following the removal of the preempt call. If a preempt call is reapplied during this time, the preemptor shall revert to start of dwell interval. This time shall be programmable from 0-25.5 seconds in one-tenth second increments.

A programmable duration time shall be provided to control the minimum time that a preemptor remains active. This time shall be programmable from 0-65535 seconds in one second increments.

A programmable maximum time shall be provided to control the maximum time that a preemptor input remains active and still be recognized by the controller. Once failed, the input must return to inactive state to be recognized again.

Phases timing at the beginning of a preemption sequence shall remain in effect for a minimum time before the controller advances to the next sequential interval. If the phase has been timing for longer than the programmed preemptor minimum time, the controller shall immediately advance to the next sequential interval. Minimum times shall be programmable for the following intervals:

- Green/walk/pedestrian clearance
- Yellow
- Red

A phase shall advance immediately to pedestrian clearance if it has been timing a WALK interval at the beginning of a preemption sequence. It shall be

possible to time the minimum pedestrian clearance through the yellow interval, or alternately to advance immediately to yellow. During preemption, pedestrian indicators shall be selectable as being a solid DONT WALK, OFF (blank) or fully operational.

If an overlap is in effect when the preemption sequence begins, it shall be possible to terminate the overlap so that it remains red for the remainder of the preemption sequence. Overlaps terminating or forced to terminate shall time the preemptor minimum yellow and red clearance times.

Each preemptor shall provide user-programmable green, yellow and red track clearance intervals. These shall begin timing immediately after the preemptor minimum red interval.

Up to four permissive phases shall be selectable as track clearance phases. During the track clearance period, the selected phases shall time the track clearance green, yellow and red intervals once, and then advance to the hold interval. If track clearance phases are not selected the track clearance interval shall be omitted from the preempt sequence. Controller interval timing shall be used if track clearance interval times have been programmed as zero.

The preemption hold interval shall begin immediately after track clearance. It shall remain in effect until the preemptor duration time and minimum hold times have elapsed and the preemptor call has been removed or the preemptor maximum time has been exceeded. During the preemption hold interval, any one of the following conditions shall be selectable:

- Hold phase green
- Limited phase service
- All red
- Flash

Any valid phase, except a track clearance phase, shall be selectable as a hold phase. If hold phases are not selected, the controller shall remain in all red during the hold interval. If flash is selected for the hold interval, up to two permissive phases shall be selectable to flash yellow, and the remaining phases shall flash red. Overlaps associated with the phases flashing yellow shall also flash yellow unless they have been forced to terminate, in which case they shall remain red.

The preemptor shall immediately cause flashing operation if the preemption input and the track interlock input are not in opposite states and the track interlock function is enabled.

Each preemptor shall provide a user-programmable green, yellow and red hold interval, during which the hold phase(s) shall operate normally, except that the minimum green interval time shall equal the hold green time. At the completion of the hold green interval, the controller shall time the hold yellow and red clearance intervals prior to transfer to the exit phases.

Up to four permissive exit phases shall be selectable to time after the preemption sequence has been completed. These shall serve as transition phases to return the controller to normal operation. It shall also be possible to place calls on selected phases upon exiting preemption. The option shall be provided to cause the preemptor to exit preemption to the correct phase to maintain coordination.

Each preemptor shall provide a user-programmable exit maximum time. Upon exiting the preemption sequence, this time shall serve as the maximum green time in effect for one controller cycle for all phases except hold phases.

Preemptor linking shall permit preemption sequences, where lower-priority preemptors may call the higher-priority preemptors from their preemption sequence.

Preemptor active outputs shall be provided for each of the preemptors. The output shall be set to ON when the preemption sequence begins and shall remain ON for the duration of the sequence. It shall also be possible to program preempt active outputs to be ON only during preempt hold intervals. Additionally, it shall be possible to program the non-active, non-priority preemptor outputs to flash while another preemptor is active.

Preemptors shall normally override automatic flash. It shall be possible to inhibit this feature for each preemptor.

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

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

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

   A re-service time shall be provided to avoid excessive utilization of the same bus preemptor. If a call is received before the re-service time has elapsed, the bus preemptor shall not be re-serviced. If re-service time has not been

entered then all phases with a call when leaving the bus preemption sequence shall be serviced before the bus preemptor may be served again.

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

Bus preemptors shall provide the following entrance intervals:

- Green/walk/pedestrian clearance
- Yellow
- Red

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

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

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

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

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

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

   A check-in detector input shall be provided that senses the arrival of the transit vehicle. When active this input shall initiate Transit Signal Priority (TSP).

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

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

Assignment of a single pulse from the check-in detector and check-out detector to the controller inputs shall be programmable to any controller input. Inputs from devices that continuously pulse (pulsing as long as the vehicle requires TSP) shall be through EVP 1-4, for a controller with a C1 connector, or through Preemptor inputs 3 – 6, on a controller with a MSD connector.

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

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

(G) Time-Based Control and Non-Interconnected Coordination:

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

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

   In addition to entering time and date via the keyboard, it shall be possible to download the information from another controller, a computer or a system master.

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

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

2. Time-Based Control: Time-based control shall utilize a day plan program format. The month program shall consist of 200 programmable schedules, each assignable to one of sixteen day programs. Each day program shall consist of from 1 to 50 program steps which define a program for the entire

day. Each program step shall be programmed with a starting time and an action plan number. The day plans shall also be assigned to days of the week and days of the month.

Time based control shall use action plans to assign:

- Coordination pattern number
- Vehicle detector plan number
- Controller sequence
- Timing plan
- Vehicle detector diagnostic plan
- Pedestrian detector diagnostic plan
- Automatic flash
- System override
- Detector log
- Dimming
- Special functions
- Auxiliary functions
- By-Phase functions
- Pedestrian recall
- Walk 2 enable
- Vehicle extension 2 enable
- Vehicle recall
- Vehicle max recall
- Max 2 enable
- Max 3 enable
- Conditional service inhibit
- Phase omit

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

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

3. Non-Interconnected Coordination: A minimum of 200 time base schedule programs shall be available for the day-programs. These shall not have to be entered in any special sequence. It shall be possible to add and delete steps

from a day-program without affecting any other day-program. Each of the program steps shall permit selection of the following functions:

- Day program assignment
- Start time
- Action plan

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

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

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

(H) Detectors:

1. Detector Functions: The controller shall provide a minimum of 64 vehicle detector inputs. Each input shall be assignable to any phase and be programmable as to detector function. Extend and delay timing shall be provided for each detector. Each detector shall be capable of operating in a lock or non-lock mode. The controller shall also be capable of providing 16 pedestrian detector inputs. Each pedestrian detector shall be assignable to any phase.

2. Detector Cross Switching: The controller shall provide detector cross switching, which permits all vehicle detectors to alternately place calls on their assigned phases and their assigned cross switch phases. If the assigned phase is not green and the cross-switch phase is green, the detector shall place calls on the cross switch phase. If the assigned phase is omitted for any reason, the detector shall place calls on the cross switch phase.

3. Detector Types: Each vehicle detector shall be user-programmable to operate as one of the following 3 detector types:

   - Type 0 (zero): supports all NTCIP or standard detector functionality.
   - Type 1: (GREEN DELAY) The first detection received when the phase goes green is recognized immediately, whether the detector is active

when green starts or is activated after the green is timing. Detections received before the first timeout of the extension interval are also recognized immediately. Once the detector extension interval (not the phase extension interval) times out, all further detector inputs are recognized only if continuously present for a period equal to the programmed delay time AND the delayed signal is NOT extended. The first detection received when the phase goes green, whether present when green starts or received later, is recognized immediately. Detections received before the first timeout of the extension interval are also recognized immediately. Once the detector extension interval (not the phase extension interval) times out, all further detector inputs are recognized only if continuously present for a period equal to the programmed delay time AND the delayed signal is NOT extended.

- Type 2: (STOP BAR WITH EXTEND TIME AND RESET) The detector input must be true when assigned phase green starts else the detector is disconnected for the balance of phase green. If the detector input is true when phase green starts the extension timer is reset while the input remains true. When the detector input is removed the extension timer begins running. If another detector input is received before extension time expires, the extension timer is reset for the duration of the input and once again begins timing when the input goes false. This action is repeated until the extension timer times out, at which time it is disconnected for the balance of phase green.

4. System Detectors: Each detector input shall be capable of functioning as one of 16 system detectors.

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

(l) System Communications:

1. On-Street Master Communications: The controller shall be capable of communicating with an on-street system master. This capability shall be provided by a separate telemetry module, which shall be included in the controller when required by the plans and specifications. The telemetry module shall receive system master commands and data transmissions. In addition, it shall transmit the controller status, data base and system detector information to the system master.

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

   - Cycle, offset, and split (coordination pattern)
   - System sync
   - Special function commands (minimum of four)
   - Free and flash mode commands
   - Time and date
   - Request for local status
   - Recall to Max

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

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

   Status Data – The status of each of the following functions shall be transmitted to the system master in response to a local status request:

   - Green and yellow status for all phases and overlaps
   - Walk and pedestrian clearance status for all phases
   - Vehicle and pedestrian detector status
   - Phase termination status
   - Local time
   - Coordination status
   - Command source
   - Sync or transitioning status of coordinator
   - Conflict flash status
   - Local flash status
   - Preempt activity and calls
   - Volume and occupancy data from a minimum of 16 system detectors
   - Speed data from a minimum of two speed detectors
   - Maintenance required (cabinet door open) status
   - Status of two user-defined alarms

   Split Reporting – The status of each of the following parameters shall be calculated on a per-cycle basis and transmitted to the system master:

   - Actual time spent in each phase
   - Time of day at end of cycle
   - Phases forced off during cycle
   - Type of coordination operation

- Whether transitioning to new offset
- Cycle, offset, and split in effect during last cycle
- Flash status if operation is Free

Upload/Download Capability – The telemetry module shall provide the capability to upload/download the entire intersection database. Phase assignments for overlaps and preemptors shall not be downloaded to preclude unsafe controller operation. It shall be possible to inhibit downloading of phases in use and left-turn head control. Data transfer shall not require the intersection to be in flash.

3. Telemetry: Telemetry shall utilize TDM/FSK data transmission from 1200 baud to 9600 baud over two pairs of wires. These may be leased lines (Type 3002, voice grade, unconditioned) or dedicated cable. Optional fiber optic communications capability shall also be available.

   The nominal transmitter output level shall be 0 dbm into a 600-ohm load. The receiver sensitivity shall be -34 dbm and shall be adjustable from -40 to +6 dbm.

   Parity and error checking shall be employed to assure transmission and reception of valid data. Indicators shall be provided on the telemetry module to show telemetry activity as follows: transmit, receive carrier, and valid data.

   In the event of a telemetry failure, the controller shall revert to the non-interconnected coordination mode after it has self-synchronized for a number of cycles, which shall be selectable from 0-255.

4. Communications Protocols: The controller shall have the capability of supporting communications with traffic management systems using industry standard protocols with the installation of appropriate optional software. At a minimum the controller shall have optional software to support the following protocol:

   NTCIP Level 2 as defined by Section 3.3.6 of NEMA TS2- 2003. NTCIP v02.06 capabilities shall include for all NTCIP mandatory and optional objects. The controller vendor shall provide access to all controller data via vendor specific objects. These and all other objects supported by the controller shall be defined in a standard MIB file.

5. Ethernet Communications: The controller shall have the capability of supporting communications through Ethernet. This communications shall be using internal circuitry.

6. External Clock: The controller shall have the capability of communicating with an external clock like a GPS or WWV clock in order to set its internal time of day clock.

7. Communications Ports: The controller shall as a minimum have the following internal communications ports:

   - Port 1 SDLC for communications to other devices in the cabinet
   - Port 2 Terminal port for communications with a computer for the purposes of uploading, downloading or upgrading the controller software
   - Port 3 Systems communications port. This port shall be provided to either communicate to an on-street master or a central computer system
   - An option circuit board shall be available to expand communications by adding two additional serial communications ports

   Serial communications shall operate at 1200 to 115.2 K baud

(J) Diagnostics:

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

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

   Operator initiated diagnostics shall allow the operator to verify proper operation of all controller input, output, communications, keyboard, and display functions. Both manual and automatic test modes shall be provided.

2. Detector Diagnostics: Time-of-day controlled detector diagnostics shall be provided that allow testing vehicle and pedestrian detectors for no activity, maximum presence, and erratic output.

   A minimum of eight detector diagnostic plans shall be provided. These plans shall be selectable on a time-of-day basis. This shall allow varying the detector diagnostic intervals to correspond with changes in detector activity.

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

   - Detector fail recall from 1 to 255 seconds

- Maximum Recall
- Disable the detector from calling or extending

Diagnostics for NEMA TS2 detectors connected to the controller using a Bus Interface.

(K) Logging:

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

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

   Detector logging shall be capable of being enabled or disabled by time-of-day.

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

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

   Detector failure logging shall be capable of being disabled.

3. Event Logging: The controller shall include an event log buffer capable of storing a minimum of 200 time and date-stamped events or alarms. Once logged, events shall remain in the buffer until cleared or the log buffer capacity is exceeded at which time the oldest events shall be overwritten.

   At a minimum the following events shall be logged: communication failures, coordination faults, MMU and local flash status, preempt, power ON/OFF, low battery, and status of a minimum of two alarm inputs. An on-line event shall be logged when an event or alarm returns to normal status.

   If security is enabled, an event shall be logged when a user enters a data change. This event shall include the user's ID. It is necessary to log the first change only and not every change. Also an entry shall be recorded when a user logs in and out of the controller.

Event logging shall be capable of being enabled or disabled for each category of event or alarm.

4. MOE Logging: The controller shall accumulate phase utilization data, phase termination data and detector data for a number of cycles selectable by the operator.

   The MOE log shall include the number of gap outs, force offs and max outs per phase.

   The MOE log shall include the mode of operation and phase utilization. If the controller is operating under coordination, the log shall include the pattern in effect and the average phase split for each period. If the controller is operating free, the log shall include the timing plan (1 – 4), the maximum in effect and the average phase maximum for each period.

   Each logged period shall include the volume, number of stops and the delay per phase.

   Each log period shall record the number of times a phase was skipped and the number of times walk was served per phase.

3.0 Construction Requirements:

(A) Warranty:

The traffic signal controller shall be warranted by the manufacturer against mechanical and electrical defects for a period of 2 years from date of shipment. The manufacturer's warranty shall be supplied in writing with each controller. Second party extended warranties are not acceptable.

(B) Replacement Coverage:

If a malfunction occurs during the warranty period, the supplier shall, within two (2) weeks after notification furnish a like unit, module, or auxiliary equipment, for use while the warranted unit is being repaired.

(C) Reliability Clause:

While under warranty, the isolation and repair of any unit malfunction shall be the responsibility of the supplier. Any unit experiencing a total of three failures that has twice been returned to the supplier for repair shall be replaced with a new unit of the same type at no charge to the City. The replacement unit's warranty shall be that of a new unit.

Malfunctions do not include damage caused by lightning, power surges, negligence, acts of God, or use of equipment in a manner not originally intended by its manufacturer.

4.0 Method of Measurement:

New Traffic Signal Controllers will be measured as a unit for each controller.

