CITY OF SAN ANTONIO, TEXAS
GOVERNING SPECIFICATIONS

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SPECIAL SPECIFICATIONS

621 TRAY CABLE
633 BATTERY BACKUP SYSTEM FOR TRAFFIC SIGNAL
6007 REMOVING TRAFFIC SIGNALS
8100 ITS TRAFFIC MONITORING CAMERA
ITEM 615
TRAFFIC SIGNAL CONTROLLER CABINET

615.1. DESCRIPTION: The purpose of this specification is to describe a traffic signal controller cabinet for use with Type 170E and 2070-L controllers. The work shall consist of furnishing the controller cabinet, associated equipment described herein, mounting equipment, and auxiliary load rack if specified, and mounting in the field. The Contractor will make all field wire terminations inside the cabinet unless otherwise specified. Contractor shall supply the cabinet as specified on the plans.

615.2. MATERIALS: The Contractor shall include all warranties and/or guarantees with respect to materials, parts, workmanship and performance of the product he proposes to supply.

Each cabinet is to be bid as a unit, including the cabinet, load switches, relays, isolators, auxiliary load racks, etc.

All equipment shall be warranted for a period of twenty-four (24) months from date of installation.

The warranty shall cover all units, defects, parts, labor, and shipping costs.

Each cabinet shall be supplied with a cabinet drawing and a complete cabinet wiring diagram.

The equipment supplied under these specifications from any manufacturer shall not be construed as endorsement of this equipment by the City of San Antonio. No reference to this purchase will be permitted.

The Contractor will bear all expenses connected with the return of any equipment which the City deems necessary to have returned to the factory for repair during the guarantee period.

The Contractor shall, at the option of the City, supply the City with a standard production model for evaluation by the City prior to approval. Such requested sample unit shall be provided within six weeks of the request from the City. The Contractor shall arrange to have the unit transported back to the original sender at no expense to the City.

All equipment required for proper operation of the control equipment, must be provided.

All equipment, including cabinet and all internal components shall conform to the Federal Highway Administration Publication FHWA-IP-78-16, December 1978, and Caltrans' Transportation Electrical Equipment Specifications, dated March 2009, with Errata #1, dated January 21, 2010, and all current errata, revisions and changes noted within these specifications. In case of conflicting requirements, the Project Plans or Invitation to Bid shall prevail over these specifications, which shall prevail over the Caltrans specifications, which shall prevail over the FHWA specifications.

All cabinet output file back panels shall be hard-wired with individual copper conductors. Printed circuit boards shall not be used for output file back panels.

615.3 CONTROLLER CABINETS: This specification defines the cabinets to be used with the Model 170E and 2070-L controller units. This specification replaces Chapter 11 of Federal Highway Administration Publication FHWA-IP-78-16, Type 170 Traffic Signal Controller System, hereafter referred to as TSCS.

Details of alternative designs must be submitted to the Traffic Signal Engineer for approval prior to fabrication.
A. **General Cabinet Construction:**

All cabinets shall be rainproof. The cabinet top shall be "crowned" or slanted to prevent standing water.

The cabinet and doors shall be fabricated of 0.125-inch [3 mm] minimum thickness aluminum. All exterior seams for cabinet and doors shall be continuously welded. All exterior welds shall be smooth. All edges shall be filed to a radius of 0.03125 inch [0.794 mm] minimum.

Cabinets shall conform to the requirements of ASTM Designation: B 209 for 5052-H32 aluminum sheet.

Welding shall be done by the gas metal arc (Mig) or gas tungsten arc (Tig) process using bare aluminum welding electrodes. Electrodes shall conform to the requirements of the American Welding Society (AWS) A5.10 for ER5356 aluminum alloy bare welding electrodes.

Procedures, welders and welding operators for welding on aluminum shall be qualified in accordance with the requirements of AWS B3.0, "Welding Procedure and Performance Qualification," and to the practices recommended in AWS C5.6.

The surfaces of each aluminum cabinet shall be the original cast-like finish or fabricated finish. Any variations of finish shall be preapproved in writing by the City. Each cabinet shall be equipped with two electric fans with ball or roller bearings and a capacity of at least 100 cubic feet [3 cubic meters] of free air delivery per minute per fan.

The fans shall be mounted within the cabinet and vented out between the top of the cabinet and the front door.

The fans shall be thermostatically controlled and shall be manually adjustable to turn on between 33 °C and 65 °C with a differential of not more than 6 °C between automatic turn on and turn off. The cabinet fan circuit shall be protected at 125 percent of the ampacity of the fan motor.

Intake (including filter) and exhaust areas shall pass a minimum of 60 cubic feet [2 cubic meters] of air per minute.

Each cabinet shall be provided with louvered vents in the front door with a removable pleated disposable air filter. The filter shall cover the vents and shall be held firmly in place with bottom and side brackets and a spring-loaded upper clamp.

The bottom filter bracket shall be formed into a waterproof sump with drain holes to the outside. The louvered vents shall be designed and constructed such that a stream of water from a pressure head, such as a Rainbird sprinkler or other type sprinkler, will not enter the cabinet.

All cabinets shall have a police panel. The police door shall provide access to the "Auto-Flash", "Signals On-Off" and “Manual Control Enable (MCE) On-Off” switches. In addition to these switches, an Interval Advance push button on a 6 ft. cord, a receptacle for the cord, and a 12 VAC transformer shall be provided as required for manual operation. Police Access shall be limited to these three switches and push button. The police panel door shall be equipped with a lock keyed for a master police key.

One key shall be furnished with each cabinet for the police lock. Each police key shall have a shaft at least 1.75 inches [44mm] in length.
Type 332 and 336 cabinets shall have single front and rear doors, each equipped with a lock. When each door is closed and latched, the door shall be locked. The latching handles shall have provision for padlocking in the closed position. The operating handle shall be stainless steel with a 7.5-inch [191 mm] handle and a minimum 0.50 inch [13 mm] stainless steel shank. The cabinet door frame shall be double flanged out on all four sides and shall be provided with strikers to hold tension on and form a firm seal between door gasketing and cabinet door frame.

The flange width shall be a minimum of one inch [25 mm], measured from front edge to flange to cabinet outside surface.

Each cabinet will be supplied with locks keyed alike to the standard Corbin #2 core combination. Two keys shall be supplied with each cabinet.

The locks shall have rectangular, spring-loaded bolts. The bolts shall have a 0.281-inch [7 mm] throw and shall be 0.75 inch [19 mm] wide by 0.375 inch [9 mm] thick (dimension tolerance is +0.035 inch [0.89 mm]). The locks shall be left hand on the front door and right hand on the rear door. Keys shall be removable in the locked position only. Locks shall be rigidly mounted with two stainless steel machine.

All load switches shall be solid-state switches and shall turn on and off within plus or minus 5 degrees of the zero voltage point of the AC sinusoidal line. In the locked position, the throw shall extend a minimum of 0.25 (+ 0.03) inch [6 mm (+0.76 mm)]. The front portion of the lock shall neither be recessed nor shall it extend more than 0.1875 inch [5 mm] from the face of the door. The locks shall be mounted on the door in such a position that the tumblers are in the upper quadrant.

The latching mechanism shall be a three-point draw roller type. The center catch and pushrods shall be plated. Pushrods shall be turned edgewise at the outward supports and cross section shall be 0.25 inch [6 mm] by 0.75 inch [19 mm], minimum.

Supports shall be 0.105 inch [3 mm] steel, minimum. Rollers shall have a minimum diameter of 0.875 inch [22 mm] and shall be equipped with ball bearings and nylon wheels. The center catch shall be fabricated of 0.1875-inch [5 mm] plated steel, minimum.

Each door shall be equipped with two bolt hinges, minimum 3.5 inches [89 mm] long. Each hinge shall have a fixed pin. All doors shall be provided with catches to hold the door open at both 90 degrees and 180 degrees, plus or minus ten degrees. The catches shall be 0.375 inch [10 mm] diameter minimum, plated steel rods. Door latches, in latched position, shall not come in contact with cabinet surface or flange lip. The catches shall be capable of holding the door open at 90 degrees in a 60 MPH [96.54 kph] wind at an angle perpendicular to the plane of the door.

On all cabinets, door hinge pins and bolts shall be made of stainless steel. Door hinges shall be made of aluminum. The hinges shall be bolted to the cabinet and may be welded to the door. The hinge pins and bolts shall be covered by the door edge and shall not be accessible when door is closed. Hinge pins will be welded at each end to form a cap and welds filed or ground smooth.

Type 332 cabinets shall be provided with two lifting eyes to be used when placing the cabinet on the foundation. Each eye attached to the cabinet shall have a minimum diameter of 0.75 inch [19 mm] and shall be capable of supporting the cabinet.

Gasketing shall be provided on all door openings and shall be dust-tight. Gaskets shall be 0.25 inch [6 mm] minimum thickness closed cell neoprene and shall be permanently bonded to the metal. The mating surface of the gasketing shall be covered with a silicone lubricant to prevent sticking to the mating surface.
B. Power Supply:

A power supply shall be provided in the cabinet for all equipment installed in the cabinet except the Models 242 Isolators.