5.0 Basis of Payment:

The accepted quantities of each Traffic Signal Controller, measured as provided above, will be paid for at the contract unit price each, which price shall be full compensation for the work, complete in place.

ITEM 4-3 MALFUNCTION MANAGEMENT UNIT (MMU)

1.0 Description:

The malfunction management unit (MMU) monitors the levels of D.C. voltage supply signals from power supplies used to power associated traffic control equipment. A D.C. voltage from each power supply is checked against a reference threshold value in the malfunction management unit. If either voltage drops below the threshold value for a minimum time period, a fault signal is generated and the operation of the traffic control equipment is overridden. The threshold value used to test the D.C. voltage levels is selectable between the same level for all inputs or different levels for different inputs.

2.0 Materials:

Each traffic signal cabinet assembly shall be supplied with one MMU as defined by the requirements of Section 4 of the NEMA TS2 -2003 Standard.

Acceptable malfunction management units to be installed by contractor are EDI MMU-16LEip with 10/100 Mbbs Ethernet Port, or approved equivalent.

The MMU shall include:

Two high contrast liquid crystal displays that continuously show full RYG(W) intersection status. A separate graphic LCD shall provide a menu driven user interface for status, signal voltages, configuration, event logs, and the Help system.

Provide a time-stamped nonvolatile event log recording the complete intersection status as well as the AC line events, configuration changes, monitor resets, temperature and true RMS voltages

Supports the MUTCD flashing yellow arrow PPLT operation with two different mode for either TS-2 or TS-1 cabinet configurations.

A minimum of one set of manuals for the MMU shall be supplied with each cabinet.

3.0 Construction Requirements:

(A) Warranty:

The MMU shall be warranted by the manufacturer against mechanical and electrical defects for a period of 2 years from date of shipment. The manufacturer's warranty shall be supplied in writing with MMU. Second party extended warranties are not acceptable.

(B) Replacement Coverage:

If a malfunction occurs during the warranty period, the supplier shall, within two (2) weeks after notification furnish a like unit for use while the warranted unit is being repaired.

(C) Reliability Clause:

While under warranty, the isolation and repair of any unit malfunction shall be the responsibility of the supplier. Any unit experiencing a total of three failures that has twice been returned to the supplier for repair shall be replaced with a new unit of the same type at no charge to the City. The replacement unit's warranty shall be that of a new unit.

Malfunctions do not include damage caused by lightning, power surges, negligence, acts of God, or use of equipment in a manner not originally intended by its manufacturer.

4.0 Method of Measurement:

MMUs will be measured and paid for under the cost of the traffic signal control cabinet. No additional or separate payment will be made. The cost considered incidental to the cost of the traffic signal control cabinet.

5.0 Basis of Payment:

None

ITEM 4-4 LOAD SWITCH

1.0 Description:

Load switches shall be solid state and shall conform to the requirements of Section 6.2 of the NEMA TS2 Standard and these specifications.

2.0 Materials:

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.

The full complement of load switches shall be supplied with each cabinet to allow for maximum phase utilization for which the cabinet is designed.

Other load switch requirements

Meet NEMA TA-1994, TS-1998, and Type 170 requirements
Maximum load current: 10 Amps RMS over temperature range of -34 degrees Celsius to +74 degrees Celsius
Operating voltage range: 60 to 135 VAC
Maximum input current less than 20 mA
Peak Inverse Voltage: 600 V
Once cycle surge: 250 A peak

Acceptable load switch to be installed by contractor are EDI 510 Load Switch or approved equivalent.

3.0 Construction Requirements:

(A) Warranty:

The load switch shall be warranted by the manufacturer against mechanical and electrical defects for a period of 1 year from date of shipment.

Any defects shall be corrected by the manufacturer or supplier at no cost to the owner.

(B) Replacement Coverage:

If a malfunction occurs during the warranty period, the supplier shall, within two (2) weeks after notification furnish a like unit, module, or auxiliary equipment, for use while the warranted unit is being repaired.

(C) Reliability Clause:

While under warranty, the isolation and repair of any unit malfunction shall be the responsibility of the supplier. Any unit experiencing a total of three failures that has twice been returned to the supplier for repair shall be replaced with a new unit of the same type at no charge to the City. The replacement unit's warranty shall be that of a new unit.

Malfunctions do not include damage caused by lightning, power surges, negligence, acts of God, or use of equipment in a manner not originally intended by its manufacturer.

4.0 Method of Measurement:

Load switches will be paid for under the cost of the traffic signal control cabinet. No additional or separate payment will be made. The cost considered incidental to the cost of the traffic signal control cabinet.

5.0 Basis of Payment:

Blank

ITEM 4-6 VIDEO DETECTION (1,2, 3 OR 4 CAMERA)

1.0 Description:

The contractor shall furnish, install, and test a video detection system consisting of video image detectors (VID) for vehicle detection at traffic intersections and at other (mid-block) locations, as shown on the Project Plans. Acceptable video detection products include Autoscope Terra or approved equal.

2.0 Materials:

(A) General Requirements:

The video detection system shall consist of a detector rack power supply, hard-wired color video cameras, all necessary video and power cabling with connections, surge suppression, video detection processor(s) capable of processing the number of camera and phase combination video sources shown on the Project Plans. The video detection processor may reside either in the traffic control cabinet or in the VID camera housing.

All VID cameras shall be of the same brand and shall be completely compatible with the video detection processor, and shall be qualified by the manufacturer to ensure proper system operation.

The detection processor (if in the traffic signal cabinet) or interface cards (if processor in camera) shall mount in a standard detector rack, using the edge connector to obtain power and provide contact closure outputs, no adapters shall be required. Detector rack rewiring shall not be required. Each processor card shall be IP addressable using the UDP/IP message packet and routing standard.

VID software shall consist of systems communications that shall operate over any appropriate serial communications links and automatically assign IP addresses for all devices in the system. System software shall be able to allocate IP addresses

automatically for all processor units. A means of communications and recovery when two devices have the same IP address shall be provided.

The system shall be supplied with a software developer's kit that provides the necessary tools for software programmers to integrate the video detection system into a larger traffic management system.

The contractor shall furnish all necessary mounting brackets to mount the cameras to the luminaire mast arms, as shown in the Plans. Mounting brackets shall result in a fixed-position mounting capable of withstanding a wind load of 90 mph with a 30% gust factor.

(B) Environmental Requirements:

The VID processor shall be designed to operate from –34°C to +74°C with no cooling airflow, 0 – 95% relative humidity, non-condensing. The VID cameras shall be designed to operate from –34°C to +60°C with no cooling airflow, 0 – 95% relative humidity, non-condensing.

Both the VID processor and VID cameras shall be compliant with NEMA TS-1/TS-2 and Caltrans Traffic Signal Control Equipment Specifications for shock, vibration, and voltage transient protection.

(C) Functional Requirements:

The VID shall adhere to the following functional requirements:

1. Detection Performance:

    - The video detection processor shall be capable of outputting the detection signal directly to the traffic signal controller.
    - The detection performance of the processor card shall support the camera locations as shown on the Project Plans, and detection zones, per phase, as directed by the COG traffic signal supervisor.
    - Provide stop bar and advance detection, speeds, counts and five levels of vehicle classification simultaneously.
    - Capable of combining the output of multiple detectors with logical operators (AND, OR, NAND), and modify the combined state based on delay or extension timers relative to the state of any signal phase, or other inputs.
    - The processor shall be able to detect the absence of a valid video signal on each image sensor input. Upon detecting the absence of a valid video signal, the processor shall place all detector outputs associated with the failed image sensor input on maximum recall.
    - The processor shall be able to detect when the quality of the video input signal is not sufficient to enable video detection. Use of this video loss

detection capability shall be selectable by the user. If a video failure is detected, the processor shall place the detector outputs associated with the failed sensor on recall, maximum recall, or fixed time recall, as selected by the user.

- Detection zones shall be able to be overlapped for optimal roadway coverage. Selective groups of detectors shall be able to be logically combined into a single output and further modified by using optional delay and extension timing and signal state inputs.
- Capable of detecting both approaching and receding vehicles with similar accuracy.

2. Camera/Video:

   - Capable of a minimum distance of 500 feet from the camera location to the traffic signal cabinet.
   - High resolution color video output (460 TVL horizontal, minimum) consistent in all weather and lighting conditions. For intersection VID installations, analog video from all four cameras shall be available at the traffic control cabinet for eventual transmission to the TMC for viewing.
   - Signal to Noise Ratio (SNR) of 46 dB, minimum.
   - Automatic Gain control (AGC) to produce a satisfactory image in low light.
   - The camera shall produce a useable video image of the bodies of vehicles under all roadway lighting conditions, regardless of time of day. The minimum range of scene luminance over which the camera shall produce a useable video image, without AGC, shall be 1.0 lux.
   - Contained in a sealed environmental enclosure with a sunscreen. The maximum dimensions of the entire unit (including sunscreen) shall not exceed 17” in length, 6” in diameter, and shall not weigh more than 6 pounds.
   - Variable focal length lens that can be adjusted remotely using computer configuration software. The minimum horizontal angle of view for the camera/lens combination shall be 10° to 70°.
   - The camera shall be equipped with an automatic iris.

3. Cabling:

   - Video cable shall be as specified by the VID manufacturer.
   - Power cables shall be three conductor cable rated for 90°C, 300 V operation and be of a gauge specified by the VID manufacturer. Conductor insulation color coding shall be Black, White, and Green.
   - Power cables shall be UL listed and be suitable for installation in conduit and exposed to sunlight.

4. Surge Protection:

- All video inputs shall be protected with EDCO in-line surge suppressor CX06-BNCY or EDCO panel-mounted surge suppressor NRMCX-06 and RM4POS.

3.0 Construction Requirements:

The VID system shall be installed and setup by factory certified installers of the equipment, per the manufacturer's recommendations.

Where coaxial cable serving the cameras is required, it shall run unspliced between the camera and the controller cabinet, with 10 feet of slack provided in the controller cabinet.

The Contractor shall maintain and protect in place the existing VID units installed in the project area.

The Contractor shall protect in place all existing inductive loop infrastructure in the project area. This includes maintaining and protecting in place all in-pavement inductive loops, DLCs, home runs, cabinet termination panels, and connectors. Any existing inductive loop circuits that the Contractor disconnects from the existing controller shall be labeled, neatly wrapped, and left in functioning order in the cabinet, for possible future use by the COG in the future. Any existing inductive loop circuits that are removed or damaged during construction shall be replaced in kind by the Contractor at no cost to the COG.

(A) Test Requirements:

1. Stand-Alone Test:

   - Intersection Detection:
     The intersection VID shall be tested twice, once at dawn for the East and South facing cameras and again at dusk for the West and North facing cameras, during times approved by the COG. Testing two phases simultaneously is acceptable. Each phase shall be monitored for a 30-minute period for detection accuracy. During this period the contractor shall verify that no missed calls or false calls are made during this 30-minute test period. A false call is defined as any call that is placed continuously for 5 seconds or longer when there are no vehicles present within the detection zone. A missed call is defined as any continuous period of time greater than or equal to 5 seconds, during which a vehicle is present within a detection zone without a call on the VID. If a false call or missed call occurs during the test, the video detection camera, hardware, software, or detection zones configuration shall be adjusted as necessary to improve performance and a new 30-minute test period shall be used to ensure that no false or missed calls are occurring.

- Video Quality:
  Each intersection video output shall be displayed on a color monitor at the traffic signal cabinet (prior to connection to the quad splitter) at dawn and dusk and the quality of the picture shall be verified to be similar in quality to existing CCTV images.

2. System Acceptance Test:

   No specific testing is required of the contractor during the System Acceptance Test. However, the COG shall monitor the status of the detectors during this period and verify that all detectors and video images (intersections only) appear to be working properly. If an anomaly is noticed, the City shall alert the contractor immediately. If the detector is not functioning correctly, the System Acceptance Test period shall be halted until such time that the contractor repairs the detector and is functioning properly. The test shall then be restarted with one day added to the test time. If three such events occur, the System Acceptance Test shall be reinitialized to day zero and restarted.

4.0 Method of Measurement:

The Video Detection Systems furnished and installed shall be measured per each for each Video Detection System per location, and shall include all labor, material, testing, and documentation needed to complete an operational VID in accordance with the Plans and these Special Provisions**.**

5.0 Basis of Payment:

The accepted quantities of each type of Video Detection System, measured as provided above, will be paid for at the contract unit price, which shall be full compensation for the work, complete in place.

ITEM 4-7 SIGNAL HEADS

1.0 Description:

The contractor shall furnish and install traffic signal indication assemblies, pedestrian signal indications, and internally illuminated street name signs at the locations shown on the project plans and in accordance with the details shown on the plan, standards, and the requirement of these specifications.

2.0 Materials:

(A) General:

All new signals, except for pedestrian types, installed at any one intersection shall be of the same manufacturer and of the same material.

Each traffic signal head shall consist of a number of complete identical signal sections fastened together to present a continuous appearance. Any (POLYCARBONATE) signal head being supplied must have documentation that the unit is molded from LEXAN Composite ML 4754 polycarbonate resins.

(B) Signal Head Housing (Metal):

The housing of each section shall be a one-piece corrosion resistant aluminum alloy die casting. Two integrally cast hinge lugs shall be on the left of each section, and two integrally cast latch screw lugs shall be on the right side of the housing. The top and bottom of the housing shall have an opening to accommodate a standard 1-1/2 inch pipe bracket. Each signal section shall be capable of being attached one above the other. The top and bottom opening of the signal housing shall have a Shurlock boss integrally cast into the housing and shall have an ornamental cap installed in the openings at time of delivery. The radial angular grooves of the Shurlock boss shall provide positive five degree increment positioning of the entire signal head to eliminate rotation or misalignment of the signal head.

(C) Signal Head Housing (Non-Metal):

The housing of each section shall be one-piece injection molded from polycarbonate resins. Two integrally cast hinge lugs shall be on the left of each section, and two integrally cast latch screw lugs shall be on the right side of the housing. The top and bottom of the housing shall have an opening to accommodate a standard 1-1/2 inch pipe bracket. Each signal section shall be capable of being attached one above the other. The top and bottom opening of the signal housing shall have a Shurlock boss integrally cast into the housing and shall have an ornamental cap installed in the openings at the time of delivery. The radial angular grooves of the Shurlock boss shall provide a positive five degree increment positioning of the entire signal head to eliminate rotation of misalignment of the signal head.

(D) Housing Door (Metal):

The housing door of each section shall be a one-piece, corrosion resistant aluminum alloy die casting. Two hinge lugs shall be cast on the left of each door, and two latch jaws shall be cast on the right side of each door. Two hinge pins shall attach the doors. Two latch screws and wing nuts on the right side of the housing shall provide for opening and closing the signal door without the use of any special tools. The door shall accommodate a weatherproof and mildew-proof closed-cell resilient, neoprene gasket. The outer face of the door shall accommodate the signal head visor. All hinges, bolts, screws and other metal in the signal head shall be stainless steel or other corrosion resistant material.