All Power Supply Assemblies (PDA) for cabinets shall meet Caltrans’ Transportation Electrical Equipment Specifications for PDA #2, dated March 2009 or latest revision.

The power supply shall be ferro-resonant design having no active components and shall conform to the following requirements:

- Line Regulation: Two percent from 95 to 135 VAC at 60 Hz, plus an additional 1.6 percent for each additional one percent frequency change.
- Load Regulation: Five percent from one ampere to five amperes with a maximum temperature rise of 30°C above ambient.
- Design Voltage: +24 (+0.5) VDC at full load and 30°C C with 115 VAC input line after 0.5 hour warm-up.
- Full Load Current: Five amperes, minimum.
- Ripple Noise: Two volts peak-to-peak and 500 millivolts rms at full load.
- Line Voltage: 95 to 135 VAC.
- Efficiency: 60 percent, minimum.
- Minimum Voltage: 22.8 VDC.

The power supply front panel shall include:

- All fuses or circuit breakers.
- Pilot lamp.
- Test points or meter for monitoring output voltage.

The power supply, including terminals, shall be protected to prevent accidental contact with energized parts.

Wiring for 120 VAC power input to power supply shall be terminated on terminal strips. AC plugs will not be acceptable.

The power supply cage and transformer shall be securely braced with nylon strapping to minimize damage in transit.

C. Flash Transfer Relay:

The Flash Relays shall conform to the requirements of these specifications.

A leakage resistor, which will permit 3 to 8 volts to be applied to the relay coil, shall be installed across the terminals of each relay socket to overcome the residual magnetism.

The flash transfer relay shall transfer field outputs from switchpack output to flash control. Transfer of the flash transfer relay circuit to flash control shall not interrupt the operation of the controller unit.
The coils of the flash transfer relays shall be energized only when the signals are in flashing operation and the police panel "ON/OFF" switch is in the "ON" position.

D. Equipment Removal:

The following equipment shall be completely removable from the cabinet without removing any other equipment and using only a screwdriver:

1. Power Supply
2. Power Distribution Assembly
3. Input File
4. Output File

E. Miscellaneous:

All fuses, circuit breakers, switches, (except police panel switches and fan fuse) and indicators shall be readily visible and accessible when the front door is open.

All equipment in the cabinet shall be clearly and permanently labeled. The marker strips shall be made of a material that can be easily and legibly written on using a pencil or ball-point pen. Marker strips shall be located immediately below the item they are to identify and must be clearly visible with the items installed. Glossy marker strips are not acceptable because ink tends to bubble and smear. Resistor/Capacitor transient suppression shall be provided at the relay socket (across relay coils) and in the fan circuit.

F. Cabinet Wiring Diagram:

One set of nonfading (comparable to Xerox 2080) readable cabinet wiring diagrams shall be supplied with each cabinet. The diagram shall be nonproprietary. They shall identify all circuits in such a manner as to be readily interpreted. The cabinet drawing shall show the component layout in an elevation view as viewed from the rear of the cabinet with the left and right cabinet walls shown in their relative positions. The diagrams shall be placed in a heavy duty side opening clear plastic pouch and attached to the front cabinet door. The pouch shall be of such design and material that it provides adequate storage and access to the wiring diagram, and shall be constructed of a material which will not react with or stick to xerographic plastic toners used in copy machines.

Detailed equipment layout scale drawings and wiring diagrams of all equipment installed in the cabinet shall be submitted to the Traffic Engineer for approval prior to production. Review by the City does not lessen the contractor's responsibility to meet the specifications.

G. Cabinet Light:

Each cabinet shall be equipped with a fluorescent or LED lighting fixture mounted inside the top front of the cabinet. The fixture shall have an 8 watt lamp AT5-CW, operated from a normal power factor, U.L. listed ballast. The lamp shall be shaded to diffuse the light. A door switch shall be installed to turn the cabinet light on when the front door is opened. The door switch shall be on a separate circuit by itself, and used only to turn on the light and operate the door alarm.

On the Type 332 and 336 cabinets, additional wiring shall be provided from the load (normally open) side of the light switch to Input File location I11D, run AC- to Input File location I11E, and C1-80 shall be wired to IUF for the door alarm circuit.
H. Conductors:

Conductors used in cabinet wiring shall terminate with properly sized spring-spade type terminals or shall be soldered to a through-panel solder lug on the rear side of the terminal block. All crimp-style connectors shall be applied with a power tool which prevents opening of the handles until the crimp is completed.

Conductors in the controller cabinet between the service terminals and the signal bus breakers including the chassis ground conductor to Power Distribution Assembly shall be No. 8, or larger.

All conductors used in controller cabinet wiring shall be No. 22, or larger, with a minimum of 19 copper strands. Conductors shall conform to Military Specification: MIL-W-16878D, Type B or better. The insulation shall have a minimum thickness of 10 mils and shall be nylon jacketed polyvinyl chloride except that Conductors No. 14 and larger may have Type THHN insulation, and shall be stranded with a minimum of seven copper strands.

All conductors, except those which can be readily traced, shall be labeled. Labels attached to each of the conductors shall identify the destination of the other end of the conductor.

All conductors used in controller cabinet wiring shall conform to the following color-code requirements:

- The grounded conductors of AC circuits shall be identified by a continuous white or gray color.
- The equipment grounding conductors shall be identified by a solid green color or by a continuous green color with one or more yellow stripes.
- The DC logic ground conductors shall be identified by a solid white color with a colored (except green) stripe.
- The ungrounded conductors shall be identified by any color not specified above.

All cabinet wiring harnesses shall be neat, firm and routed to minimize crosstalk and electrical interference. Printed circuit motherboards may be used to eliminate or reduce cabinet wiring on the input files, only.

- Wiring containing AC shall be routed and bundled separately or shielded separately from all logic voltage control circuits.
- Cabling shall be routed to prevent conductors from being in contact with metal edges. All conductors, terminals or parts, which could be hazardous to maintenance personnel, shall be protected with suitable insulating material.

Within the cabinet wiring, the DC logic ground and equipment ground shall be electrically isolated from the AC grounded conductor and each other by 500 megohms when tested at 250 VDC, with the power line surge protector disconnected.

Conductors from Connector C to the input file shall be of sufficient length to allow any conductor to be connected to any detector output terminal (Positions S, F, and W). The AC-copper terminal bus shall not be grounded to the cabinet or connected to the logic ground and shall provide a minimum of 10 terminals for connection to field conductors. Nylon screws with a minimum diameter of 0.25 inches [6 mm] shall be used for securing the bus to the service panel.

An equipment grounding (earth ground) bus shall be provided in each cabinet. The bus shall be copper and grounded to the cabinet.
The output common of the cabinet power supply shall be connected to the DC logic ground bus using a No. 14, or larger, stranded copper wire.

The DC ground bus shall be located on the input panel.

A No. 8, or larger, copper conductor shall be connected between equipment ground bus and rack rails.

Terminals for the signal wires shall be fitted with 90 degree lugs for #14 AWG wire. Lugs shall be the type that the end of the field wire slips into and is held in place with a compression screw on the wire. (Blackburn #L35 or equivalent)

Each loop detector lead-in, from the field terminals in the cabinet to the sensor unit rack connector shall be a cable UL Type 2092 or better. The stranded tinned copper drain wire shall be connected to a terminal on the input file terminal block. This input terminal shall be connected to the equipment grounding bus through a single conductor.

I. Surge Protection:

All cabinets shall be provided with an EDCO Model # SHA-1210 or approved equal. Cabinet shall be wired so filtered AC+ shall be supplied to the controller unit receptacles (2) and conflict monitor only.

Surge protection shall be provided for all cabinet power.

All signal output lines shall be protected by a MOV installed at the field wiring terminal block inside the swing down back panel so as to not interfere with the field wiring, between the terminal and earth ground. The MOV shall be Type V150LA20.

J. Controller:

The Contractor shall provide a Type 2070-L Controller that meets the requirements of TxDOT Special Specification 6443 and shall include the following:

- 2070-1B Central Processing Unit (CPU) module
- 2070-2A Field Input/Output (I/O) Module (C1 and C11 connectors)
- 2070-3B Front Panel (8 line display)
- 2070-4A (10 Amp) power supply
- 8MB of DRAM and 8MB of Flash Memory.

K. Conflict Monitor:

The Contractor shall supply a conflict monitor that conforms to the TEES specification for the Model 2070L controller. The conflict monitor shall be EDI, Model 2018 KCLiP, or approved equivalent. The Contractor shall supply one (1) CMU Data Key Programming Tool (data key programming device) for each group of less than fifty (50) monitors furnished.

L. Heavy Duty Relays:

This specification defines the Model 430 heavy duty relays to be used with the Model 170E controller unit.
This specification replaces chapter 17 of Federal Highway Administration Publication FHWA-IP-78-16, Type 170 Traffic Signal Controller System:

1. Heavy duty relays shall be the electromechanical type and shall be designed for continuous duty at 95 to 135 VAC.

2. Each relay shall mate with the eight-pin Jones-type socket as shown on the plans and shall be enclosed in a removable, clear plastic cover.

3. The manufacturer's name and part number, and electrical rating, shall be provided on the cover. They shall be permanent, durable and readily visible when the relay is mounted in its socket.

4. Each relay shall be provided with double-pole, double-throw contacts. Contact points shall be of fine silver, silver alloy or superior alternative material. Contact points and contact arms shall be capable of switching at 20 amperes tungsten load per contact, and 120 VAC once every two seconds with a 50 percent duty cycle, for at least 250,000 operations, without contact welding or excessive burning, pitting or cavitation.

5. The relay coil shall have a power consumption of 10 volt-amperes or less.

6. Each relay shall withstand a potential of 1,500 volts at 60 hertz between insulated parts, and between current carrying parts and non-current carrying parts.

7. Each relay shall have a one-cycle surge rating of 175 amperes RMS.

M. Isolators:

1. DC Isolators shall be Model 242 and shall meet FHWA-IP-78-16 specifications chapter 7. See Section O for quantities to be supplied with particular cabinets.

2. AC Isolators shall be Model 252 and placed in input file slot I11, with marker strip labeled "DOOR ALARM" in each Type 332 and 336 cabinets. See Section O for quantities to be supplied with particular cabinets.

N. Load Switches:

Load switch can be Type 200 in accordance with the specification of FHWA-IP-78-l6.

O. Supply Quantity:

All cabinets shall be supplied with all necessary equipment for proper operation, including the plug-in items listed in the following table, in all cases, regardless of the intended operation.

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</tr>
<tr>
<td>AC Isolators</td>
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P. Output Files:

There shall be eight capacitive dummy loads mounted to a terminal block on the rear of the swing-down back panel. One side of each dummy load shall be tied to AC-. Four of the dummy
loads shall be connected at the factory to the center (yellow) output of the load switches assigned to ped signals for Phases 2, 4, 6, and 8.

The P20 connector and cable assembly for monitoring the red outputs of all load switches shall be provided and mounted to the swing-down back panel, for future use.

Auxiliary output files shall be provided in each Type 332 cabinet. Auxiliary output files shall be supplied in Type 336 cabinets if specified (adequate rack length shall be provided in all 336 cabinets for an aux file in case the City retrofits one at a later date). The file shall accommodate six load switches and two flash relays. The file shall be connected via a cable to the C6 connector on the rear of the standard 12-position output file. Six dummy capacitive loads shall be provided on a terminal block for selective jumping to the outputs of the load switches. The red and yellow signal circuits of switch packs 13, 14, 16, and 17 shall be available at a Molex type 1375 receptacle which shall intermate with a Molex type 1375 plug to allow flash programming. A plug connector, with programming jumpers, shall be furnished for each circuit to allow red or yellow flash programming. Plugs shall be readily accessible without the removal of any other equipment. Plug pins shall be crimped and soldered.

The cabinet shall be wired to ensure that all available output channels can be used and monitored. For a 332 cabinet with Auxiliary output file, this means that all 18 output channels can be used and monitored.

615.3. TYPE 332 CABINET:

A. Rack Assembly:

A standard EIA 19-inch [483 mm] rack cage shall be installed inside the cabinet for mounting the controller unit, input file power supply, output file and power distribution assembly. The EIA rack portion of the cage shall consist of two pairs of 53-inch [1346 mm] minimum usable, continuous, adjustable equipment mounting angles of 0.1345 inch [3 mm] nominal thickness plated steel tapped with 10-32 threads with EIA universal spacing. The angles shall comply with Standard EIA RS-310-B and shall be supported top and bottom by welded support angles to form a cage. Clearance between rails for mounting assemblies must be 17.75 inches [451 mm].

Two plated supporting angles extending from the front to the back rails shall be supplied to support the controller unit. The angles shall be designed to support a minimum of 50 pounds [22.7 kilogram] each. The horizontal side of each angle shall be mounted 17.5 inches [445 mm] from the top of the rack and shall be adjustable vertically.

The cabinet shall have supporting angles (railing) on either side level with the bottom edge of the door opening to provide horizontal support for the cage. The cage shall be vertically attached to each side of the cabinet at four points, two at the top and two at the bottom of the rails.

A minimum of 10.5 inches [267 mm] of EIA rack height and 20 inches [508 mm] of depth (18 inches [457 mm] behind and two inches [50 mm] in front of the mounting ears) shall be provided for the controller unit.

A 2-inch [50 mm] tall drawer shall be rack-mounted in each Type 332 cabinet. The drawer shall be provided with a hinged top cover and shall be capable of supporting 50 pounds [22.68 kg] in the extended position.
B. Input File:

The input file shall utilize 5.25 inches [133 mm] of rack height. The input file shall intermate with and support 14 two-channel inputs.

The input file shall provide card guides (top and bottom) and a 22-pin single-readout, edge connector centered vertically for each detector. The input file shall allow air circulation through the top and bottom.

Pins D, E, F, J, K, L, and W on each edge connector slot shall be terminated on their associated terminal block mounted on the rear of their input file. Pins F and W for each slot shall terminate on the terminal blocks mounted on the rear of the input file and will connect to the proper controller unit inputs in the Connector C1S wiring harness. Common grounding of output emitters will be permitted and common grounding conductor brought out to TB15, Terminal 4 (CTR DC GND).

The edge connectors shall be double-sided connectors with the numbered side of each pin shorted to its respective lettered side internally.

The card guide shall begin 1.0 (+0.5) inch [25 mm +12 mm] back from the front face of the file.

The input file shall be provided with marker strips to identify isolators and detectors in the file as described in Section V-E.

C. Power Distribution Assembly:

The power distribution assembly shall be furnished and mounted on the EIA 19-inch [483 mm] rack utilizing no more than seven inches [178 mm] of rack height. All equipment shall be readily accessible for ease of replacement. The depth of the assembly shall not exceed 10 inches [254 mm] from the front cabinet rails including terminal blocks.

The following equipment shall be provided with the power distribution assembly:

- 2 - Equipment duplex receptacles (one on the front panel, and another on the back panel readily accessible from back door)
- Controller unit duplex receptacle
- 1 - Main circuit breaker
- 1 - Six-pole single bus circuit breaker
- 1 - Two-pole flash bus circuit breaker
- 1 - Equipment circuit breaker
- 1 - Solid State Relay (Normally Closed) – rated minimum 50 Amperes, 120 VAC, Crydom A2450-B or equal.
- 1 - Auto/Flash Switch
- 1 – Heavy Duty Relay (Transfer Relay) and socket
- 2 - Flasher Unit sockets
- 2 - Model 204 Flasher Units
- 1 - Flash Indicator light
- Terminal Blocks
The main circuit breaker shall be rated for 50 amperes at 120 VAC. The circuit breakers for the equipment receptacles and signal bus shall be rated for 15 amperes at 120 VAC. The flash bus circuit shall be rated for 20 amperes at 120 VAC. Rating of breakers shall be shown on face of breaker or handle. Breaker function shall be labeled below breakers on front panel.

Equipment Receptacles shall be NEMA 5-15R duplex type. The Equipment Receptacles shall have ground-fault circuit interruption as defined in the National Electrical Code. Circuit interruption shall occur on six milliamperes of ground-fault current and shall not occur on less than four milliamperes of ground-fault current.

An "Auto/Flash" switch shall be provided which, when placed in "Flash" position (down), shall energize the contactor coil. When the switch is placed in the "Auto" position (up) the switch packs shall control the signal indications. The switch shall be a single-pole single-throw toggle switch rated for 15 amperes at 120 VAC.

A lamp labeled "Flash Operation" shall be provided on the front panel of the assembly. The lamp shall be driven by the Flasher Unit Output through Transfer Relay Circuit No. 1.

The two Controller Unit Receptacles shall be a hospital grade NEMA 5-15R mounted on the back panel of the assembly. AC+ to the controller unit receptacle shall be from the filtered outputs of the SHA-1210 surge protector.

Terminal Blocks shall be provided and mounted on the back panel of the assembly. The blocks shall be of type specified for signal field wire terminal blocks. All conductors from the power distribution assembly routed to the cabinet wiring shall be connected to the terminal block on the common side, except for the AC power conductor between the service terminal block and main circuit breaker.

All internal conductors terminating at the blocks shall be connected to the other side of the blocks.

The Flash Relays shall conform to the provisions for "Heavy Duty Relays, Model 430."

A leakage resistor, which will permit three to eight volts to be applied to the relay coil, shall be installed across the terminals of each relay socket to overcome the residual magnetism.

**D. Output File:**

Card guides shall be provided to support the switch packs and the monitor unit.

The output file shall utilize 10.5 inches [267 mm] of rack height and shall be supplied with 12 Model 200 Switch Packs. Four Model 430 Flash Transfer Relays shall be furnished with each output file. The depth of the assembly including terminal blocks and relays shall not exceed 14.5 inches [368 mm] from the front cabinet rails.

The output file shall be provided with marker strips to identify switch packs when mounted in the file, as specified in Section V-E.

Switch pack connectors, monitor unit connectors, flash transfer relay sockets and flash programming connectors shall be accessible from the back of the output file without the use of tools.

Three field wire terminal blocks shall be mounted vertically on the back of the assembly. The terminal blocks shall be the 12-terminal type.
The controller unit outputs to the output file shall be connected through Connector C4.