(E) Housing Door (Non-Metal):

The housing door of each section shall be a one-piece, injection, molded from LEXAN Composite ML 4754 polycarbonate resins. Two hinge lugs shall be cast on the left of each door, and two latch jaws shall be cast on the right side of each door. Two hinge pins shall attach the doors. Two latch screws and wing nuts on the right side of the housing shall provide for opening and closing the signal door without the use of any special tools. The door shall accommodate a weatherproof and mildew-proof closed-cell resilient, neoprene gasket. The outer face of the door shall accommodate the signal head visor. All hinges, bolts, screws and other metal in the signal head shall be stainless steel or other corrosion resistant material.

(F) Painting:

All surfaces interior and exterior of the housing, door and visors shall be finished with tow coats of best quality oven baked paint before assembly.

First coat-primer: Shall be Epoxy Oxide Baking Primer or equivalent and shall meet Federal Specifications TT-P-636.

Second coat-enamel: Shall be Traffic Signal Black Exterior Baking Enamel and Shall meet Federal Specifications TT-C-595-1415.

(G) Visors (Metal):

Visors shall be tunnel visors and formed from corrosion resistant aluminum alloy sheet. Tunnel visors shall have a four inch open slot at the bottom and twist-on attaching ears to facilitate installation. On a standard 8 inch traffic signal head the visor shall be seven to eight inches long and on 12 inch traffic signal head the visor shall be nine to ten inches long.

(H) Weight:

The weight of each eight inch signal section shall not exceed nine pounds, less frame work. The weight of each 12 inch signal section shall not exceed 13 pounds, less frame work.

(I) Backplates (Metal):

All backplates shall be one-piece, anodized aluminum sheet metal 16 gauge. The color shall be flat black.

(J) LED's:

LED's are required to be installed in all signal heads. For LED's the operating Voltages shall have a range of 80 VAC to 135 VAC on 60 Hz AC line. Maximum wattage for standard LED traffic signal lamp (ball) shall be 24 watts for a 12" and 12 watts for an

8”at 120 VAC @25C. Maximum wattage for 12” arrow lamp shall be 12 watts at 120 VAC @25C. Operating current measured across each LED shall not exceed an average of 30mA at normal voltage (120 VAC).

In a standard “approved” (COG) Signal housing, the installation of the LED lamps shall be a “NO TOOL” installation and shall not require the removal of any of any components of the traffic signal except the removal of the replaced incandescent bulb.

Transient voltage suppression shall be rated at 1,500 watts for 1 millisecond and fusing with a maximum rating of 2 AMPS. LED's shall be arranged in no less than six (6) loaded circuits. The LED signal lamp shall have a diode string failure rate of no more than “1 for 5” (20%), that is, for any individual diode failure no more than five (5) diodes shall be extinguished. Power Factor shall meet (or exceed) FCC title 47, part 15, sub part B, Class A (section 15.07(b)) Standard, in accordance with ANSI C63-4-1992, and shall be no more than 0.90. Total harmonic distortion shall be no more than 20%. Electrical connection shall be wireless and made via an Edison type screw in device, and shall be capable of corrective alignment to ensure correct orientation to accurately match the dominant wavelength of existing signal house lens. Beam of color, each LED lamp shall meet ITE specifications (VTCSH-July 1998). Beam intensity, each LED lamp shall meet (or exceed) ITE specifications (VTCSH- July 1998, Table 1). LED shall use TS-AlInGap technology for Red and Yellow lamps and GaIn technology for Green lamps. LED lamps shall be rated for 100,000 or more hours of operation at the specified amperage and operating temperature. Each LED lamp shall have a Low temperature compensation circuit with a range of -40F (-40C) and shall have a high temperature compensation circuit with a range of up to + 74C (+165F). LED lamps shall be dust and moisture tight to protect internal LED electrical components and shall allow for safe handling in all weather conditions. LED lamps shall retain a minimum of 85% of its luminous intensity for at least 36 months as per the value specified in Section 1.04 of the VTCSH. Each lamp shall be marked with an arrow denoting the “UP” position for correct orientation when installed.

Each LED shall be marked with its own serial number.

(K) LED Ped Head:

LED Ped heads shall conform to all ITE specifications and the following. The pedestrian head shall overlay the “HAND” and “MAN” symbols on the left side of the signal face. On the right side of the signal face shall be a two digit countdown “TIMER”. The “HAND” , “MAN” and “TIMER” symbols shall have an “incandescent look”. Symbols with an LED look and “outline figures” will not be acceptable. The “HAND” symbol and “TIMER” numerals shall be Portland Orange. The “TIMER” numerals shall be a minimum of 9 inches in height. The “MAN” symbol shall be Lunar White. The LED's shall be rated for a minimum of 100,000 hours of continuous operations. The housing for the Ped Heads shall be flat black; die cast aluminum alloy signal sections equivalent to a McCain MTS-113SGO or ICC 7037 units. For LED's the operating voltages shall have a range of 80 VAC to 135 VAC on a 60 HZ AC line. Maximum wattage for a standard LED Ped head

shall not be greater than 12 watts at 120 VAC @ 25 C. Operating temperature for the LED Ped head shall be from -40C (-40F) to +74C (165F).

(L) Miscellaneous:

Internal illuminated street name signs, when furnished by contractor, shall be NUART NAIM 1-4-200-D or McCain M60162C, or Myers MEIS 1648-s, with lamps included. The illuminated sign face shall be a blank face on which the City can stencil or silk screen the appropriate street name.

3.0 Construction Requirements:

Construction shall be such that all conductors are concealed within assemblies. Cable guides shall be used to support and protect conductors entering through poles. All threads shall be coated with rust-preventive paint during assembly.

Each vehicle, pedestrian signal, or flasher assembly shall be mounted at the location and in the manner shown on the project plans.

When signal faces are mounted on a mast arm, the plumbizer when specified shall be placed on the mast arm, and a 3/8-inch by four-inch bolt shall be used to fasten both together.

Materials removed and not designated to be salvaged or incorporated into the work shall become property of the contractor.

All traffic signal heads not in use shall be covered with burlap and shall be unmistakably out of service when observed by an approaching driver. Plastic coverings shall not be allowed.

4.0 Method of Measurement:

Traffic signal heads, pedestrian signal head, and internally illuminated street name signs will be measured as a unit price for each type of signal head or internally illuminated street name sign furnished and installed.

5.0 Basis of Payment:

The accepted quantities of traffic signal heads, pedestrian signal heads, and internally illuminated street name signs, measured as provided above, will be paid for at the contract unit price for each, for the type of signal head, pedestrian signal head, and internally illuminated street name sign designated in the bidding schedule, complete in place, which price shall be full compensation for the work described and specified herein and on the plans, including visors, backplates, lamps and all hardware necessary to provide a complete, functional installation.

No direct payment will be made for assembly of City-furnished items, the cost being considered as included in the contract price bid for the item in place.

ITEM 4-8 SIGNAL STRUCTURES

1.0 Description:

The contractor shall furnish all materials and construct new supports and foundations for traffic signal indication mounting assemblies, poles, mast arms, at the locations shown on the project plans and in accordance with the details shown on the plan, standards, and the requirement of these specifications.

Pole foundations shall include all conduit, elbows, anchor bolts, grounding wire and reinforcing steel.

2.0 Materials:

(A) General:

Supports for traffic signals, mast arms and poles shall comply with the current "2001 Standard Specifications for Structural Supports for Highway Signs, Luminaries, and Traffic Signals" by the American Association of State Highway and Transportation Officials (AASHTO). The structures shall comply with the 80 mph wind load criteria and detail requirements of the AASHTO specification.

(B) Poles and Mast Arms:

Poles and self-supporting mast arms shall be a true continuous tapered circular tube. Steel material used shall conform with the minimum strength requirements of ASTM A595 Grade A. There shall not be more than one longitudinal welded seam. Longitudinal seams shall be automatically electrically welded. All welds shall conform to the current "American Welding Society" structural welding code. Weld seams shall be neat and uniform in appearance and shall have thickness not less that 1/16 inch. The number of sections and welds on signal mast arms shall be limited so that no section is less than ten feet in length and that the first section of the largest diameter near the pole connection plates shall be a minimum of 20 feet in length. A reduction in size or thickness may be permitted on the "Q" series poles, 12 inches above the mast arm connection, to complete the full length of the pole.

Poles shall be fitted with a weld-on base plate manufactured form structural steel, which meets or exceeds ASTM A36 minimum strength requirements. Each pole shall include a reinforced steel hand hole frame and cover, oriented opposite the direction of the mast arm and at the base of the pole. In addition, "Q" series poles shall have an additional reinforced hand hole frame and cover mounted opposite the mast arm connection plate. Details of hand hole are on Specification Sheet T 5-10. Captive hardware for the hand hole cover shall be stainless steel, plated or galvanized steel and

be equipped with a stainless steel small link high strength chain connected to the pole and cover. The chain shall be six inches in length.

Mast arms requiring guy rods, truss framing or under bracing shall not be permitted. Signal mast arms shall be provided with a four bolt attachment plate. The pole attached assembly shall consist of suitable plates with gussets forming a box at the specified angle to accept the mast arm. Assembly of the mast arm to the pole shall be by high strength plated or galvanized bolts. The connection shall accept the full moment resisting capability of the arm with load as specified on the drawings. The butt diameter of the mast arm shall not exceed the nominal diameter of the pole at the point of attachment.

(C) Anchor Bolts:

High strength anchor bolts, washers and nuts shall be fabricated from steel which meets or exceeds ASTM A325 minimum strength requirements and elector-galvanized, the entire length of the bolt, in accordance with ASTM B633. Welding shall not be performed on any portion of the body of the high strength anchor bolt. All anchor bolts shall be 2 x 90 and have a six inch L bend at the bottom and shall be threaded to six times the diameter at the top end. Four anchor bolts with double nuts and washers shall be supplied with each pole. Specifications shall be supplied with each set of anchor bolts.

(D) Base Covers:

Each pole shall be supplied with a two piece base cover made of suitable material and per the standards.

(E) Incidentals:

Each pole and mast arm shall be furnished with a suitable pole cap with captive set screws. Each pole shall be furnished with four suitable mast arm bolts screwed into the mast arm base plate holes and three suitable luminary mast arm bolts screwed into the luminary mast arm base plate.

All steel metal products shall be galvanized after fabrication in accordance with the current ASTM specifications. The manufacturer shall identify the ASTM method on the shop drawings for approval.

All poles and mast arms supplied shall carry the name of the manufacturer and/or fabricator and dimensions of the device on a permanent metal tag attached by rivets above the base hand hole cover on poles and near the mounting base, on the bottom side, for mast arms. All dimensions shall be given in feet and inches.

Supports not specifically detailed and alternates to the bid shall be demonstrated, to the satisfaction of the Engineer, as being structurally equivalent to the specified design. The general appearance of the alternative structures shall be the same as detailed in

the City's specifications. Differences in manufacturing standards and techniques are understandable. For the purposes of complying with these specifications and drawings the gauge of the steel specified and the nominal thickness may vary as long as the developed strengths are applicable and comply with the AASHTO specifications.

3.0 Construction Requirements:

Construction requirements shall be in accordance with Section 731-2 of the ADOT Standard Specifications.

4.0 Method of Measurement:

The structural supports and foundations for traffic signal and lighting will be measured as a unit for each type of support and foundation furnished and installed.

5.0 Basis of Payment:

The accepted quantities of supports and foundations for signals and lighting, measured as provided above, will be paid for at the contract unit price for each , for the type of support or foundation designated in the bidding schedule, complete in place, which price shall be full compensation for the work described and specified herein and on the plans, including all hardware, wire, excavation, backfill and incidentals necessary to complete the work.

No measurement or direct payment will be made for anchor bolts, the cost being considered as included in the unit price paid for foundations.

ITEM 4-9 SERVICE/UNINTERRUPTIBLE POWER SUPPLY (UPS) EQUIPMENT

1.0 Description:

A Service/Uninterruptible Power Supply (UPS) battery backup system shall be furnished and installed by the contractor in accordance with the Plans and these specifications.

The UPS system shall protect the 120 volt circuits supporting the traffic signal controller, controller cabinet, traffic signal faces and pedestrian faces. The UPS system is not intended to support any safety lighting or sign lighting unless otherwise specified on the Plans.

2.0 Materials:

The Service/UPS system shall be combined in a single cabinet containing the meter pedestal components and UPS system components.

The UPS system shall consist of a UL-listed UPS controller unit, manufacturer recommended batteries of sufficient amp-hour ratings to support the specified load and operating duration, manual bypass switch, and manufacturer specified surge protection devices.

UPS system in combined UPS/meter pedestal cabinet shall be TESCO Model 27-22 BBS Combination.

TESCO Controls Inc.
3409 52nd Avenue
P.O. Box 239012
Sacramento, Ca. 95823-9012
(916) 395-8800
www.tescocontrols.com

The contractor shall verify that the specific proposed UPS equipment models are approved by the City. Products or models not specifically pre-approved by the City or other than those listed above, must be approved by the City prior to use.

The contractor is responsible for obtaining approval of the specific UPS equipment models and cabinets from the utility company providing electrical service, when utilizing a combined UPS/meter pedestal cabinet.

(A) Cabinet:

The cabinet shall be steel and of tamperproof construction with piano-hinged doors and provisions for padlocks. The housing shall be of a NEMA 3R weather resistant construction. There shall be no exposed nuts, bolts, screws, rivets or other fasteners on the exterior of the enclosure.

The cabinet shall be treated on the inside and outside with one coat of primer paint and painted two coats of aluminum paint.

Combination UPS/meter pedestal cabinets shall be furnished with cast-in-place concrete foundations of a size and dimensions as specified by the manufacturer.

A maintenance pad of the same width as the cabinet foundation, four inches in thickness, and extending a minimum of 36 inches out from the face of the cabinet shall be provided.

Conduits in the foundation shall be as specified on the Plans.

Exact location and orientation of the cabinet shall be field determined by the Engineer.

The Service/UPS system cabinet shall not be attached to the traffic signal controller cabinet, and shall be located a minimum of five feet from any other cabinet, wall, fence or other physical obstruction.

(B) UPS Controller Unit:

The UPS controller unit shall provide sufficient output power to support the quantity and wattage of traffic signal and pedestrian faces shown on the project plans, but in no case less than 700 watts.

The UPS controller unit shall have an operating temperature of –40 degrees C to +74 degrees C.

The UPS controller unit shall be capable of providing serial communications. Serial communications shall be through an RS 232 serial port. The contractor shall furnish and install a serial cable, unspliced, from the UPS controller unit to the traffic signal controller cabinet, allowing ten feet of cable in the controller cabinet for future termination by the City. The cabinet end of the serial cable shall be furnished with spade connectors connected to each wire within the serial cable.

The UPS system shall have a manual bypass switch for maintenance or servicing purposes without affecting continuous power output to the traffic signal controller, or tripping the conflict monitor/malfunction management unit.

(C) Batteries:

Batteries shall be of sufficient amp-hour ratings to support the quantity and wattage of traffic signal and pedestrian faces shown on the project plans, but in no case less than 700 watts in an operating mode that supports full cycling and operation of the traffic signals for a minimum of four hours, followed by operation in a flashing mode of an additional minimum of four hours. The contractor shall furnish calculations or other supporting documentation bearing evidence that the proposed batteries will meet or exceed this provision.

The batteries shall be completely sealed and maintenance-free. Batteries shall be Absorbed Glass Mat/Valve Regulated Lead Acid (AGM/VRLA) or Gel type.

Batteries shall have terminal covers to protect from accidental contact with metallic terminal components.

3.0 Construction Requirements:

Blank

4.0 Method of Measurement:

Service/Uninterruptible Power Supply (UPS) Equipment will be measured as a unit for each combination meter/UPS cabinet furnished and installed.

5.0 Basis of Payment:

The accepted quantities of UPS battery backup systems, measured as provided above, will be paid for at the contract unit price each, for furnishing, assembling, installing and testing Service/UPS battery backup systems, which price shall be full compensation for the work, complete in place, as described and specified herein and on the Plans, including cabinets, foundations, conduit, elbows, anchor bolts, maintenance pad, UPS controller unit, serial cable, surge protection devices, batteries and all other components necessary to provide a complete functional UPS system for controlling the operation of traffic control signals for the time periods and in the manner specified herein.

ITEM 4-10 EMERGENCY VEHICLE PREEMPTION SYSTEM

1.0 Description:

The contractor shall furnish, install, and test an emergency vehicle preemption system consisting of Optical Preemption Detectors, Optical Detector Cable, and Optical Signal Processor for emergency vehicle preemption at signalized intersections as shown on the Project Plans.

2.0 Materials:

The emergency vehicle preemption system shall be TOMAR STROBECOM II or approved equal.

(A) Optical Preemption Detector:

The optical preemption detector shall be TOMAR 2090-SD or approved equal which meets the following requirements:

The optical preemption detector shall sense and transform optical energy from optical emitters into electrical signals to be decoded by the optical signal processor.

The optical preemption detector shall sense optical emitter signals to an adjustable range of 2500 feet (762m) in optimum atmospheric conditions.

The optical preemption detector shall transmit electrical signals to the optical signal processor via up to 1000 feet of optical detector cable.

The optical preemption detector shall have an internal terminal strip with wiring label for convenient positive connection to the detector cable.

The optical preemption detector shall have a nominal conical 13-degree field of view centered about the view port normal axis. The optical detector can be operated with standard length or optional short scope when a greater than 13 degree field of view is desired.

The optical preemption detector shall operate over a range of 12 to 30 VDC and current of up to 15 mA maximum.

The optical preemption detector shall operate within a temperature range of -40 degrees Celsius to +75 degrees Celsius.

The optical preemption detector shall be manufactured from black glass-filled, UV Stabilized polycarbonate suitable for all weather use. The detector shall be sealed and weatherproof. A weep hole shall be provided for the escape of condensation in the sigt tube of the detector.

The optical preemption detector shall be of single channel, single direction configuration only, with a ½ inch female pipe mount connection. Hardware shall be available from the manufacturer to allow mounting the optical detector to mast arm, span wire and various other possible intersection mounting configurations.

(B) Optical Preemption Detection Cable:

The optical preemption detector cable shall consist of three conductor shielded control cable with foil shield overall and ground wire which Meets the m requirements of IPCEA-S-61-402/NEMA WC5, Section 7.4, 600-Volt Control Cable, rated for 75 degree Celsius, Type B and following:

1. Conductors:

   - Quantity – 3
   - Gauge – 20 AWG (7 x 28) stranding
   - Conductor Material – Individually tinned copper strands
   - Insulation – PVC, 80C, 600V, 25 mil minimum average thickness
   - Color – 1 Blue (ground), 1 Orange (VDC), and 1 Yellow (signal)

2. Shield:

   - Aluminized polyester film or approved equal, applied with a nominal 20% overlap to provide 100% shield coverage.

3. Drain Wire

   - Gauge – 20 AWG (7 x 28) stranding
   - Material – individually tinned copper strands, Uninsulated and in contact with the shield conductive surface

4. Electrical Characteristics

   - Drain and conductor DC resistance shall not exceed 11.0 ohms per thousand feet

- Capacitance from one conductor to the other two conductors shield shall not exceed 48 pf/ft at 1000Hz

5. Jacket

- Minimum average wall thickness – 0.045”
- Temperature rating – 80C
- Voltage Rating – Voltage Rating – 600V
- Material – PVC, Black
- Nominal O.D. over jacket – 0.35”

(C) Optical Signal Processor:

The optical signal processor shall be installed in the traffic controller cabinet to decode the electrical signals from optical detectors. The Optical Preemption Dectors shall be TOMAR 2070 or approved equal which meets the following requirements:

The optical signal processor shall interface directly with NEMA TS-1 and TS-2 with suitable system interface equipment and software.

The optical signal processor shall be capable of receiving, decoding, and prioritizing signals from the TOMAR 2060 or 3060 series emitters.

The optical signal processor shall be powered from 120 VAC (95VAC to 135VAC), 50/60Hz mains and have an on board, regulated power supply that supports up to 10 optical detectors.

The optical signal processor shall operate within a temperature range of -40 degrees Celsius to +75 degrees Celsius.

The optical signal processor shall be modular in construction and come standard with four individual signal processor modules, (4 Channel) each channel capable of receiving and decoding emergency or transit band signals simultaneously.

The optical signal processor front panel shall have the following features:

A power on/off switch with corresponding indicator.

Indicators for emergency and transit band reception status for each of four channels.

Test switches for activating internal diagnostics.

A range arm switch for enabling the setting of detection range. Any number of channels and bands shall be able to be armed simultaneously for range set.

An inter-module bus expansion connector, which shall allow connection of additional optical signal processor modules or system accessories.

The unit shall be upgradeable to a higher level of features utilizing the existing circuit board and some of the on board components. This shall be accomplished with minor effort.

3.0 Construction Requirements:

The Emergency Vehicle Preemption System shall be installed and setup by factory certified installers of the equipment, per the manufacturer's recommendations.

Cable serving the OPD shall run unspliced between the detector and the controller cabinet, with 10 feet of slack provided in the controller cabinet.

4.0 Method of Measurement:

The Emergency Vehicle Preemption System furnished and installed shall be measured per each for each Emergency Vehicle Preemption System per location, and shall include all labor, material, and documentation needed to complete an operational Emergency Vehicle Preemption System in accordance with the Plans and these Special Provisions.

5.0 Basis of Payment:

The accepted quantities of each type of Emergency Vehicle Preemption System, measured as provided above, will be paid for at the contract unit price, which shall be full compensation for the work, complete in place.

ITEM 6-1 LOOP DETECTORS

1.0 Description:

The contractor shall furnish and install loop detectors in the sizes and at the locations shown on the Plans and in accordance with standard details T6-1 through T6-3 and the requirements of these specifications.

2.0 Materials:

Loop detector wire shall conform to International Municipal Signal Association (IMSA) Specification 51-5. The saw cut loop sealant shall be hot applied rubberized asphalt formulated specifically for use as a loop sensor saw cut sealant. The sealant shall be non-tracking during application and relatively stiff but flexible after application at low pavement temperatures.

Preformed loops may be required by the design plans or proposed by the contractor and shall be separately approved by the City.

3.0 Construction Requirements:

Loops shall be located in the center of the traveled lane. The loop sensor layout shall be made on the pavement surface prior to cutting and shall be approved by the Traffic Signal Supervisor.

All saw cuts shall be made with an abrasive type saw. The sawed slot shall extend to the curbside for each loop detector. Separate lead-in slots extending from the loop to the curbside shall be made for each loop detector. All corner points shall be core drilled at full depth of the loop saw cut.

All saw cuts shall be flushed clean of all debris prior to the installation of the loop wire. Loop wire shall not be installed in unclean or wet saw cuts. Loop wire in adjacent loops shall be installed in opposite directions to reduce interference. Each pair of loop sensor wires entering a curb-side pull box shall be labeled to identify which loop it represents by lane and direction.

All loops shall be given a continuity and insulation test before and after placing the sealant in the saw cuts. Minimum reading to ground shall be at least 100 Meg-Ohms. Any loop detector sensor that does not meet the insulation test or does not properly tune when connected to the amplifier shall be replaced by the contractor.

Saw cuts shall be filled with a sealant specifically intended for loop sealant applications. The sealant shall completely surround the loop sensor conductors and fill the saw cut within 1/8 in. of the pavement surface. If necessary, the pavement shall be patched with a material that matches the existing pavement or an approved equivalent.

4.0 Method of Measurement:

Loop detectors will be measured as a unit for each size and type of loop detector installed.

5.0 Basis of Payment:

The accepted quantities of detectors will be measured as described above and will be paid for at the contract unit price. Payment shall be full compensation for the work, complete in place.

ITEM 12-1 CONDUCTORS

1.0 Description:

The contractor shall furnish and install International Municipal Signal Association (IMSA) cable at the locations designated on the Plans and in accordance with the details shown on the Plans, standards, and the requirements of these specifications.

2.0 Materials:

IMSA cable shall be used as specified on the Plans. IMSA signal cables shall be polyethylene insulated copper conductors, polyvinyl chloride jacketed, rated at 600 volts

for use in underground conduit or as aerial cable conforming to International Municipal Signal Association Specification No. 19-1.

The IMSA-19 cable shall be provided with the number and size of conductors as specified on the Plans. The cable shall use the standard IMSA colors for conductor insulation. The colors and tracers shall be permanent and an integral part of the insulation, and shall not be painted, surface coated, or adhered to surface.

3.0 Construction Requirements:

Wiring shall conform to construction requirements of Section 732-3.02, 732-3.03, and 732-3.04 of the ADOT Standard Specifications.

4.0 Method of Measurement:

Conductors will be measured as a complete unit of work. This method of measurement shall be used for signal and lighting conductors shown on the signal and lighting conductor schedule on the Plans.

5.0 Basis of Payment:

The accepted quantities of conductors, measured as provided above, will be paid for at the contract lump sum price, which price shall be full compensation for the work, complete in place.

ITEM 13-1 SINGLE MODE FIBER OPTIC CABLE (12, 24, 72, OR 96 FIBERS)

1.0 Description:

The contractor shall furnish and install single mode fiber optic (SMFO) cable at locations shown in the Plans.

2.0 Materials:

(A) Documentation:

Prior to installation, certification shall be provided showing that the cables furnished and installed are in conformance with the appropriate Specifications. This certification shall be in two parts:

1. Certification from the cable manufacturer that the cable is in conformance with the Rural Electrification Administration (REA) Bulletin PE-90 (where applicable) and these Specifications.

2. Certification that the installation of the communication cable subsystem is in accordance with the cable and splice manufacturer's recommendations and these Specifications.

(B) Technical Requirements:

All fiber optic cable shall be single mode fiber optic cable that is of loose tube construction, filled with a water-blocking material, and constructed by a certified ISO 9001 or 9002 manufacturer.

Fiber optic cable shall be dielectric and comply with the requirements of REA PE-90 except where modified by these specifications. The fiber optic cable shall comply with the following requirements:

Number of fibers:	12, 24, 72, or 96 as required
Cladding diameter:	125 $\pm$1.0 μm
Core-to-cladding offset:	$\leq$0.8 μm
Cladding non-circularity:	$\leq$1.0%
Maximum attenuation:	$\leq$0.35 dB/km at 1310 nm; $\leq$0.25 dB/km at 1550 nm
Microbend attenuation (1 turn, 1.25" diameter):	$\leq$0.5 dB at 1550 nm
Microbend attenuation (100 turns, 3' diameter):	$\leq$0.05 dB at 1310 nm
Mode-field diameter (matched cladding):	9.3 $\pm$0.5 μm at 1310 nm; 10.5 $\pm$1.0 μm at 1550 nm
Maximum chromatic dispersion:	$\leq$3.2 ps/(nm x km) from 1285 nm to 1330 nm and <18 ps/(nm x km) at 1550 nm
Fiber polarization mode dispersion:	$\leq$0.5 ps/(km)1/2
Fiber coating:	Dual layered, UV cured acrylate

Coating diameter:	245 μm ±10 μm
Minimum storage temperature range:	-40°F to 158°F
Minimum operating temperature range:	-4°F to 158°F
Rated life:	Certify a 20 year life expectancy when installed to manufacturer's specifications

Buffer Tubes: Each buffer tube shall be filled with a non-hygroscopic, non-nutritive to fungus, electrically non-conductive, homogenous gel that is free from dirt and foreign matter. The gel shall allow free movement of the fibers, without loss of performance, during installation and normal operation including expansion and contraction of the buffer tubes. The gel shall be readily removable with conventional nontoxic solvents.

Buffer tubes shall be stranded around a central member using the reverse oscillation or "S-Z", stranding process. Filler rods shall be used in the fiber optic cable to lend symmetry to the cable section.

Central Strength Member: The fiber optic cable shall have a central strength member designed to prevent buckling of the cable.

Cable Core: The fiber optic cable shall utilize a dry water-blocking material to block the migration of moisture in the cable interstices.

Tensile Strength Members: The fiber optic cable shall have tensile strength members designed to minimize cable elongation due to installation forces and temperature variation.

Underground fiber optic cable shall withstand a 600 lbf tensile load where the change in attenuation does not exceed 0.2 dB during loading and 0.1 dB after loading. The cable shall be rated for an installed tensile service load of 200 lbf or more.

Cable Jacket: The fiber optic cable jacket shall be constructed of a high or medium density polyethylene (HDPE/MDPE) jacket that has been applied directly over the tensile strength members and water-blocking material. The jacket shall have at least one ripcord designed for easy sheath removal.

The cable shall be wound on the reel in such a manner as to provide access to both ends of the cable to enable testing to be performed while the cable is on the reel.

Environmental: The cable shall be capable of withstanding the following conditions without damage or decrease in function:

Total immersion in water with natural mineral and salt contents;

Salt spray or salt water immersion for extended periods; and

Wasp and hornet spray.

3.0 Construction Requirements:

(A) Cable Installation Requirements:

The cable shall not be installed in any pull box until the pull box has been approved for pulling by the City's Construction Manager.

The SMFO shall be installed in one of the innerducts as indicated on the Plans. The installation shall be continuous and without splices between allowable splice points as identified in the Plans. The contractor shall perform all final length measurements and order cable accordingly.

The main data trunk line shall be unconnectorized. Branch cables shall be connectorized with male ST-Type connectors as required. The contractor is only required to install as many connectors as is necessary to meet the communications requirements shown in the Plans.

Where connectors are required, the Contractor shall first install a fan-out kit to strengthen and protect the fibers to be connectorized. The fan-out kit shall be of the same manufacturer as the fiber cable or an Engineer approved equivalent.

Connectors shall not introduce more than 0.5 dB attenuation per connector. Connectors found to exceed 0.5 dB attenuation shall be remade at no additional cost, until this requirement is met.

Prior to installing any fiber optic cable, the contractor shall furnish the City with the cable manufacturer's recommended procedures, maximum pulling tension, a list of the cable manufacturer's approved pulling lubricants, and the lubricant manufacturer's procedures for use. The contractor shall adhere to the cable and lubricant manufacturer's installation procedures.