The red and yellow signal circuits of all switch packs assigned to vehicle signals for phases 1 through 8 shall be available at a Molex Type 1375 Receptacle which shall intermate with a Molex Type 1375 plug to allow flash programming. A plug connector, with programming jumpers, shall be furnished for each circuit to allow red or yellow flash programming. Connectors shall be readily accessible without the removal of any other equipment. Plug pins shall be crimped and soldered.

The monitor connector shall be rigidly supported printed circuit board edge connector, having two rows of 28/56 independent double readout bifurcated contacts on 0.156 inch [4 mm] centers. The connector shall terminate with a Model 210 Monitor Unit.

It shall be possible to remove the monitoring device without causing the intersection to go into flashing operation. The cabinet shall be wired so that with front cabinet door closed and with the monitor unit removed, the intersection shall go into flashing operation. The cabinet shall contain a conspicuous warning against operation with the monitor unit removed.

**E. Side Panels:**

Two panels shall be provided and mounted on the EIA rack parallel to the cabinet sides.

In viewing from the back door, the left side panel shall be designated as the "Input Panel" and the right side panel shall be designated as the "Service Panel".

All input field terminal blocks for detector field cables and other input conductors, except service conductors, shall be mounted on the "input panel". The "input panel" shall be wired per CALTRANS's March 2009 specification.

**F. Terminal Blocks:**

Terminal blocks shall be provided for terminating field conductors. They shall be readily accessible through the cabinet rear door and shall be rated for 20 amperes at 600 volts RMS, minimum.

The terminal blocks for detector field conductors, auxiliary field wires and control wires shall be the barrier type and shall be provided with 8-32 by 5/16 inch [8 mm] minimum nickel plated brass binder head screws and nickel plated brass inserts.

The terminal blocks for field wires to the signal indications, power distribution assembly and the required unused position shall be the barrier type and shall be provided with 10-32 by 5/16 inch [8 mm] nickel plated brass binder head screws and nickel plated brass inserts.

The terminal blocks for the input file and power supply shall be the barrier type and shall be provided with 8-32 by 5/16 inch [8 mm] nickel plated brass binder head screws and nickel plated brass inserts.

The terminals of the power line service terminal block shall be labeled "L1" and "AC-", and shall be covered with a clear insulating material to prevent inadvertent contact. Terminating lugs large enough to accommodate No. 2 conductors shall be furnished for the service terminal block. The terminal block shall be rated for 50 amperes at 600 volts, minimum.

**G. Connectors:**

Connector C1P shall contain 104 pin contacts and shall intermate with connector C1S mounted on the controller unit chassis. Corner guide pins for connector C1P shall be stainless steel and
shall be 0.097 inches [2 mm] in length. Corner guide socket assemblies shall be stainless steel and shall be 0.625 inches [16 mm] in length.

Connector C4 shall contain 37 contacts and shall be the circular plastic type with quick connect/disconnect capability and thread assist, positive detent coupling. The Plug Connector C4P shall be mounted on the output file.

Connector C5 shall contain 24 contacts and shall be the circular plastic type with quick connect/disconnect capability and thread assist, positive detent coupling. The Plug Connector C5P shall be mounted on the input file.

Connector blocks for Connector C1 pin and socket connectors shall be constructed of diallylphthalate or better. Contacts shall be secured in the blocks with springs of stainless steel.

615.4. TYPE 336 CABINET:

This section defines the detailed requirements for an eight-phase controller cabinet to be mounted on a post-top or foundation mount.

The cabinet shall be designed for either post-top or foundation mount. The design must be flexible enough to allow choosing the mounting type at time of installation, and to allow changing the mounting type at any time in the future. For foundation mounting, the cabinet shall be designed with a square opening in the floor of the cabinet as large as possible and still allow easy access to anchor bolts and a good seal with the foundation. For post-top mounting, an adapter shall be used which mates with the anchor bolt holes, in such a way as to provide a dust-proof attachment. The adapter shall mate with a standard 4 inch [102 mm] slipfitter, and shall be strong enough to meet the stiffness requirements defined below. All cabinets shall be supplied with an adapter and a 4 inch [102 mm] slipfitter, regardless of the stated application of the cabinet, see attached drawing for slipfitter and base plate.

All Type 336 cabinets shall be capable of housing an auxiliary output file ("stretch" version), and one shall be supplied and installed when specified.

All Model 336 cabinets shall have both a front and a rear door, keyed with a Corbin #2 lock as described previously in the general cabinet specifications.

Cabinets assembled for post-top mounting shall be adequately reinforced in the bottom of the fully-equipped cabinet to withstand a 100 mph [107 kph] wind, and shall have less than 2 inches [50 mm] of deflection at the top when a 100 pound [445 N) force is applied horizontally at the top of the cabinet on any of the four planes of cabinet faces.

The input file shall have 14 slots and an input panel as described for the Type 332 cabinet in Section VI-B. See attached drawing for 336 input file assignments.

The output file shall have 12 output slots.

The red and yellow signal circuits of all switch packs assigned to vehicle signals for phases 1 through 8 shall be available at a Molex Type 1375 Receptacle which shall intermate with a Molex Type 1375 plug to allow flash programming. A plug connector, with programming jumpers, shall be furnished for each circuit to allow red or yellow flash programming. Connectors shall be readily accessible without the removal of any other equipment. Plug pins shall be crimped and soldered.

The cabinet shall also include 4 flash relays, and two flashers.
615.6 TESTING AND CERTIFICATION:

All cabinets supplied shall be tested by the manufacturers as complete units as outlined in chapter 1, section 8 in FHWA-IP-78-16 and certification provided to the City of San Antonio that such tests were provided.

The manufacturer shall provide certification that the units supplied under these specifications are not units rejected by some other municipality or state.

615.7 DOCUMENTATION:

A. Cabinet Assembly Wiring Diagram: Each and every complete Cabinet Assembly shall be provided with one set of nonfading readable cabinet wiring diagrams as specified in Section V-F of this specification.

B. Other Equipment: Documentation is also required for each auxiliary piece of equipment. The documentation shall be sufficient for operation and maintenance of the equipment to the satisfaction of the City of San Antonio. All documentation shall be prepared in a clear, concise manner with appropriate illustrations, tables, and cut-away drawings, and voltage/wave form reference pictures. Equipment requiring this documentation shall include, but not be limited to the following:

- Program Module
- Power Supply Assembly No. 2 (PDA No. 2)
- Model 206 Power Supply, 24V
- Model 200 Load Switch
- Model 204 Flasher
- Model 242 DC Isolator
- Model 252 AC Isolator
- Flash Transfer Relays

The documentation shall be adequately bound for protection and to prevent loss of pages. The documentation material shall include, but not be limited to, the following:

- General description,
- Complete installation and set-up procedures,
- Complete and accurate schematic diagrams.
- Complete performance specifications (functional, electrical, mechanical and environmental) on the units.
- Complete and detailed system operations manuals.
- Theory of operation,
- Voltage and waveform descriptions,
- Complete maintenance and trouble shooting procedures,
- Schematic diagrams of circuits and IC boards, which are in sufficient detail to enable City of San Antonio traffic signal operations personnel to trace signals at the component level,
- Pictorial layout of IC board components,
Parts list including: Name of OEM, description, reference symbol, part number and location,

Complete parts list including names of vendors for parts not identified by universal part numbers such as JEDEC, RETMA, or EIA.

Two (2) complete auxiliary equipment documentation sets per order shall be furnished.

615.8 CONSTRUCTION: The Contractor shall contact the City Signal Shop at 207-7765 at least two weeks in advance to schedule the testing and configuration of the equipment by the City. The City will then direct the Contractor as to which day the controller cabinet unit(s) can be delivered. The equipment delivered to the City shall meet the following requirements:

- All cabinet equipment (cabinet, controller, load switches, detectors, isolators, etc.) shall be assembled and/or installed inside the cabinet by the Contractor.
- The plan sheets relating to a particular intersection shall be reduced to fit and placed inside the documentation pouch on the cabinet door.
- The Contractor shall include all applicable documentation described in Section 615.7.
- The cabinet(s) shall have a tag wired to the door handle indicating the location for which it is intended, and the Contractor's name. Tags shall be of adequate size for lettering to be read easily.

Any cabinets that are delivered to the City without all the proper devices or documentation within the cabinet, or devices not plugged into the appropriate slots (still boxed, with the exception of the extra conflict monitors) will be rejected until they are corrected.

When testing and configuration are completed, the City will notify the Contractor to pick up the cabinet(s). Upon notification, the Contractor must pick up the cabinet(s) within 2 working days. At the option of the City, the Contractor may be required to remove the cabinet(s) from the City Signal Shop. All testing will be scheduled on a first-come-first-served basis, for complete units in compliance with these specifications.

The Contractor shall be responsible for connecting all field wires inside the cabinet according to the project plans, cabinet prints, and the directions of the City. All wires to be terminated in a neat fashion and bundled for a clean appearance. Loop cable wires to have spade connectors.

Once installed on the foundation, the base of the cabinet shall be sealed against water seepage. (Foundation-mounted only)

The door of the cabinet on the controller face side shall be positioned such that the technicians can easily view the signal displays of the intersection.