The contractor shall handle fiber optic cable carefully taking care not to pull cable along the ground, over or around obstructions or through unnecessary curves or bends. The contractor shall not exceed fiber optic cable bend radius at any time. If the contractor violates the bending radius of the cable, the entire length of cable from the previous splice point shall be removed from the project and a new cable shall be pulled at no cost to the City.

Manufacturer approved pulling grips, cable guides, feeders, shoes and bushings shall be used to prevent damage to the cable during installation.

Cables shall be pulled in the conduit with a split mesh cable grip or pulling eyes designed to provide a firm hold on the cable. The cable shall not drag on the ground or pavement during installation. The contractor shall ensure that the tensile load on the cable does not exceed the allowed maximum by using a system that includes a means of alerting the installer when the pulling tension approaches the limit and displays the actual tension on the cable. The contractor may supplement this procedure with a

break-away tension limiter set below the recommended tensile limit of the cable being pulled.

When removing cable from the reel prior to installation, place it in a “figure-eight” configuration to prevent kinking or twisting. Take care to relieve pressure on the cable at crossovers by placing cardboard shims (or equivalent method) or by creating additional “figure-eights”.

In all locations where fiber enters a communications vault or No. 9 pull box, 50 feet of cable slack per cable entry shall be loosely looped on the racks and hooks in the box. Where branch fiber cables enter the traffic control cabinets, 10 feet of slack shall be looped and stowed in the cabinet.

The contractor shall label and attach the cables to the racks and hooks with industry standard cable ties immediately upon entering the box. Cable ties should be tightened so that they prevent cable slippage but do not deform or damage the cable sheath. Each cable shall be independently coiled, tied, and racked.

A 12 AWG bare locator wire shall be installed into the conduit along with the SMFO cable. The bare locator wire shall be connected at each pull box using wire nuts to form a continuous circuit for the length of the installed fiber.

(B) Splicing:

The contractor shall contact the ITS Department (623) 847-1162 of the COG at least three working days prior to splicing new cable to the existing data trunk-line.

All splices shall be fusion spliced and shall not introduce more than 0.1 dB attenuation per splice. Splices found to exceed 0.1 dB shall be re-spliced at no additional cost, until this requirement is met. Each splice shall be packaged in a protective heat-shrink sleeve and secured in the splice tray. The heat-shrink sleeve shall be approved for use by the fiber optic cable manufacturer and shall to protect the fiber from scoring, dirt accumulation, moisture intrusion, and micro-bending.

(C) Identification and Labeling:

The contractor shall submit permanent identification tags or labels, and the method of attachment, for approval by the Engineer. The cables shall be labeled at all pull boxes where cable is exposed. As a minimum, the labels shall state what fiber cable and the To/From direction. A complete labeling record in the form of an as-built cable schedule shall be provided to the Engineer with the final documentation. The cabling record shall include the distance markings on the cables at the ingress and egress points of the No. 9 pull boxes, communications vaults, and splice closures.

(D) Testing:

Fiber optic cable shall meet the following test requirements:

1. Pre-Installation Testing: The contractor shall inspect all cable upon delivery and again prior to installation. Any cable that is found to have visual damage shall be tested using an OTDR per the following section prior to installation.

2. Post-Installation Testing: After installation, the contractor shall perform the following tests:

   - Power Meter Tests: Conduct power meter tests for each fiber to demonstrate connectivity from origin to destination and to determine actual circuit attenuation. Submit a test check-off sheet of each fiber to the City. Power meter tests shall be conducted after all splices have been made. Testing shall be conducted at the cable ends. Where connectors are installed for connection to optical equipment, the contractor shall install connectors to jumper the two correct fiber ends together before testing to form a complete circuit.
   - OTDR Tests: Conduct bi-directional tests using an OTDR for each fiber. Demonstrate that the attenuation for each fiber, splice, and connector individually and as a whole, comply with the loss budgets required by these Specifications. Test fibers at 1310 nm and 1550 nm using a length of launch cable no less than three times the pulse width used to shoot the cable. Submit OTDR traces for approval. Clearly annotate each splice and identify the measured loss.

The contractor shall test all fibers, identify any unacceptable losses, and make corrective actions at no additional cost. Failed splices may be remade and re-tested for compliance. The contractor shall replace any cable in its entirety that is not compliant with these Specifications at no additional cost.

Following completion of all testing, the contractor shall compile and submit two organized test notebooks. These notebooks shall include a test summary sheet that includes at a minimum the parameters shown in the example on the following page, and the OTDR traces of each fiber by cable.

4.0 Method of Measurement:

The SMFO cable will be measured by the linear foot for each cable furnished and installed; it will be measured horizontally along the route from center of pull box to center of pull box or center of pull box to center of foundation.

No payment will be made for cable that is below ground in vertical conduit stub-ups, or for slack cable in pull boxes. No measurement will be made for splicing and terminating cables, 12 AWG bare locator wire, lubricant, testing, or sealing the conduit ends. All

materials required to complete the system shall be incidental to the cable including the installation of racks and hooks in pre-existing pull boxes where none exist.

Use of equipment required to install cable including equipment to limit pull-tension and speed will be incidental to these items and will not be measured or paid. This installation equipment will remain the property of the contractor.

5.0 Basis of Payment:

The SMFO cables measured as provided above, will be paid for at the contract unit price, which price shall be full compensation for the work, complete in place and successfully tested.

Fiber Test Summary Sheet (Example)

Fiber				Length (OTDR)	No. of Splices	Splice Loss Budget (1)	No. of Connectors	Conn. Loss Budget (2)	1310 Loss Budget (3)	1310 Actual Loss	1550 Loss Budget (4)	1550 Actual Loss	No. of Anomalies > 0.1 dB	P/F
No.	To	From	Branch Fiber No.											

Notes:

Splice Loss Budget = No. of Splices x 0.1 dB/Splice

Connector Loss Budget = No. of Connectors x 0.5 dB/connector

1310 Loss Budget = Length (OTDR) x 0.35 dB/km + Splice Loss Budget + Connector Loss Budget

1550 Loss Budget = Length (OTDR) x 0.25 dB/km + Splice Loss Budget + Connector Loss Budget

ITEM 13-2 FIBER OPTIC SPLICE CLOSURE

1.0 Description:

Splice closures are used to house and protect the splices for branch fibers to the Intelligent Transportation System (ITS) devices, and provide for future splicing to the City of Glendale (COG) traffic signal system and Information Technology communications system.

2.0 Materials:

Underground splice closures shall be either shell design or cylindrical, butt-end style, corrosion resistant, watertight, and meet the requirements of GR-771-CORE. Underground splice closures shall seal, bond, anchor, and provide efficient routing, storage, organization, and protection for fiber optic cable and splices. The splice closure shall provide an internal configuration and end cap with a minimum of two express ports for entry and exit of backbone cable and a minimum of three additional ports for distribution and branch cables.

Splice closures shall be designed to accommodate heat-shrink fusion splice trays in sufficient quantities to perform the required number of splices. At a minimum, the splice closure shall accommodate 144 splices.

Splice closures shall have a reliable dual seal design with both the cable jackets and core tubes sealed, without the use of water-blocking material. The splice closures shall be capable of being opened and completely resealed without loss of performance.

The splice closure maximum dimensions shall not exceed 32” L x 9” W.

3.0 Construction Requirements:

The contractor shall install the splice closure such that the two trunk cable entries are on the same side of the end cap so if other branch fiber cables are installed at a later date, the two existing seals remain undisturbed.

Where the contractor is splicing to existing COG fiber, the contractor shall be careful to not disturb any other splices that exist within the closure. Any splices that are damaged shall be repaired by the contractor immediately, at no cost to the City.

4.0 Method of Measurement:

The splice closures will be measured as a unit for each splice closure furnished, installed, secured to existing or new pull boxes, and tested during the SMFO installation tests. Fiber splices will not be measured or paid as they are considered incidental to the SMFO.

5.0 Basis of Payment:

The accepted quantities of splice closures, measured as provided above, will be paid for at the contract unit price, which shall be full compensation for the work, complete in place.

ITEM 13-3 FIBER OPTIC TRANSCEIVER (FOTR)

1.0 Description:

The fiber optic data transceiver (FOTR) serves as the communication device on the fiber optic cables. An FOTR may be rack mounted or shelf mounted as specified on the plans.

2.0 Materials:

The FOTR shall be manufactured by International Fiber Systems (IFS) or Optelecom and shall be the same manufacturers and model number as the FOTR's in the traffic signal system ring that is being extended.

Fiber Optic Data Transceiver
19" Rack Mount (where specified)

The Contractor shall be responsible for furnishing the following interconnect cabling to make the system functional:

EIA-232 serial data cable from the FOTR (DB-25M) to the terminal server (RJ-45).
Four SMFO fiber optic jumper cables (ST connectors) from the FOTR to the fiber optic distribution center.

3.0 Construction Requirements:

Rack Mount Only: The Contractor shall install the 19" rack mount in the equipment rack and then install the FOTR in the rack.

The Contractor shall furnish and install all electrical and optical cables required for communication to the field devices (optical) and the terminal server (electrical) and provide strain relief for all cables.

The FOTR shall be configured to communicate EIA-232 data with the anti-streaming timeout set to disabled.

As part of this item, the Contractor shall also connect the fiber optic branch cables to the existing optical transceivers. The Contractor shall verify the existing circuit configuration and shall duplicate it.

(A) Testing Requirements:

The Contractor, working with the COG Representatives, shall verify communications to all traffic controllers on the traffic data circuits. During the system acceptance testing, the Contractor with the help of COG TMC operators shall verify less than 1% communications failures on a daily basis. If the circuit fails the testing, the Contractor along with the COG shall troubleshoot the communications failure.

4.0 Method of Measurement:

The FOTR installation shall be measured as a lump sum for installing the transceiver and rack mount, fiber optic connection of field transceivers, and all labor and material needed to complete an operational communication circuit (successfully tested) in accordance with these Specifications.

The interconnect cabling is considered incidental and will not be measured or paid.

5.0 Basis of Payment:

The FOTR installation will be paid for at the contract lump sum price as designated on the bidding schedule, complete in place, this shall be full compensation for the work described.

ITEM 13-4 VIDEO OPTICAL TRANSCEIVER/RECEIVER (VOT/VOR)

1.0 Description:

Video optical transceivers (VOT) are installed in the CCTV field equipment cabinets and video optical receivers (VOR) are installed in existing equipment racks for transmission of video signals and PTZ data between the field equipment and the data center.

2.0 Materials:

The VOT shall be the following manufacturers and model numbers:

International Fiber Systems (IFS) model number VDT14130WDM
Optelecom model number 9225DT/SM-ST.

The VOR shall be the following manufacturers and model numbers:

International Fiber Systems (IFS) model number VDR14130WDM
Optelecom model number 9225DR/SM-ST.

For field installed VOT, the following interconnect cabling shall be supplied:

SMFO fiber optic jumper cable (ST connectors) from the VOT to the fiber optic distribution center.

For rack mounted VOR, the following interconnect cabling shall be supplied:

RJ-59 coaxial video cable (BNC connectors) from the VOR to the existing video multiplexer.

Serial data cable from the VOR (terminal strip) to the DSU.

SMFO fiber optic jumper cable (ST connectors) from the VOR to the fiber optic distribution center.

3.0 Construction Requirements:

The Contractor shall furnish all mounting hardware (i.e. – machine screws, nuts, locking washers) and install the VOTs securely in the cabinet. Mounting methods using tape, Velcro, and sticky back material will not be permitted.

The Contractor shall connect the fiber optic cable to the optical input of the VOT being careful not to kink the cable. The Contractor shall also connect the data cables to the PTZ data terminal strip and the coaxial video cable to the BNC connector. The Contractor shall route and bundle all cables neatly and install strain relief where required.

The Contractor shall verify the serial signal that the CCTV camera uses and configure the VOTs and VORs for the appropriate serial signal.

(A) Testing Requirements:

The Contractor, working with the COG Representatives, shall verify communications to CCTV cameras. During the system acceptance testing, the Contractor with the help of COG TMC operators shall verify less than 1% communications failures on a daily basis. If the circuit fails the testing, the Contractor along with the COG shall troubleshoot the communications failure.

4.0 Method of Measurement:

The VOT and VOR installation shall be measured as a lump sum for installing all transceivers/receivers, and all labor and material needed to complete an operational CCTV communication link (successfully tested) in accordance with these Special Provisions.

The mounting hardware and interconnect cabling are considered incidental and will not be measured or paid.

5.0 Basis of Payment:

The VOT and TOR installation will be paid for at the contract lump sum price as designated on the bidding schedule, complete in place, this shall be full compensation for the work described.

ITEM 13-5 FIELD SERIAL DEVICE SERVER

1.0 Description:

The contractor shall furnish, install, and test environmentally hardened fully managed Field Serial Device Servers used to communicate data between the central traffic signal system and the traffic signal controllers via SMFO cable. These field switches shall also have the capability of serial (EIA-232) to Ethernet conversion for communication with legacy devices such as CCTV and existing non-Ethernet traffic signal controllers.

2.0 Materials:

The Field Serial Device Server shall be manufactured by Ruggedcom part number RS400 series switch. The Field Serial Device Server shall be configured as follows:

120 VAC power supply
Din rail mounting
Two 10/100BaseTX RJ45 ports
Four EIA-232/EIA-422/EIA-485 ports via DB9 connector
Two 100FX single mode SC connectors with the transceiver for the distance

3.0 Construction Requirements:

All installed cables shall be uniquely marked as they relate to function and near and far connector termination.

(A) Switch Setup/ Pre-Cabinet Installation:

The contractor shall bring all the Field Serial Device Servers to the TMC for configuration prior to installation in the field. The contractor shall label each Field Serial Device Server with the location ID (e.g. – 83rd Ave/Bell Rd) and working with the COG representative shall configure each switch through the local management port with the required information (i.e. – IP Address, subnet, etc.) to work properly per COG instructions. Any equipment required (i.e. – laptop computer, serial cables) to perform this task shall be supplied by the contractor and shall remain the property of the contractor upon completion of the task.

(B) Field Cabinet Installation:

The contractor shall mount the Field Serial Device Server that correlates to the ID written on the unit to the side wall of the traffic control cabinet as shown in the Plans. Strain relief shall be included on all cables provided with the units. Indicators, test jacks, and other maintenance aids shall be easily accessible when the units are installed in an equipment cabinet.

To complete the communication circuits for integration into the system, the contractor shall connect optically the Field Serial Device Server per the communication schematic and splice/termination details as shown in the project Plans. The contractor shall also connect the controllers to an Ethernet/serial port of each Field Ethernet Switch using a Cat 5e/serial cable that is less than 9 feet in length.

(C) Testing Requirements:

The Field Serial Device Server shall meet the following tests:

1. Pre-Installation Testing: The Contractor shall inspect the Field Serial Device Server upon delivery for any visual damage, inventory contents, and ensure proper functionality.

2. Subsystem Testing: The Contractor shall ensure the Field Serial Device Server is correctly installed, configured, and is properly functioning as part of the Ethernet Network subsystem.

3. System Acceptance Testing (SAT): As part of the SAT the Contractor shall demonstrate that the Field Serial Device Server is functioning and operational for the duration of the SAT.

4.0 Method of Measurement:

The Field Serial Device Server furnished and installed shall be measured per each and shall include all labor and material needed to complete an operational communication link in accordance with the Plans and these Special Provisions.

The mounting hardware, interconnect cabling, power cords, and power converters (if used) are considered incidental.

5.0 Basis of Payment:

The accepted quantities of Field Serial Device Servers, measured as provided above, will be paid for at the contract unit price, which shall be full compensation for the work, complete in place.

ITEM 13-6 CLOSED-CIRCUIT TELEVISION (CCTV) FIELD EQUIPMENT

1.0 Description:

The CCTV Field Equipment includes a digital signal processing (DSP) camera mounted in a domed housing and all peripheral equipment to complete the installation as described in Section 2.0.

The work includes control center hook-up, testing and other ancillary and incidental equipment required to assemble a complete, fully-functional system integrated with equipment furnished by others.

2.0 Materials:

(A) Camera:

The camera shall be a Pelco Spectra IV series smoked dome camera with a minimum optical zoom of 35X.

(B) Camera Mount:

As part of the CCTV field equipment, the Contractor shall furnish and install a camera mounting bracket and shall install the camera housing with its equipment on the bracket. A side mount bracket shall be used.

The power shall be 120 VAC from the cabinet to the CCTV assembly. The camera mount shall have a transformer to convert to 24 volts.

No wire, cables, or conductors shall be exposed from the dome to the CCTV traffic pole. All conductors shall be routed inside the CCTV traffic pole and in underground conduit.

(C) Video, Data and Power Cables:

The coaxial video cable shall be RG-59 with a 20 AWG center conductor, a 95% braid and 75 ohm impedance with crimp type Amphenol BNC connectors.

The power cable shall be 18 AWG 1-pair stranded and meet 300 volt requirements as specified in the National Electric Code.

The data cable shall be a 22 AWG Category 5 cable.

(D) Surge Protection:

The Contractor shall furnish and install surge protection as part of the CCTV field equipment.

1. Panel: The Contractor shall install an aluminum or stainless steel panel inside each controller cabinet at each camera site to house surge protection devices. The panel will have provisions for mounting into the side rails of the traffic control cabinet. All surge protector leads shall be as straight and short as possible.

   The size of the panel shall be determined by the Contractor, with the Panel as small as practical to house all the required devices. The Contractor shall

include in the equipment submittal the surge suppression layout on the panel for approval by the Engineer.

2. Coaxial Cable Surge Protector: The Contractor shall furnish and install one coaxial cable surge protector at each camera site conforming to the following requirements:

   Connector: BNC type
   Response Time: < 5nSec
   Peak Surge Current: 100 A
   Impedance: 75 Ω
   Band Pass Range: 0 – 2 GHz
   Standing Wave Ratio: 1.2:1
   Insertion Loss: <0.3 dB
   Protection Modes: Center Pin – Shield, Shield – G

3. Low Voltage (Data) Control Cable Surge Protector: The Contractor shall furnish and install a low voltage circuit surge protectors on each conductor in the CCTV control cable. The surge protectors shall conform to the following requirements:

   Max Continuous Current: 5 amps
   Response Time: < 5 nSec
   Service Voltage: <5 V
   Max Surge Current: 2000 Amps (per pair)
   Protection Modes: L-G (All lines protected)

4. Power Cable Surge Protector: The Contractor shall furnish and install one power cable surge protector at each camera site conforming to the following requirements:

   Continuous Current: Unlimited (Parallel Installation)
   Response Time: < 5 nSec
   Service Voltage: 120V
   Max Surge Current: 22,500 A
   Protection Modes: L – N, L – G, N – G

   The surge protectors can be a single unit or individual units.

3.0 Construction Requirements:

It is recommended that the Contractor test the camera assembly before installation on the pole.

The Contractor shall mount the dome camera assembly which includes the housing, camera, zoom lens, pan/tilt drive, and receiver/driver on the traffic signal pole. The surge suppression panel shall be bolted to the inside of the traffic signal cabinet, and all surge suppressors connected per the manufacturer's instructions. All cabling, connectors, and hardware required to interconnect the various CCTV field and fiber optic communications equipment shall be furnished and installed by the Contractor.

The camera shall be mounted in a manner so that a clear view of all four legs of the intersection up to ½ mile if possible.

(A) Testing Requirements:

1. General: All CCTV components shall be subject to testing and monitoring to determine conformance with all applicable specifications and to ensure proper operation of the equipment and system.

   For purposes of completing the tests, "bright sunlight" conditions shall be defined as occurring between 10:00 a.m. local time and 2:00 p.m. local time on a sunny day. "Night" conditions shall be defined as occurring between one hour after local sundown and one hour before local sunrise.

2. Stand-Alone Field Tests: The test shall exercise all stand-alone (non-network) functional operations of the CCTV. The test shall verify the following:

   - Control of focus, zoom, digital zoom, white balance, iris, tilt/pan, and power on/off
   - Response to automatic preset positioning commands
   - Display of sector text messages
   - Video "blacked out" when in a privacy zone
   - Presence and quality of video signal during bright sunlight and night conditions
   - Retention of non-volatile RAM data (i.e., sector text, preset positions)

3. System Acceptance Test (SAT): As part of the SAT, at least once per week and on the final day of the SAT, Contractor shall demonstrate that all CCTV system functions tested in the stand-alone test are operational.

4.0 Method of Measurement:

CCTV equipment installation will be measured as each for installing and testing all CCTV field equipment, complete in place. The installation shall include but not be limited to the domed housing, which includes the video camera, zoom lens, receiver/driver and tilt/pan drive, along with pole mounts, surge protection devices, and all incidental cables, connections, and hardware.

5.0 Basis of Payment:

The accepted CCTV assembly installation, measured as provided above, will be paid for at the contract unit price each, which shall be full compensation for the work, complete in place and successfully tested.

ITEM 9240120 MISCELLANEOUS WORK (ETHERNET BACKBONE SWITCH):

1.0 Description:

This item governs the furnishing and installation of Field Hardened Ethernet Backbone Switch at designated locations as shown on the plans, as detailed in accordance with these special provisions, and as directed by the Engineer.

2.0 Materials:

Provide all Field Hardened Ethernet Backbone Switches of the same manufacture. All equipment shall be new and in strict accordance with the details shown on the plans and in the specifications.

Provide high-performance and Field Hardened Ethernet Backbone Switches supporting standard Open System Interconnection (OSI) Layer 2 and 3 functionality. Provide Field Hardened Ethernet Backbone Switches supporting direct connectivity to existing networks configured in ring and mesh fault tolerant topologies enabling applications to operate reliably and with low latency.

Include all equipment licenses, where required, for any software or hardware in the system.

Comply with the following standards for all Field Hardened Ethernet Backbone Switches furnished, assembled, fabricated, or installed under this item:

- IEEE 802.1d – Spanning Tree Protocol
- IEEE 802.1d – MAC Bridges
- IEEE 802.1p – Class of Services
- IEEE 802.1q – VLAN Tagging
- IEEE 802.1w – Rapid Spanning Tree Protocol
- IEEE 802.1x – Port Based Network Access Control
- IEEE 802.3 – 10BaseT
- IEEE 802.3u – 100BaseTX, 100BaseFX
- IEEE 802.3x – Flow Control
- IEEE 802.3z – 1000BaseLX
- IEEE 802.3ab – 1000BaseTX
- IEEE 802.3ab – Link Aggregation
- RFC768 – UDP
- RFC783 – TFTP
- RFC791 – IP
- RFC792 – ICMP
- RFC793 – TCP
- RFC826 – ARP
- FRC854 – Telnet

- RFC894 – IP over Ethernet
- RFC1112 – IGMP v1
- RFC1519 – CIDR
- RFC1541 – DHCP (client)
- RFC2030 – SNTP
- RFC2068 – HTTP
- RFC2236 – IGMP v2
- RFC2284 – EAP
- RFC2475 – Differentiated Services
- RFC2865 – Radius
- RFC3414 – SNMPv3-USM
- RFC3415 – SNMPv3-VACM
- NEMA TS-2 (traffic control equipment)

Provide all Field Hardened Ethernet Backbone Switches with a physical design that conforms to the following requirements:

- Provide up to three (3) Gigabit Ethernet ports consisting of copper and/or fiber.
- Provide up to sixteen (16) Fast Ethernet ports consisting of copper and/or fiber.
- Shall be configurable in point-to-point, daisy-chain, ring, and mesh topologies for connectivity into new and existing fiber optic and copper based Ethernet networks.
- Designed with an operating system that allows individual ports to be configured for port mirroring, speed, duplex, auto-negotiation, and flow control. The operating system shall also provide for broadcast storm frame filtering with user defined thresholds.
- Designed with an operating system that allows for the collection of statistics on a per port basis and provides for full support of Remote Monitoring (RMON) statistics, history, alarms, and event groups.
- Shall be capable of providing port security to prevent unknown devices from gaining access to the network. Unauthorized attempts to access the network shall result in the port being shutdown for a definable period of time along with Simple Network Management Protocol (SNMP) trap and alarm generation.
- Shall have an operating environmental range of -40°C to +74°C with no fans.

Provide the following functionality and features:

(A) Port Performance:

- Provide Gigabit Ethernet Single mode Fiber ports that operate at 1000 Mbps.
- Provide Fast Ethernet Single mode Fiber ports that operate at 100 Mbps.
- Provide Fast Ethernet RJ-45 copper ports with auto-negotiate operation at 10 Mbps and 100 Mbps.
- Provide external optical attenuators as necessary to support interconnectivity with close range devices upstream or downstream.

(B) Packet-Processing:

- Processing type: store and forward
- Frame buffer memory: 2 Mbit
- Switching Latency: 7 us
- Priority Queues: 4
- Virtual Local Area Networks (VLAN): 4096
- Internet Group Management Protocol (IGMP) multicast groups: 256
- Switching bandwidth: 9.2 Gbps

(C) Gigabit Ethernet Network Connections:

- Four (4) duplex SC connector ports for single mode fiber at a distance of 25km.

(D) Fast Ethernet Network Connections:

- Eight (8) RJ-45 connector ports for copper.
- Four (4) duplex ST connector ports for single mode fiber at a distance of 20km.

(E) Power Requirements:

- 120 VAC (± 10%), 60 Hz (± 3 Hz)

(F) Mechanical:

- Enclosure: Shall be constructed from a minimum 18 gage high strength galvanized steel case with metal mounting plates, suitable for stand-alone, shelf, rack, or din mounting. Enclosure shall be permanently and clearly identified with name, model number, serial number, and any other pertinent information required to facilitate equipment maintenance.

2.01 General Requirements:

(A) Documentation:

The contractor shall provide certification that the Field Hardened Ethernet Backbone Switches furnished and installed is in conformance with the manufacturer standard and these specifications.

(B) Warranty:

The Field Hardened Ethernet Backbone Switch shall be warranted by the contractor against all defects in material and workmanship in accordance with Subsection 106.13 as amended by these Special Provisions with the following additional requirement:

The warranty for the Field Hardened Ethernet Backbone Switch shall provide that in the event of a malfunction during the warranty period, the defective unit, card, module,

subassembly, or auxiliary device shall be replaced with a working unit within three (3) working days for use while the warranted unit is being repaired.

3.0 Construction Requirements:

Minimum requirements for the Contractor or designated subcontractor involved in the installation and testing of the Ethernet equipment are:

- Three (3) years experience in the installation, testing and maintenance of Ethernet equipment.

- Two (2) installations where an Ethernet switches were deployed and the network has remained in continuously satisfactory operation for at least two (2) years. The Contractor shall submit as proof, photographs or other support documents, and the names and contact information of the operating personnel who can be contacted regarding the networks operation.

Necessary documentation of subcontractor qualifications must be approved by Engineer prior to purchasing the Field Hardened Ethernet Backbone Switch.

Installations of equipment shall be for ease of maintenance, with all component parts being readily accessible for inspection and maintenance.

Ensure that all external screws, nuts and locking washers are stainless steel. The use of self-tapping screws shall not be used without written approval by the Engineer.

Contractor shall meet all applicable codes and standards requirements for all external wiring to Field Hardened Ethernet Backbone Switches. All wires and cables shall be neatly installed and secured per common practices and standards. Contractor shall provide service loop at all connection points.

Contractor shall provide and install one (1) duplex single mode SC to ST Fiber patch cable for each Gigabit Ethernet port install in the Field hardened Ethernet Backbone Switch.

Contractor shall provide and install one (1) duplex single mode ST to ST Fiber patch cable for each Fiber Fast Ethernet port installed in the Field Hardened Ethernet Backbone Switch.

Contractor shall provide and install one (1) category 5e patch cord for each Copper Fast Ethernet port install in the Field Hardened Ethernet Backbone Switch.

Contractor shall coordinate with the Engineer all switch configuration information, (i.e. IP addresses, VLANs etc.) forty five (45) days prior to installing Ethernet Switches.

(A) Testing Requirements:

The Field Hardened Ethernet Backbone Switch shall meet the following tests:

- Pre-Installation Testing:

The Contractor shall inspect the Field Hardened Ethernet Backbone Switch upon delivery for any visual damage, inventory contents, and ensure proper functionality.

- Subsystem Testing:

The Contractor shall ensure the Field Hardened Ethernet Node, Backbone, and Distribution Switches, are correctly installed, configured, and are properly functioning as networked subsystem.

- System Acceptance Testing (SAT):

As part of the SAT the Contractor shall demonstrate that all Field Hardened Ethernet Switches functioning and are operational for the duration of the SAT.

4.0 Method of Measurement:

Each Field Hardened Ethernet Backbone Switch furnished and installed shall include all material, hardware, configuration, testing, and labor necessary to make a complete and accepted installation as specified on the Plans and these Special Provisions. All mounting brackets, mounting hardware (i.e., screws, nuts, bolts), power cords, power transformer, fiber patch cables and adapters, copper patch cords, and documentation shall be included under this item.

5.0 Basis of Payment:

The Field Hardened Ethernet Backbone Switch will be paid for as measured. Contract unit price shall be full compensation for furnishing and installing the Field Hardened Ethernet Backbone Switch described and specified herein and in the plans, complete and in place.

ITEM 9240121 MISCELLANEOUS WORK (ETHERNET DISTRIBUTION SWITCHES):

1.0 Description:

This item governs the furnishing and installation of Field Hardened Ethernet Distribution Switches at designated locations as shown on the plans, as detailed in accordance with these special provisions, and as directed by the Engineer.

2.0 Materials:

Provide all Field Hardened Ethernet Distribution Switches of the same manufacture. All equipment shall be new and in strict accordance with the details shown on the plans and in the specifications.

Provide high-performance and Field Hardened Ethernet Distribution Switches supporting standard Open System Interconnection (OSI) Layer 2 and 3 functionality. Provide Field Hardened Ethernet Distribution Switches supporting direct connectivity to existing networks configured in ring and mesh fault tolerant topologies enabling applications to operate reliably and with low latency.

Include all equipment licenses, where required, for any software or hardware in the system.