615.9 TRAINING: Upon the purchase of five (5) or more cabinets, the Contractor shall provide forty hours of training by factory technicians in troubleshooting and repair, theory of operation, and diagnostic testing. Operational and maintenance training shall be provided to designated personnel. This training shall be provided through practical demonstrations, seminars and other related technical procedures. The training shall include, but not be limited to the following:

1.-“Hands-on” operation for each type of equipment.
2.- Explanation of all system commands, their function and usage.
3.- Required preventive maintenance procedures.
4.- Servicing procedures.
5.- Equipment “troubleshooting” or problem identification procedures.

Training shall take place within four weeks following the testing and configuration by the City at the Traffic Operations Facility, 223 South Cherry Street in San Antonio, Texas. Training shall be scheduled at least one month in advance by contacting the Traffic Signal Superintendent at (210)207-7769.

615.10 MEASUREMENT: Controllers and cabinets shall be measured for payment as combined units, including auxiliary items, per each controller cabinet unit, in accordance with the project plans and specifications.

615.11 PAYMENT: The accepted number of units shall be paid for at the contract unit price which shall be full compensation for furnishing all materials, labor, and tools; installing the controller unit(s); and shipping the unit(s) to and from the City Signal Shop for testing and configuration.

615.12 BID ITEM:

- Item 615.1 - Controller Cabinet Assembly (Type 332) – per Each
- Item 615.4 - Controller Cabinet Assembly (Type 336) – per Each
696.1. DESCRIPTION: Furnish and install Radar Vehicle Detection Devices (RVDD), including: Radar Advance Detection Devices (RADD) and/or Radar Presence Detection Devices (RPDD) to detect vehicles on a roadway via processing of radar electromagnetic waves and provides detector outputs to a traffic signal controller or similar device.

696.2. DEFINITIONS

A. RADAR: Radio detection and ranging. High frequency electromagnetic energy waves used to detect, identify, and determine the range, direction, and/or speed of an object such as a motor vehicle.

B. Radar Vehicle Detection Device (RVDD): Device that emits electromagnetic waves and senses return waves from passing and/or approaching vehicles. The RVDD shall be spatially monostatic; the transmitter and receiver shall be located on the same sensor device.

C. Radar Advance Detection Device (RADD): Device that accurately and continuously detects, tracks, and identifies speed of approaching vehicles simultaneously to an intersection in the selected direction of travel. The RADD is capable of detection as described in section 696.3.A. The RADD shall maintain detection of a vehicle moving within 100 ft. to 500 ft. from the device as programmed by the user.

D. Radar Presence Detection Device (RPDD): Device that accurately and continuously detects and tracks approaching vehicles simultaneously to an intersection in the selected direction of travel. The RPDD is capable of true presence detection as described in section 696.3.B. The RPDD shall maintain detection of a vehicle moving or stopped within a programmed detection zone set up by the user.

E. Interface Module: Device that interfaces with the cabinet detector rack allowing for contact closure to occur on a selected detector channel.

F. Communications Link: The communications connection between the RVDD processor unit and a local area network (LAN) or laptop computer.

G. Detection Accuracy: The measure of the basic operation of a detection system (shows detection when a vehicle is in the detection zone and shows no detection when there is not a vehicle in the detection zone).

H. Passage Detection: The ability of a vehicle detector to detect the passage of a vehicle moving through the zone of detection and to ignore the presence of a vehicle stopped within the zone of detection.

I. Presence Detection: The ability of a vehicle detector to sense that a vehicle, whether moving or stopped, has appeared in its zone of detection.
J. **Delay Timing**: When selected, applies delayed contact closure to the associated detector channel input. When a vehicle is detected by the RVDS, the delay timing must time out before contact closure is removed from the associated detector channel.

K. **Extension Timing**: When selected, applies additional contact closure to the associated detector channel input. When a vehicle is no longer detected within a detection zone, extension timing must time out before contact closure is removed from the associated detector channel.

696.3. **FUNCTIONAL CAPABILITIES**

A. **Radar Advance Detection Device (RADD) Capabilities and Requirements**

1. The RADD shall provide passage detection and contact closure to the interface module for vehicles approaching the intersection (the unit).

2. The RADD shall provide vehicle detection, tracking, and speed of moving vehicles approaching an intersection at a range of 100 feet to 500 feet from the radar sensor.

3. The RADD system software shall be capable of creating multiple detection zones within the detection range and applying conditional logic to the detection zones, allowing contact closure to occur only when logic conditions are achieved by the RADD. The user shall be able to apply logic gating such as: “and”, “or” to a detection zone from the software GUI provided with the system. Conditional logic programming will allow the user to control when contact closure occurs to the detector rack interface module.

4. The RADD system software shall be capable of minimum and maximum speed settings to create a desired speed range for contact closure to the detector channel. Vehicles detected within the minimum and maximum speed settings will apply contact closure to the assigned detector channel input.

5. Detection accuracy will be determined by the detection of any moving vehicle or cluster of vehicles within a defined detection zone and within the minimum and maximum speed parameters programmed for the detection zone. With four (4) detection zones programmed, each zone 100 feet in length, a minimum of 95% detection accuracy shall be required for each zone. Detection zones will be set up between 100 feet and 500 feet. Conditional logic for each zone shall be set up in the “or” gate position allowing for contact closure to occur when vehicle speed conditions are met in the detection zone.

6. The RADD shall be capable of delay timing as defined in 696.2.J of this specification. As a minimum the user shall be able to program and select extension timing from 0-25 seconds in one/tenth (0.1) second increments from the GUI provided with the RVDS system.

7. The RADD shall be capable of extension timing as defined in 696.2.K of this specification. As a minimum the user shall be able to program and select extension timing from 0-25 seconds in one/tenth (0.1) second increments from the GUI provided with the RADD system.

8. The RADD shall be capable of adjusting the extension time automatically based on speed of a moving vehicle.
B. Radar Presence Detection Device (RPDD) Functional Capabilities and Requirements

1. The RPDD shall provide presence detection and contact closure to the interface module for vehicles approaching an intersection. Presence detection shall operate as defined in 696.2.1 of this specification.

2. The RPDD shall, as a minimum detect vehicles within a 100 feet, 90 degree cone of detection from the sensor. Stop bar radar units shall be able to detect vehicles in 10 lanes of detection. The number of lanes used and detection zones shall be set up and selected from the GUI.

3. The RPDD shall be able to assign up to 4 detector outputs per unit and capable of using 2 or 4 channel interface modules to the detector rack.

4. The RPDD shall be able to distinguish and omit wrong way traffic from activating an assigned detector output.

5. The RPDD shall as a minimum, maintain a detection accuracy of 95% for each detection zone set-up on the GUI.

696.4. MATERIALS: Provide components necessary for RVDD installation. A RVDD shall consist of the following components: Radar sensor (1), detector rack interface module (1), power and surge protection panel or module (1), and all associated equipment required to set up and operate in a field environment including software, serial and Ethernet communications ports, cabling, electrical connectors, and mounting hardware.

A. RVDD Interface Module

1. The RVDD interface module must comply and operate with NEMA TS-2 Type 1 detector rack or Type 170/2070 input file.

2. The RADD shall be capable of 16 contact closure inputs to the detector rack. The user shall be able to assign each contact closure to an associated detector channel. The contact closure shall occur through the interface modules or controller module plugged into the rack.

3. All components of the RVDD housed in the controller cabinet shall be rated to operate in a temperature range from -34°C to +74°C (-30°F to +165°F) at 0 percent to 95 percent relative humidity, non-condensing.

4. The RVDD shall provide a “fail safe” operation that triggers when communication between the radar vehicle sensor and the interface module is broken. Contact closure will occur on all programmed detector channels associated with the interface module when the fail safe is triggered and will remain in this state until communication is reestablished between the interface module and the radar vehicle sensor.

5. The RVDD shall be capable of either “pulse mode” or “presence mode” operation. In the pulse mode, when a vehicle is detected and conditional logic is satisfied, contact closure will occur for approximately 125 ms. In the presence mode, contact closure will occur for as long as a vehicle is detected and conditional logic programming is satisfied.
B. RVDD Sensor

1. The RVDD shall be able to operate in all types of weather conditions including: rain, snow, sleet, ice, fog, and wind-blown dust. The RVDD shall be able to operate normally and with no degraded performance when the radar vehicle sensor is encased in a 1/2 inch ice.

2. The RVDD shall be rated to operate in a temperature range from -34°C to 60°C (-30°F to 140°F) at 0 percent to 95 percent relative humidity.

3. The RVDD shall comply with all applicable Federal Communications Commission (FCC) requirements. The manufacturer will provide documentation of compliance with FCC specifications. Each RVDD will be FCC certified under CFR 47, Part 15, and Section 15.245 as a field disturbance sensor or Section 15.249 as an intentional radiator. This certification will be displayed on an external label on each device according to the rules set forth by the FCC.

4. The RVDD shall maintain frequency stability without the use of manual tuning elements by the user.

C. Power and Surge Protection

1. Lightening and surge protection will be provided for power connections and communications links to the RVDD meeting or exceeding EN 61000-4-5 class specifications.