Comply with the following standards for all Field Hardened Ethernet Distribution Switches furnished, assembled, fabricated, or installed under this item:

- IEEE 802.1d – Spanning Tree Protocol
- IEEE 802.1d – MAC Bridges
- IEEE 802.1p – Class of Service
- IEEE 802.1q – VLAN Tagging
- IEEE 802.1w – Rapid Spanning Tree Protocol
- IEEE 802.1x – Port Based Network Access Control
- IEEE 802.3 – 10BaseT
- IEEE 802.3u – 100BaseTX, 100BaseFX
- IEEE 802.3x – Flow Control
- IEEE 802.3z – 1000BaseLX
- IEEE 802.3ab – 1000BaseTX
- IEEE 802.3ab – Link Aggregation
- RFC768 – UDP
- RFC783 – TFTP
- RFC791 – IP
- RFC792 – ICMP
- RFC793 – TCP

- RFC826 – ARP
- FRC854 – Telnet
- RFC894 – IP over Ethernet
- RFC1112 – IGMP v1
- RFC1519 – CIDR
- RFC1541 – DHCP (client)
- RFC2030 – SNTP
- RFC2068 – HTTP
- RFC2236 – IGMP v2
- RFC2284 – EAP
- RFC2475 – Differentiated Services
- RFC2865 – Radius
- RFC3414 – SNMPv3-USM
- RFC3415 – SNMPv3-VACM

Provide all Field Hardened Ethernet Distribution Switches with a physical design that conforms to the following requirements:

- Provide up to nine (9) Fast Ethernet ports consisting of copper and/or fiber.
- Shall be configurable in point-to-point, daisy-chain, ring, and mesh topologies for connectivity into new and existing fiber optic and copper based Ethernet networks.
- Designed with an operating system that allows individual ports to be configured for port mirroring, speed, duplex, auto-negotiation, and flow control. The operating system shall also provide for broadcast storm frame filtering with user defined thresholds.
- Designed with an operating system that allows for the collection of statistics on a per port basis and provides for full support of Remote Monitoring (RMON) statistics, history, alarms, and event groups.
- Shall be capable of providing port security to prevent unknown devices from gaining access to the network. Unauthorized attempts to access the network shall result in the port being shutdown for a definable period of time along with Simple Network Management Protocol (SNMP) trap and alarm generation.
- Shall have an operating environmental range of -40°C to +74° with no fans.

Provide the following functionality and features:

(A) Port Performance:

- Provide Fast Ethernet Single mode Fiber ports that operate at 100 Mbps.
- Provide Fast Ethernet RJ-45 copper ports with auto-negotiate operation at 10 Mbps and 100 Mbps.
- Provide external optical attenuators as necessary to support interconnectivity with close range devices upstream or downstream.

(B) Packet-Processing:

- Processing type: store and forward
- Frame buffer memory: 2 Mbit
- Switching Latency: 8 us (100 Mbps)
- Priority Queues: 4
- Virtual Local Area Networks (VLAN): 64
- Internet Group Management Protocol (IGMP) multicast groups: 256
- Switching bandwidth: 1.8 Gbps

(C) Fast Ethernet Network Connections:

- Three (3) duplex ST connector ports for single mode fiber at a distance of 20km.

(D) Fast Ethernet Network Connections:

- Six (6) RJ-45 connector ports for copper.

(E) Power Requirements:

- 120 VAC (± 10%), 60 Hz (± 3 Hz)

(F) Mechanical:

- Enclosure: Shall be constructed from a minimum 20 gage high strength galvanized steel case with metal mounting plates, suitable for stand-alone, shelf, rack, or din mounting. Enclosure shall be permanently and clearly identified with name, model number, serial number, and any other pertinent information required to facilitate equipment maintenance.

2.01 General Requirements:

(A) Documentation:

The contractor shall provide certification that the Field Hardened Ethernet Distribution Switches furnished and installed is in conformance with the manufacturer standard and these specifications.

(B) Warranty:

The Field Hardened Ethernet Distribution Switch shall be warranted by the contractor against all defects in material and workmanship in accordance with Subsection 106.13 as amended by these Special Provisions with the following additional requirement:

The warranty for the Field Hardened Ethernet Distribution Switch shall provide that in the event of a malfunction during the warranty period, the defective unit, card, module,

subassembly, or auxiliary device shall be replaced with a working unit within three (3) working days for use while the warranted unit is being repaired.

3.0 Construction Requirements:

Minimum requirements for the Contractor or designated subcontractor involved in the installation and testing of the Ethernet equipment are:

- Three (3) years experience in the installation, testing and maintenance of Ethernet equipment.

- Two (2) installations where an Ethernet switches were deployed and the network has remained in continuously satisfactory operation for at least two (2) years. The Contractor shall submit as proof, photographs or other support documents, and the names and contact information of the operating personnel who can be contacted regarding the networks operation.

Necessary documentation of subcontractor qualifications must be approved by Engineer prior to purchasing the Field Hardened Ethernet Distribution Switch.

Installations of equipment shall be for ease of maintenance, with all component parts being readily accessible for inspection and maintenance.

Ensure that all external screws, nuts and locking washers are stainless steel. The use of self-tapping screws shall not be used without written approval by the Engineer.

Contractor shall meet all applicable codes and standards requirements for all external wiring to Field Hardened Ethernet Distribution Switches. All wires and cables shall be neatly installed and secured per common practices and standards. Contractor shall provide service loop at all connection points.

Contractor shall provide and install one (1) duplex single mode ST to ST Fiber patch cable for each Fast Ethernet fiber port installed in the Field Hardened Ethernet Distribution Switch.

Contractor shall provide and install one (1) category 5e patch cord for each Fast Ethernet copper port install in the Field Hardened Ethernet Distribution Switch.

Contractor shall coordinate with the Engineer all switch configuration information, (i.e. IP addresses, VLANs etc.) forty five (45) days prior to installing Ethernet Switches.

(A) Testing Requirements:

The Field Hardened Ethernet Distribution Switch shall meet the following tests:

- Pre-Installation Testing:

The Contractor shall inspect the Field Hardened Ethernet Distribution Switch upon delivery for any visual damage, inventory contents, and ensure proper functionality.

- Subsystem Testing:

The Contractor shall ensure the Field Hardened Ethernet Node, Backbone, and Distribution Switches, are correctly installed, configured, and are properly functioning as networked subsystem.

- System Acceptance Testing (SAT):

As part of the SAT the Contractor shall demonstrate that all Field Hardened Ethernet Switches functioning and are operational for the duration of the SAT.

4.0 Method of Measurement:

Each Field Hardened Ethernet Distribution Switch furnished and installed shall include all material, hardware, configuration, testing, and labor necessary to make a complete and accepted installation as specified on the Plans and these Special Provisions. All mounting brackets, mounting hardware (i.e., screws, nuts, bolts), power cords, power transformer, fiber patch cables and adapters, copper patch cords, and documentation shall be included under this item.

5.0 Basis of Payment:

The Field Hardened Ethernet Distribution Switch will be paid for as measured. Contract unit price shall be full compensation for furnishing and installing the Field Hardened Ethernet Distribution Switch described and specified herein and in the plans, complete and in place.

ITEM 924#### MISCELLANEOUS WORK (VIDEO ENCODER, MPEG4, SINGLE CHANNEL):

ITEM 924#### MISCELLANEOUS WORK (VIDEO ENCODER, MPEG4, 8 CHANNEL):

1.0 Description:

The work includes furnishing and installing Video Encoder MPEG-4 equipment for data and video communications to/from the field devices and GTOB. The video encoders are an Ethernet device that connects to the Ethernet switches to provide video and CCTV control back to the GTOB and TMC. The Contractor shall furnish and install all cables and ancillary items required to provide a fully functional system.

The Video Encoder equipment shall receive full motion analog NTSC color video signals and encode the signals for transmission over a fiber optic IP network using MPEG-4

standard compression technology. This signal is then decoded at the COG TMC to allow the full motion video to be seen on a video wall. The communications equipment shall also be capable of transmitting IP addressable low speed data for camera PTZ control, independently of the video.

2.0 Materials:

(A) Mechanical:

The field units shall be designed to be shelf mounted in traffic control cabinets. The dimensions shall not exceed 3 inches x 6 inches x 6 inches.

The unit construction and materials shall prevent fungal growth and cathodic action caused by use of dissimilar metals. The external markings shall include the product function name, model number, part number, serial number and manufacturer's name. The unit shall have PCB Conformal Coating for environmental protection.

(B) Video:

The device shall have a minimum of one video interface which shall conform to the following requirements for the video interface:

- Video Input: NTSC (30 Fps)
- Connector: BNC, 75 Ohms
- Video Encoding: MPEG-4 Simple Profile (ISO/IEC 14496- 2)
- Data Rate: 9.6 Kbps – 4 Mbps
- Latency: No Greater Than 125 ms
- Resolution:
  - Full : 720 X 480
  - 4cif: 704 X 480
  - 2cif: 704 X 240
  - Cif: 352 X 240
  - Qcif: 176 X 120
- The Device Shall Be A Managed Unit With The Ability To Remotely Change Frame Rate (1-30fps), Bit Rate (9.6Kbps-4Mbps), And Video Resolution.

The device shall be comptible with the City of Glendale's existing Camera Cameleon system. Cameleon drivers shall be provided by the contractor to allow decoding of video on the Camera Cameleon clients.

(C) Ethernet Interface:

The device shall adhere to the following requirements for the Ethernet interfaces:

- Format: IEEE 802.3

- Connectors: RJ-45
- Interface: Half/Full Duplex, Auto Sensing
- Data Rate: 10/100 Mbps
- Protocols Supported: TCP, UDP, IPv4, IGMP, SNMP, HTTP, Telnet, RDP, Multicast, Unicast

(D) Network Management

The units shall support SNMP, HTTP, and TELNET protocols to provide the ability to control and monitor all configuration parameters and diagnostics from a remote location. The SNMP MIB's are required with the product delivery.
Each unit shall support a local console accessible using a serial interface to provide access to all configuration menus of the product including the initial IP address as well as for troubleshooting purposes. The interface shall be menu driven.
Each unit shall support 'remote' Telnet console access functionality to provide access to all configuration menus of the product. The interface shall be menu driven.

(E) Data Interface:

The device shall adhere to the following requirements for the asynchronous serial data interfaces:

- Interfaces Supported: EIA-232, EIA-422/485, 2 Or 4 Wire, Full Duplex
- Connectors: RJ-45 Female
- Number of Channels: 2
- Data Rate: 1.2 Kbps – 115 Kbps, Standard Rates

The serial interface type and configuration shall be locally and remotely programmable and programming shall be retained in the event of a power failure without the use of batteries.

Hardware modifications to the device shall not be allowed.

Serial data will be transmitted over TCP/IP. Each serial port shall support IP addressing with the ability to select the appropriate IP socket number. The unit shall provide the ability to establish an IP connection directly from a workstation to any encoder IP address and socket number to pass serial data.

(F) Power:

The units shall operate to specification under the following power conditions. The use of an external AC power adapter is acceptable if the units require voltage other than the 120 VAC supplied at the equipment cabinets. If supplied, the power supply adapter shall have a keyed connector to prevent improper insertion of the power supply connector.

- Input Voltage: 120 +10/-25 Vac, 60 ± 3 Hz
- Power Consumption: 15 W Maximum

(G) Environmental:

The units shall operate to specification under the following environmental conditions:

- Temperature: -34°C - +74°C
- Relative Humidity: 0 – 95%, Non-Condensing

3.0 Construction Requirements:

The Contractor shall furnish and install the communications equipment identified in this special provision at each cabinet site shown on the plans. The Contractor shall install all Video Encoder equipment in a neat and orderly fashion within each cabinet. The Contractor shall coordinate with the Engineer on the placement and mounting of equipment within the cabinets. Include cable ties and wire and connector labels.

4.0 Method of Measurement:

Provision and installation of all field communications equipment described in this special provision will be measured as an each, complete and in place, in accordance with the plans and special provisions.

5.0 Basis of Payment:

All Video Encoder equipment will be paid for at the contract each price as designated on the bidding schedule, complete in place; this shall be full compensation for the work described herein and on the Plans.

ITEM 924#### MISCELLANEOUS WORK (VIDEO DECODER, MPEG4, 8 CHANNEL)

1.0 Description:

The Video Decoder equipment is required to facilitate convert MPEG4 streaming video (from the Layer 3 Gigabit Ethernet switch in the TMC) to NTSC format for input into the COG existing video switch located in the TMC. The contractor shall furnish, install, and test six (6) 8-Channel Video Decoders. In addition, the Contractor shall furnish and install all cables and ancillary items required to provide a fully functional system The Video Decoder equipment shall meet the following specifications:

2.0 Materials:

(A) Mechanical:

The Video Decoder units shall be designed to be rack mounted in existing 19 inch EIA racks. Video Decoder units shall not require more than 1U of vertical rack space. The unit construction and materials shall prevent fungal growth and cathodic action caused by use of dissimilar metals. The external markings shall include the product function name, model number, part number, serial number and manufacturer's name.

The unit shall have PCB Conformal Coating for environmental protection.

(B) Video:

The device shall have a minimum of one video interface which shall conform to the following requirements for the video interface:

- Laser (Wavelength 1310, 1550 nm) over one single mode fiber
- Connector LC, 100 Base-FX
- Minimum connection of 2' of cable with no optical attenuation required
- Video Outputs: (8) NTSC (30 Fps)
- Connector: (8) BNC, 75 Ohms
- Video Decoding: MPEG-4 (ISO/IEC 14496-2) Advanced Simple Profile, Simple Profile
- Data Rate: 9.6 Kbps – 4 Mbps Per Channel Adjustable
- Latency: No Greater Than 150 ms Per Channel
- Video Resolution
- Combinations:
  - (8) Streams @D1, 5fps : 720 x 480
  - (8) Streams @4CIF, 15fps: 704 x 480
  - (8) Streams @2CIF, 30fps: 704 x 240

- o (8) Streams @1CIF, 30fps: 352 x 240
- o (8) Streams @QCIF, 30fps: 176 x 120

The device shall be a managed unit with the ability to remotely change configuration parameters independently for each channel.

(C) Ethernet Interface:

The device shall adhere to the following requirements for the Ethernet interfaces:

- Format: IEEE 802.3
- Connectors: RJ-45
- Interface: Half/Full Duplex, Auto Sensing
- Data Rate: 10/100 Mbps
- Protocols Supported: TCP, TCP/IP, UDP, IPv4, IGMP, SNMP, HTTP, Telnet, RDP, Multicast, Unicast

(D) Network Management

The units shall support SNMP, HTTP, and TELNET protocols to provide the ability to control and monitor all configuration parameters and diagnostics from a remote location. Each unit shall be equipped with a local console port accessible using a serial interface to provide access to all configuration menus of the product including the initial IP address as well as for troubleshooting purposes. The interface shall be menu driven.

Each unit shall support 'remote' Telnet console access functionality to provide access to all configuration menus of the product. The interface shall be menu driven.

(E) Serial Data Interface:

The device shall adhere to the following requirements for the asynchronous serial data interfaces:

- Interfaces Supported: EIA-232, EIA-422/485, 2 Or 4 Wire, Full Duplex
- Connectors: DB9 (DB9 To RJ45 Adaptor Cable Is Acceptable)
- Number Of Serial Interfaces: 1 (Min)
- Data Rate: 1.2 Kbps – 115 Kbps, Standard Rates

The serial interface type and configuration shall be locally and remotely programmable and programming shall be retained in the event of a power failure without the use of batteries. Hardware modifications to the device to achieve compliance with these Special Provisions shall not be allowed.