D. Software and Communication Requirements

1. The RVDD system software shall utilize a GUI that runs in a Microsoft Windows Mobile and Microsoft Windows XP environment or newer Microsoft operating system. The GUI shall graphically illustrate vehicle movement and directionality when detection is achieved by the RVDD. The software shall be capable of auto configuration upon set up of the RVDD.

2. Programmed parameters from the GUI to the sensor shall be stored in non-volatile memory devices such as Flash RAM or EEPROM within the sensor. The RVDD shall not rely on batter backup or the use of a super capacitor to retain memory.

3. The RVDD shall provide a RS232 serial communications link allowing the user to interface with a laptop computer and operate the GUI. The RS232 serial port shall be full duplex and will support true RTS/CTS hardware handshaking for interfacing to various communications devices.

4. The RVDD shall provide an Ethernet communications link allowing the user to interface the system and operate the GUI via a LAN and using TCP/IP protocol.

5. The RVDD firmware shall be upgradeable by external, local, or remote download via serial or Ethernet ports.

6. The serial and Ethernet communications ports as a minimum will support the following baud rates: 9600, 19200, 38400, 57600, and 115200. The user shall be able to select the desired baud rate from the GUI.

7. The operator shall be able to save configurations settings to a file or reload the configurations settings to the RVDD from a saved file using the GUI.
8. The RPDD software shall allow for a virtual connection option so that the software can be used without connecting to an actual sensor.

E. Cabling: The cable end connector shall meet the MIL-C-26482 specification and shall be designed to interface with the appropriate MIL-C-26482 connector. The connector back shell shall be an environmentally sealed shell that offers excellent immersion capability. All conductors that interface with the connector shall be encased in a single jacket and the outer diameter of this jacket shall be within the back shell’s cable O.D. range to ensure proper weather sealing. The back shell shall have a strain relief with enough strength to support the cable slack under extreme weather conditions. The cable shall conform to the following specifications:

1. Radar Advance Detection Device (RADD) Cabling
   a. Shielded, twisted pairs with a drain wire
   b. Nominal Capacitance Conductor to Conductor @ 1 KHz <= 26 pF/Ft
   c. Nominal Conductor DC resistance at 20°C (68°F) <= 15 ohms/1000 Ft
   d. Single continuous run with no splices allowed.
      • If communication is conducted over the RS-485 bus, the communication cable can be terminated only at the two farthest ends of the cable and the operational baud rate and cable lengths shall not exceed the following limits:

<table>
<thead>
<tr>
<th>Baud Rate*</th>
<th>Cable Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>115.2 Kbps</td>
<td>300 ft</td>
</tr>
<tr>
<td>57.6 Kbps</td>
<td>600 ft</td>
</tr>
<tr>
<td>38.4 Kbps</td>
<td>800 ft</td>
</tr>
<tr>
<td>19.2 Kbps</td>
<td>1000 ft</td>
</tr>
<tr>
<td>9.6 Kbps</td>
<td>2000 ft</td>
</tr>
</tbody>
</table>

   *Note: These represent Maximum data rates. The data rate used should be the minimum data rate required for operation.

   e. RVDS supplied shall use 24 VDC, the power cable shall meet the following specifications:
      • Two shielded, twisted pairs with two drain wires connected in parallel
      • Nominal capacitance conductor to conductor @ 1 KHz <= 26 pF/Ft
      • Nominal conductor DC resistance @ 20°C (68°F) <= 15 ohms/1000
      • The cable length shall not exceed 600 ft.

   f. If a cable length of 600 ft to 2,000 ft is required, the power cable shall meet the following specifications:
      • 10 AWG conductor size/gauge
      • Two conductor count
      • Stranded Cable Type
      • Bare Copper Material
      • 600 Volt Range
      • 90°C Temperature Rating
      • PVC/Nylon insulation material
      • PVC jacketing material
- 40 Amps per conductor

g. Both communication and power conductors may be bundled together in the same cable as long as the above-mentioned conditions are met.

2. Radar Presence Detection Device (RPDD) Cabling

a. The RS-485 conductors shall be a twisted pair.

b. The RS-485 conductors shall have nominal capacitance conductor to conductor of less than 71 pF/Ft at 1 KHz.

c. The RS-485 conductors shall have nominal conductor DC resistance of less than 16.5 ohms/ (304.8 m) at 20°C (68°F).

d. The power conductors shall be one twisted pair with nominal conductor DC resistance of less than 11.5 ohms/ (304.8 m) at 20°C (68°F).

e. Each wire bundle or the entire cable shall be shielded with an aluminum/Mylar shield with a drain wire.

f. The cable O.D. shall not exceed 0.4 inches.

g. The cable length shall not exceed 2,000 ft (609.6 m) for the operational baud rate of RS-485 communications (9.6 Kbps).

h. The RVDS shall use 24 VDC and the cable length shall not exceed 500 ft (182.9 m).

i. Both communication and power conductors can be bundled together in the same cable as long as the above-mentioned conditions are met.

696.5. EQUIPMENT: Provide the machinery, tools, and equipment necessary for proper prosecution of the work. All machinery, tools, and equipment used shall be maintained in a satisfactory and workmanlike manner.

696.6. CONSTRUCTION: Install RVDD in accordance with the details shown on the plans and the requirements of this item

A. Manufacturing and Testing

1. The internal electronics of the RVDD shall utilize automation for the surface mount assembly. The RPDD shall comply with the requirements set forth in IPC-A-610C Class 2 and the RADD with the requirements in IPC-A-610C Class 3, Acceptability of Electronic Assemblies.

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

a. Functionality testing of all internal sub-assemblies

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

c. Final unit functionality testing prior to shipment.
B. Installation and Training

1. When requested by COSA personnel or purchasing agency, the supplier of the RVDD shall supervise the installation and testing of the radar equipment.

2. If requested by COSA personnel or purchasing agency, up to two days of training shall be provided to personnel of COSA in the operation, setup, and maintenance of the RVDD. Instruction and materials shall be provided for a maximum of 20 persons and shall be conducted at a location selected by COSA. COSA or purchasing agency shall be responsible for the cost of training.

3. Instruction personnel are required to be certified by the equipment manufacturer. The User’s Guide is not an adequate substitute for practical, classroom training and formal certification by an approved agency.

4. Formal levels of factory authorized training are required for installers, contractors, and system operators. All training must be certified by the manufacturer.

C. Warranty, Maintenance, and Support

1. The RVDD shall be warranted to be free of defects in material and workmanship for a period of 5 years from date of shipment from the supplier’s facility. During the warranty period, the supplier shall repair with new or refurbished materials, or replace at no charge, any product containing a warranty defect or fails to operate properly after installation provided the product is returned FOB to the supplier’s factory or authorized repair site. Product repair or replaced under warranty by the supplier will be returned with transportation prepaid. This warranty does not apply to products damaged by accident, improper operation, abuse, serviced by unauthorized personnel or unauthorized modification.

2. If a RVDD fails with no visible or physical damage to any electronic/electrical component of the system or its wiring, then the unit is considered to have failed under normal operating conditions. A blown fuse or surge protection device failure shall be considered to have failed under normal operating conditions. Acts-of-God will not be accepted as excusable unit failures of the RVDD system.

3. Repair or full replacement will be required if a RVDD fails to operate as specified under normal operating conditions. Repaired or replaced components of the RVDD will be provided at no cost to COSA. The replaced or repaired units will inherit the remainder of the failed unit’s warranty.

4. During the warranty period, technical support shall be available from the supplier via telephone within 4 hours of the time a call is made by a user, and this support shall be available from factory certified personnel or factory certified installers.

5. Ongoing software support by the supplier shall include firmware updates for the RVDD processor unit and external software needed to set up and operate the RVDD system. These updates shall be provided free of charge during the warranty period. The update of the RVDD software shall be tested and approved by COSA before installation.

6. The supplier shall maintain a program for technical support and software updates following expiration of the warranty period. This program shall be made available to COSA in the form of a separate agreement for continuing support.
7. The supplier shall maintain an adequate inventory of parts to support maintenance and repair of the radar system.

696.7. **MEASUREMENT:** This item will be measured as each RADD or RPDD installed, tested, and made operational including the radar sensor, detector rack interface module, processor units, power and surge protection panel or module, software, serial and Ethernet communication ports, electrical connectors and mounting hardware.

The RVDD communication and power cable(s) will be measured by the linear foot of the cable type furnished (RADD or RPDD)

696.8. **PAYMENT:** The work performed and materials furnished in accordance with this item and measured as provided under “Measurement” will be paid for at the unit price bid for each item listed in Section 696.9, “Bid Items”. These prices are full compensation for furnishing, placing, and testing all materials and equipment, and for all tools, labor, equipment, hardware, operational software packages, supplies, support, personnel training, shop drawings, documentation, and incidentals. A power cable meeting the specifications outlined in Section 696.4 “Materials” shall be included with communication cable and is considered subsidiary to the price of the communication cables.

These prices also include any and all interfaces required for the field and remote communications links along with any associated peripheral equipment, including cables; all associated mounting hardware and associated field equipment; required for a complete and fully functional RVDD system.

696.9. **BID ITEMS:**

- Item 696.01 - Radar Advance Detection Device (RADD) – per each
- Item 696.02 - Radar Presence Detection Device (RPDD) – per each
- Item 696.03 - Radar Advance Detection Device (RADD) Communication and Power Cable – per linear foot
- Item 696.04 - Radar Presence Detection Device (RPDD) Communication and Power Cable – per linear foot
- Item 696.12 - Install Radar Detection Device – per each
- Item 696.14 - Install Radar Communications Cable – per linear foot
SPECIAL SPECIFICATION 621

TRAY CABLE

621.1. DESCRIPTION: Furnish and install tray cable.

621.2. MATERIALS: Provide new materials that comply with the details shown on the plans and meet the requirements of Item 620, “Electrical Conductors.”

A. Tray Cable. Furnish tray cable from new materials in accordance with Texas Department of Transportation DMS-11050, “Electrical Conductors.”

B. Suppliers. Provide tray cable from manufacturers prequalified by the Texas Department of Transportation (TxDOT). The TxDOT Traffic Operations Division maintains a list of prequalified tray cable manufacturers.

621.3. CONSTRUCTION: Perform work in accordance with the details shown on the plans and the requirements of this Item.

Provide an additional 5 ft. of cable coiled in each ground box when installing cable in underground conduit. Splice tray cable conductors only at locations shown on the plans. Obtain the Engineer’s written approval for each splice. Ensure allowed splices are watertight. Test the cable’s conductors after installation and before any connection. Remove and replace tray cable exhibiting a DC insulation resistance of less than 5 megohms at 1,000 volts DC at no additional cost to the Department.

621.4. MEASUREMENT: This Item will be measured by the foot of each cable.

This is a plans quantity measurement Item. The quantity to be paid is the quantity shown in the proposal, unless modified by Change Order. Additional measurements or calculations will be made if adjustments of quantities are required.

621.5. PAYMENT: The work performed and materials furnished in accordance with this Item and measured as provided under “Measurement” will be paid for at the unit price bid for “Tray Cable” of the types and sizes specified. This price is full compensation for furnishing and installing materials and for equipment, labor, tools, and incidentals.

621.6. BID ITEM:

Item 621.12 – Tray Cable (12 AWG) (3 Conductor) - per foot of cable
SPECIAL SPECIFICATION 633

BATTERY BACKUP SYSTEM FOR TRAFFIC SIGNAL

633.1. DESCRIPTION:
Furnish, fabricate, assemble or install a Battery Backup System (BBS) for traffic signal including rack mounted power inverters, battery charger, electronic controls, bypass switch, charging management system, battery cables and connectors; and all wiring, hardware and incidentals necessary to form a complete battery backup system including batteries and externally mounted battery case.

633.2. MATERIALS: Furnish new materials in accordance with these specifications, the details shown on the plans, and the following standards:

1. UL 1778 (Underwriter Laboratories) Standard for UPS Equipment.
2. CSA 22.2 (Canadian Standards Association - CUL Equipment).
4. ISO 9001 Quality Assurance program.

A. General.

The BBS supplier shall provide and install the BBS and the associated components, to be utilized to provide emergency power for the traffic control systems, and associated equipment in the event of a utility power failure, or when the utility power is beyond the "normal" voltage and frequency parameters as programmed within the BBS. The BBS shall be a line-interactive type and provide voltage regulation and power conditioning when using utility power. The transfer from utility power to battery power, and vice versa, shall not interfere with the normal operation of the traffic controller, or any other peripheral devices within the traffic controller assembly. The BBS shall be equipped with a programmable front panel display to allow status of real time events occurring in the power system. The BBS shall be equipped with an RS-232 data port and an Ethernet SNMP interface that can be utilized for programming the flashing mode timer, monitoring the BBS system, and transferring status and event data to a laptop computer, or a remote central location. The BBS shall be equipped with dry contacts that can provide the following monitoring features: 1) Battery On, 2) Low Battery, 3) General alarm, to Indicate out of range line frequency, low output voltage, no temperature probe, overload, batteries not connected, high temperature, low temperature, and BBS failure. The BBS shall be fully compatible with incandescent and LED traffic signal control equipment, pedestrian signals, and camera systems. The BBS shall consist of a rectifier, batteries, solid-state inverter, and wrap around maintenance bypass switch/automatic transfer switch. The wrap around maintenance bypass switch shall allow the removal and replacement of the BBS module without disruption to the traffic signal control equipment. Supplier must have manufactured BBS systems for traffic control applications for 10 or more years.

B. System Description.

1. Components.

The BBS system shall consist of the following major equipment:
a. BBS Module.
   i. Insulated Gate Bipolar Transistor (IGBT) Inverter, or other technology to limit THD current and voltage to 3% or less.
   ii. Diode Bridge + IGBT DC/DC Rectifier.
   iii. Digital Signal Processor (DSP) using Pulse Width Modulation (PWM)

b. Battery system.
c. Battery protective and disconnect device.
d. Maintenance bypass switch/automatic transfer switch


The BBS shall be designed to operate continuously at rated capacity as an on-line, automatic reverse transfer system in the following modes:

a. **Normal.** The inverter continuously supplies AC power to the critical load. The rectifier converts a utility AC power source to regulated DC power which then serves as the inverter input and, simultaneously, as a float charge input to the storage battery. The BBS provides voltage regulation and power conditioning when using utility power.

b. **Emergency.** In the event of a utility AC power failure, or over voltage, the inverter shall derive its input from the system battery, therefore providing uninterrupted power to the critical load. This transition shall be accomplished in 65 milliseconds or less. The BBS or external relay shall indicate loss of utility power and energize an external lamp mounted on the BBS cabinet.

c. **Recharge.** Subsequent to restoration of utility AC power, the rectifier shall automatically reactivate and provide DC power to the inverter, simultaneously recharging the system battery. The automatic transfer switch will provide automatic switching from battery power to utility power. This occurs automatically and without interruption to the critical load, with a 65 millisecond or less re-transfer time.

d. **Maintenance Bypass.** The BBS system shall be equipped with an external MBS to allow safe and reliable maintenance of the BBS. The maintenance bypass switch shall be equipped to prevent a malfunction feedback to the cabinet or from feeding back to the utility service per UL 1778, Section 48 "Back-feed protection Test". The upstream back feed voltage from the bypass switch shall be less than 1 volts AC for the protection of the traffic technician.

e. **Return to Utility Power, Under voltage.** Upon restoration of utility power, the BBS shall return to the utility power source when the source voltage exceeds 105 volts for more than 30 seconds. Over voltage-The BBS shall return to utility power source when the utility power source has been restored to below 128 volts for more than 30 seconds. The time delay to initiate the return to utility power shall be field programmable from 3-10-30 and 50 seconds. Transition time from BBS back to utility shall be no more than 65 milliseconds.

f. **BBS Failure.** Upon failure or loss of BBS, the automatic transfer switch will isolate the BBS from the system, and provide power from the utility source (if available). An external alarm will be provided to indicate loss of BBS, or BBS failure.
3. **Submittals.**

   a. **Submittals shall include:**
      
      i. System configuration with single-line drawings.
      ii. Functional relationship of equipment including weights, dimensions, and heat dissipation.
      iii. Descriptions of equipment to be furnished, including deviations from these specifications.
      iv. Detailed layout of customer power and control connections.
      v. Detailed installation drawings including all terminal locations delivery.

   b. **Submittals upon BBS delivery shall include:**
      
      i. Shop Drawings. Submit system configurations with single line diagrams, detailed layout of power and control connections, dimensional data and detailed installation drawings including all terminal locations.
      ii. Product Data. Provide product data for BBS and battery including catalog sheets and technical data sheets to indicate electrical performance, BBS type, battery type, detailed equipment outlines, weight, dimensions, control and external wiring requirements, heat rejection and air flow requirements.
      iii. Owners and technical manual.
      iv. Complete set of specifications for all electronic components.
      v. Test Report. Submit a copy of factory and field test reports as applicable.

4. **Environmental Conditions.**

   a. The BBS shall be capable of withstanding any combination of the following external environment conditions without mechanical damage, electrical failure or degradation of operating characteristics.
      
      i. Operating ambient temperature: -40 degrees C to +74 degrees C (-40 degrees F to 165 degrees F).
      ii. Non-operating and storage ambient temperature: -40 degrees C to +70 degrees C (-40 degrees F to 158 degrees F).
      iii. Operating relative humidity: 5% to 95 %, non-condensing.
      iv. Recommended operating relative humidity: 30 % to 95%.
      v. Operating altitude: Sea level to 2700 meter (9000ft).

   b. **Audible acoustical noise.** Noise generate by the BBS, when operating under full rated load, at a distance of one meter from any BBS operator surface, shall not exceed 55 dB as measured on the A scale of a standard sound level meter at slow response.

   c. **Input surge withstand capability.** The BBS shall be in compliance with IEEE C62.41/C62.45 Category A & B.

5. **Warranty.** The BBS manufacture shall warrant to the original end user that the Battery Backup System shall be free from defects in material and workmanship under normal use and service for a period of thirty six (36) months from the date of installation.
6. **Quality Assurance.** The BBS manufacture shall fully and completely test the system to assure compliance with the specifications, before shipment.