Serial data will be transmitted to/from the video encoder over Ethernet using TCP/IP. The video encoder shall decode IP data packets by IP address and port number. Each

IP address and port number combination shall be decoded as a unique serial data stream for bidirectional full duplex serial data transmission.

(F) Power:

The use of an external AC power adapter is acceptable if the units require voltage other than the 120 VAC supplied at the equipment cabinets. If supplied, the power supply adapter shall have a keyed connector to prevent improper insertion of the power supply connector.

The units shall operate to specification under the following power conditions.

- Input Voltage: 120 +10/-25 Vac, 60 ± 3 Hz
- Power Consumption: 15 W Maximum

(G) Environmental:

The units shall operate to specification under the following environmental conditions:

- Temperature: -34°C - +50°C
- Relative Humidity: 0 – 95%, Non-Condensing

3.0 Construction Requirements:

All installed cables shall be uniquely marked as they relate to function and near and far connector termination.

4.0 Method of Measurement:

The Video Decoder furnished and installed shall be measured per each and shall include all labor and material needed to complete an operational communication link in accordance with the Plans and these Special Provisions.

The mounting hardware, interconnect cabling, and power converters (if used) are considered incidental.

5.0 Basis of Payment:

The accepted quantities of Video Decoders, measured as provided above, will be paid for at the contract unit price, which shall be full compensation for the work, complete in place.

ITEM 9240171 DMS POLE AND ASSEMBLY INSTALLATION:

1.0 DESCRIPTION:

The work under this section shall consist of installing and testing LED dynamic message signs (DMS), DMS controllers, controller cabinets, DMS poles and ancillary equipment at specified locations on the project. All DMS assemblies shall be installed on existing foundations. DMS and DMS cabinets will be furnished by the City of Glendale. Poles and ancillary equipment are to be furnished by the contractor. The contractor shall contact Ms. Debbie Albert (623) 847-7524 of the COG prior to construction kick-off to coordinate DMS installation.

2.0 MATERIALS:

The City of Glendale will furnish the DMS equipment. The contractor shall furnish DMS poles and ancillary equipment.

(A) Submittals:

The contractor shall prepare and submit drawings for each sign installation. The contractor shall illustrate the method of connection and indicate the types of materials proposed, including cabling and connectorization. The fabricator's drawings shall be submitted for the Engineer to review. The contractor shall obtain approval of these drawings prior to installation of the DMS poles.

(B) Documentation:

The contractor shall furnish shop drawings for mountings, modifications made during installation and calculations for the power cabling.

(C) Environmental:

All connections shall be watertight. Unused conduits shall be capped or sealed to prevent the intrusion of water, mud, gravel, etc. A waterproof plug shall be affixed to each unused conduit in the assembly.

(D) DMS Pole Mount Cabinet:

The contractor shall furnish and install the DMS pole on existing foundations as shown on the plans. The DMS poles shall support signs with the following dimensions:

- Approximate width: 15-feet
- Approximate height: 5-feet
- Approximate depth: 2.5-feet
- Approximate weight: 900 lbs.

The contractor shall install the DMS controller cabinet on the DMS pole. The sign controller unit cabinet and the sign pole shall form an integral unit.

Personnel shall be protected from all dangerous voltages.

A 120 VAC, 60 Hz, 15 amp NEMA 5-15 G.F.I. convenience duplex outlet shall be mounted in the cabinet for energizing test equipment or tools. The outlet shall be over current protected.

The cabinet shall be connected to the pole using anchor bolts.

The alignment of the cabinet on the pole shall be parallel with the roadway on the side opposite of the direction of travel.

(E) Dynamic Message Sign Installations:

The DMS installation shall include all components and parts required to provide a complete assembly. The contractor shall provide appropriate calculations to the engineer showing that the sign pole will support the DMS. These drawings shall be submitted with a seal of a professional engineer.

The contractor shall install the DMS assembly supplied by the DMS supplier and the design location.

The mounting hardware for the DMS shall be designed to provide a nominal downward tilt of 2° to 4° about the horizontal axis with the top of the sign forward. Means shall be provide to allow adjustment of ±2° about the horizontal axis. The sign shall operate properly at all of these positions.

(F) Interconnection between Cabinet and DMS:

All interconnecting control cables, supplied by the DMS supplier, shall be installed within the sign support structure between the sign controller unit cabinet and the DMS. The contractor shall install the cables in accordance with the DMS supplier on-site representative's recommendations.

The contractor shall integrate the DMS controller unit and the DMS with the communications system. The contractor shall work with the DMS supplier and the engineer to debug any problems in the overall DMS system operation until the DMS assembly is accepted by the engineer.

3.0 CONTRUCTION REQUIREMENTS:

3.01 Sign Delivery and Storage:

The contractor is responsible for accepting deliver of the DMS, controllers, and other accessories required for complete installation and operation of signs. The contractor will be responsible for the DMS and its components from the moment the contractor begins handling the DMS and its components in any manner. The contractor shall be responsible for storage of the sign upon receipt of equipment from the City of Glendale.

The contractor shall thoroughly inspect all of the equipment before the delivery truck departs and note, in writing, any damage on the bill of lading. In the event that damage is found, the contractor shall notify the DMS manufacturer immediately. In the event that damage is found, the contractor shall notify the engineer immediately and send a copy of this notification to the DMS sign supplier immediately thereafter. The contractor shall contact the engineer at least two (2) business days before delivery to request that City personnel be made available at the point of delivery.

The contractor shall store each sign in a secured location, beginning at the time of delivery to the time of installation. All equipment must be stored according to the equipment manufacturer's storage specifications. Any material arriving in a cardboard box must be stored indoors.

The contractor shall transport the sign from storage to the installation site, where the contractor will unload it.

3.02 Installation:

The contractor shall schedule installation on a just-in-time basis (for the DMS supplier's technician) and install the DMS equipment on the sign structure at locations shown schematically on the plans.

The DMS supplier shall be notified of installation 14 days prior to any installation. The contractor shall keep the DMS supplier apprised of any changes in the schedule that affect the date of the DMS installation. The DMS supplier will have a representative on-site during installation to terminate the DMS wiring. To maximize the efficiency of the manufacturer's technician, the contractor shall install both DMS during the single visit. The contractor shall incur all of the manufacturer's costs caused by contractor's non-adherence with the schedule (storage, personnel time, airfare, hotels, etc.) The contractor shall not install the DMS without the presence of the DMS technician.

The contractor shall not delay and shall coordinate with the DMS supplier to arrange the traffic closure, to establish path connections between the DMS and the DMS controller cabinets, to supply power to the assembly and to determine the mounting requirements. The DMS supplier will prepare the DMS and controller cabinet contents, hook-up and verify local operation, and provide the required communications protocol. The DMS supplier will terminate all wiring between the controller cabinets and the DMS on terminal strips.

The contractor shall perform other items of work (which are paid under separate items) to complete the DMS installation. The contractor shall provide the necessary traffic control including a lane closure required to install DMS. This work must be coordinated such that it occurs during the phase when traffic is not using the pavement beneath the DMS assembly. The DMS may be used in traffic control if needed, but only after passing the stand-alone test.

The contractor shall furnish and install cabling for power and communications necessary for a complete DMS assembly. The contractor shall coordinate with the City and with the power utility company to establish power at the DMS locations as shown on the plans.

Any item of work requiring coordination with or access to DMS equipment procured by the City of Glendale shall be pre-arranged with the Engineer, subject to convenience of the City.Power and signal cables shall be in separate conduits where available.

The Contractor shall install the DMS Cabinet on the DMS Pole with banding straps per the plan details. All conduit entries into the DMS Cabinet shall be made watertight by the Contractor.

All DMS installation work that requires closure of more than one lane of traffic will be performed during hours approved by the City (typically nighttime hours).

For any and all DMS installation work that requires traffic control, the Contractor shall provide static traffic control signs at both adjacent intersections.

The DMS manufacturer's technical representative shall provide on-site technical assistance in following areas:

- Sign to controller cabling
- Initial sign turn on and test

The initial powering up of the sign(s) shall not be executed without the permission of the DMS manufacturer's technical representative.

The contractor shall install the cabinet and related transformer equipment on the sign structures.

The size of conductors from the power source to transformer and the DMS cabinet shall be as required by the load and distance. The voltage drop shall not exceed 2% from the service to the load center and 3% from the load center to the DMS, for a total voltage drop of less than 5% between power source and sign.

3.03 Testing Requirements:

The DMS shall be subjected to the following tests.

(A) Design Approval Test (DAT):

The DMS will be subject to a DAT prior to acceptance for use by the City. The Engineer may accept certification by an independent testing lab in lieu of the DAT to verify that the requirements have previously been satisfactorily met.

The DAT shall be conducted by the DMS vendor on one or more samples of equipment of each type, as approved by the Engineer, to determine if the design of the equipment meets the requirements of this Specification. The test shall be conducted in accordance with the approved test procedures.

If the unit fails the DAT, the design fault shall be corrected and the entire DAT shall be repeated. All deliverable units shall be modified, without additional cost to the City, to include design changes required to pass the DAT.

The DAT shall cover the following:

TEMPERATURE AND CONDENSATION:

The DMS system equipment shall successfully perform all the functionality requirements listed in this specification under the following conditions in the order specified below:

- The equipment shall be stabilized at -40°F. After stabilization at this temperature, the equipment shall be operated without degradation for two hours.
- Moisture shall be caused to condense on the equipment by allowing it to warm up to room temperature in an atmosphere having relative humidity of at least 40% and the equipment shall be satisfactorily operated for two hours while wet.
- The equipment shall be stabilized at 149°F. After stabilization, the equipment shall be satisfactorily operated for two hours without degradation or failure.

PRIMARY POWER VARIATION:

The equipment shall meet the specified performance requirements when the nominal input voltage is 115 +/-15 V. The equipment shall be operated at the extreme limits for at least 15 minutes during which the operational test of the FDT shall be successfully performed.

POWER SERVICE TRANSIENTS:

- The equipment shall meet all performance requirements when subjected to the power service transient specified in 2.1.6 “Transients, Power Service”, and 2.1.8 “Nondestruct Transient Immunity” of the NEMA standard TS1.

RELATIVE HUMIDITY:

- The equipment shall meet its performance requirements when subjected to a temperature of 149°F and a relative humidity of 90%. The equipment shall be maintained at the above condition for 48 hours. At the conclusion of the 48 hour soak, the equipment shall meet the requirements of the operational test of the FDT within 30 minutes of beginning the test.

VIBRATION:

- The equipment (excluding cabinets) shall show no degradation of mechanical structure, soldered components, or plug-in components and shall operate to specification after being subjected to the vibration tests as described in Section 2.2.5, “Vibration Test”, of the NEMA standard TS1.

(B) Factory Demonstration Test (FDT):

If the DMS submitted by the Contractor is not Skyline Model LEDVMS-28x70-3L-8-IR, then it will be subject to a FDT at the DMS Vendor facility. If the DMS fails to pass the FDT, the DMS shall be corrected and another DMS substituted in its place and the test successfully repeated.

The Engineer shall be notified a minimum of 30 calendar days before the start of tests. The DMS Vendor shall pay for all travel expenses, including airfare, rental car, hotel, meals, etc., for up to two City personnel for the FDT at the Vendor’s Manufacturing Facility. All tests shall be conducted in accordance with the approved test procedure. All equipment shall pass the following individual tests:

EXAMINATION TESTS:

- Equipment shall be examined carefully to verify that the materials, design, construction, markings and workmanship comply with the requirements of the Specification.

- Demonstrate the LED mechanical axis is normal ±1.00° to the face of the sign to ensure brightness uniformity over the face of the sign.

- Demonstrate the brightness and color of each pixel is uniform over the entire face of the sign within the 30° cone of vision from 450 feet to 50 feet in all lighting conditions.

- Demonstrate no flashing, flickering, blinking, dimming, or other disturbance of the message during the pixel read tests.

CONTINUITY TESTS:

- The wiring shall be checked to determine conformance with the requirements of the appropriate paragraphs in the Specifications.

OPERATIONAL TESTS:

- The equipment shall be operated long enough to permit equipment temperature stabilization, and to check and record all performance characteristics to ensure compliance with the requirements of this Specification.

- Equipment functionality will be thoroughly tested to verify complete compliance with all areas of this Specification.

- Certification shall be provided that demonstrates that the LEDs were tested and binned in accordance with CIE 127-1997 Test Method A.

(C) Stand-Alone Test:

A stand-alone test will be required on all DMS supplied.

The test shall, as a minimum, exercise all stand-alone (non-network) functional operations of the DMS with all of the equipment installed as per the plans, or as directed by the Engineer.

If any DMS fails to pass its stand-alone test, the failure shall be corrected or another unit substituted in its place and the test successfully repeated.

If a DMS has been modified as a result of a stand-alone test failure, a report shall be prepared and delivered to the Engineer prior to the re-testing of the unit. The report shall describe the nature of the failure and the corrective action taken. If a failure pattern develops, the Engineer may direct that design and construction modifications be made to all units without additional cost to the City or extension of the contract period.

(D) Subsystem Test (SST):

The subsystem test shall include the contractor verifying proper DMS operation using the communications between the TMC and the DMS cabinet.

(E) System Acceptance Test (SAT):

The sign will be controlled from the central DMS server. Test messages shall be displayed and verified for correctness. The sign shall remain illuminated with various test messages for the duration of the 30-day SAT.

4.0 METHOD OF MEASUREMENT:

DMS, DMS Pole, and Pole-mount DMS Cabinet will be measured as a unit for furnishing, installing, and testing each component of DMS equipment, complete in place, which includes the LED sign, the pole structure, sign controller, sign controller cabinet, and all additional parts. The sign controller and DMS set-up activities and central database activities are considered incidental to DMS equipment and will not be measured or paid.

Each installation shall include, but not be limited to, terminating the SMFO cable, providing power, and coordinating with the sign supplier to complete an operational sign.

5.0 BASIS OF PAYMENT:

The accepted quantity of DMS installation and DMS Poles, measured as provided, will be paid for at the contract unit price as designated on the Bid Schedule, complete in place. This shall be full compensation for the work described herein and on the Plans.

The contractor shall provide a schedule to the engineer to permit just-in-time delivery after coordinating deliver of the DMS equipment with the engineer and the DMS supplier. The contractor shall pay for storage, at a location acceptable to the engineer, and insurance of the sign beginning 48 hours after the time the sign arrives in Glendale, Arizona, until it is installed, tested and accepted.

The contractor shall pay any additional DMS supplier labor and materials expenses beginning 48 hours after DMS delivery until it is installed, if the Contractor-Vendor agreed upon schedule is not met.

The contractor shall incur any DMS manufacturer costs cause by the contractor's failure to meet the schedule; including, but not limited to storage, personnel time, airfare, hotels, meals, vehicle rental, and other miscellaneous expenses.

Failure to provide power to the DMS within 48 hours of installation shall be considered prima facie evidence of a delay to the DMS supplier in performing testing.