C. **Product.**

1. **Electric Characteristics.** The BBS shall have the following characteristics:

   a. The BBS shall be capable of withstanding any combination of the following external environment conditions without mechanical damage, electrical failure or degradation of operating characteristics.
      i. Operating ambient temperature: -40 degrees C to +74 degrees C (-40 degrees F to 165 degrees F).
      ii. Non-operating and storage ambient temperature: -40 degrees C to +70 degrees C (-40 degrees F to 158 degrees F).
      iii. Operating relative humidity: 5% to 95%, non-condensing.
      iv. Recommended operating relative humidity: 30% to 95%.
      v. Operating altitude: Sea level to 2700 meter (9000ft).

   b. BBS Output Capacity
      i. A. BBS shall be capable of supporting a nominal 2 kVA. Load at rated power factor.
      ii. Power factor-variable, 30-100%

   c. Battery Capacity
      i. 2 Hours of Full Operation, and 2 hours Minimum at Red Flashing.

   d. AC Input
      i. Nominal input voltage: 120V.
      ii. Number of phase: 1 phase, 2 wire, plus ground.
      iii. Voltage range: 90 volts to 135 volts
      iv. Frequency: 60Hz
      v. Wave Shape: Sine Wave
      vi. Power factor: 0.98 typical at 100% load.

   e. AC Output
      i. Nominal output voltage: 120V, +/- 10% in line mode.
      ii. Nominal output voltage: 120 V, +/- 6%, back up mode.
      iii. Output Frequency: 60Hz, +/- 5% in line mode, and back up mode.
      iv. Number of phase: 1 phase, 2 wire, plus ground.
      v. Waveform Output: Sinusoidal
      vi. BBS Efficiency at Nominal Line Voltage: 98%
      vii. BBS Efficiency in Back up Mode: 84%
      ix. Step Load Response: Full recovery in ½ cycle @ 50% change with a resistive load.
      x. Output voltage and current harmonic distortion: 1. 3% maximum with a resistive load.

   f. DC Input and Battery
      a) Voltage: 12.0V DC Nominal.
      b) Voltage Ripple (normal operation): less than 2% of DC voltage.

   g. Efficiency-(84% or Greater)
h. **BBS Protection.** The BBS shall indicate an overload warning with a flashing alarm LED when the load is between 95% and 105% of the rated output of the BBS. The BBS shall shutdown, and the fault LED shall turn ON, after two minutes of operation in back up mode when the load is between 106% and 115% of the rated output for the BBS, and the fault LED shall turn ON. The fault LED shall clear when the overload is removed and the utility line power returns. The BBS shall shutdown and the fault LED shall turn ON, after one minute of operation in back up mode when the load is greater than 115% of rated output. The fault LED shall clear when the overload is removed and the utility line power returns. The BBS shall disable the backup mode function when operating in line mode if the load exceeds 115% of the rated output for the BBS. The BBS shall display an alarm LED if the battery ambient temperature is greater than 75 degrees Centigrade and disable the backup mode function. The alarm shall clear when the battery ambient temperature is less than 70 degrees Centigrade. The BBS shall display a fault when operating in back up mode and shutdown the inverter if the internal temperature is greater than 110 degrees Centigrade. The fault shall clear when the utility power returns and the internal temperature is less than 90 degrees Centigrade. The BBS shall have output over-voltage protection to electronically shutdown the BBS if the output voltage exceeds 132 volts a.c. The BBS shall disable the battery charger and display an alarm LED if the battery voltage exceeds 59 volts d.c. for two seconds. The alarm shall be cleared and the charger enabled when the battery voltage drops to less than 57 volts D.C. The BBS shall display an alarm LED to indicate the BBS ventilation fan is enabled but not turning.

2. **Components.** BBS module shall be comprised of the following:

a. Hybrid Converter Section. AC input, converter input contactor, converter input fuse, input harmonic filter, and hybrid converter utilizing:

   i. High Power Diode Bridge Rectifier
      a) General. A high power diode bridge rectifier converts the utility AC input power into regulated DC power that serves as the inverter input and also as dc charge power to the system battery through the chopper/booster. An AC reactor and capacitor shall filter the harmonic content of rectifier input.
      b) Input Over-Current Protection. BBS input circuit breaker, converter input contactor, and the input current limit control shall provide rectifier protection against excessive input overload conditions.
      c) Step Load Change Operation (0-100%). In the occurrence of a 100% step load change, the BBS Module inverter shall draw power only from the rectifier to provide the required load demand. The charger/booster shall not be utilized and the system batteries will not be cycled at any time during a step load change.

   ii. Charger/Booster
      a) General. The charger/booster utilizes solid state Pulse Width Modulation (PWM) controlled Insulated Gate Bipolar Transistors (IGBT)
      b) Battery Charge Current Limit. Battery charging will be temperature compensated to maximize battery life. The battery charger current of the BBS shall be user programmable for 3, 6, and 10 amps. The battery charger current default setting for the BBS shall be 6 amps. The battery charger in the BBS shall turn OFF when the battery temperature is 50 degrees Centigrade. (122 degrees Fahrenheit) The battery charger will have a maximum float voltage of 56 volts D.C.
c) DC Input Protection. The DC input circuit shall be protected by a DC circuit breaker. The DC circuit breaker allows complete interruption of DC current and isolation of the BBS Module DC input and the battery system.

The DC Circuit Breaker shall be provided as standard equipment.

d) Ripple Voltage. The DC (battery) bus RMS ripple voltage shall be less than 2% of the BBS nominal DC voltage level at 100% load. This shall provide for maximum battery life.

e) Charging Equalization. The charging system shall be equipped with a charging management system that shall spread the charge voltage equally across the batteries. The battery charging management system shall compensate for batteries with varied internal resistances, and provide a final balance of +/-100 mV maximum between any two batteries in the string. The battery charging system shall be designed to CSA C22.2 NO. 107.1 and UL 1778 Standards for safe unattended operation.

iii. Batteries

a) General. The individual batteries shall be 12 volt D.C., and shall be easily replaced and commercially available as "off the shelf" items. The batteries shall be electrically configured to provide a 48 volt, D.C. system. Batteries shall be provided with quick disconnect terminals and a polarized keyed battery cable for easy field installation. The batteries shall be sized to accommodate 4 hours of run time as specified previously.

b) Battery Type. The batteries shall be "gel cell" Valve Regulated Lead Acid (VRLA) specifically designed for outdoor use. The batteries shall be designed for "Float Service" to provide 100% out-of-box runtime capacity. The batteries shall have silver alloy positive plates. The batteries shall have a five year full replacement, non-prorated warranty. Absorbed glass mat (AGM) batteries shall not be utilized.

b. Operation/Display Panel

The BBS module shall be provided with a control/indicator panel. The panel shall be on the front of the BBS module. Controls, meters, alarms and indicators for operation of the BBS module shall be on this panel. The panel display will indicate current battery charge status, various input/output voltages, power output, battery temperature, date, time, and settings of the various field programmable relays. All control, programming, maintenance and inquiry shall be accessible via the keyboard on the face of the BBS module without the need for the use of external equipment, or computer. The BBS shall be equipped with an event log that stores up to 100 events, date and time stamped. The events shall be date and time stamped. The event log shall be retrievable via the RS 232 interface, or from the LCD screen.

i. Communication. The BBS shall have, as standard equipment, an RS 232 smart port as well as an SNMP Ethernet port allowing the user to interface the BBS status information to a host computer. Any necessary software for enabling communication to the device over the network shall be provided.

ii. Service Functions

a) The BBS shall be capable of performing a self test, locally from the BBS front panel LCD, or remotely via the communication interface. The duration of the self-test shall be programmable.
b) The BBS shall be capable of performing a battery test to determine the integrity of the battery system.

3. Mechanical Design.

a. Cabinet Structure (Enclosure)
   i. The enclosure shall be .125" thick, aluminum alloy, grade S052-H32, rated as NEMA 3R. The cabinets shall be provided with three point latching systems, a thermostatically controlled fan kit, door lock, continuous piano hinges for doors, and the appropriate louver openings for ventilation. The cabinets shall be constructed to allow a pad-mounted type installation, and capable of being mounted directly adjacent to the existing traffic controller panels.
   ii. The BBS shall be installed in a rack mounted configuration, with heavy-duty structures meeting with NEMA standard for floor mounting.
   iii. The cabinet shall be equipped with an exterior, weather rated lamp that will be utilized to indicate when normal utility power is not available at the control cabinet. The lamp shall be visible from the street in order to allow service technicians to identify a power loss at the cabinet, and shall be protected to avoid vandalism. Incandescent lamps shall not be utilized.

b. Serviceability. The BBS shall have front access for all servicing adjustment and connections only for maintenance or service. Side access or rear access shall not be accepted. The BBS shall be designed such that its rear can be pressed against the existing traffic controller cabinet.

633.3 CONSTRUCTION

A. Site Preparation.
The UPS provider shall prepare the site for installation of the equipment.

B. Installation.
   1. The BBS shall be set in place, wired and connected in accordance with the approved installation drawings and owners/technical manual delivered with equipment. The BBS enclosure will be provided as a stand-alone, pad mounted cabinet that can be mechanically affixed to the existing traffic controller cabinet.

   2. The equipment shall be installed in accordance with local codes and manufacturer's recommendation.

C. Field Quality Control.
   1. The equipment shall be checked out and started by a customer support representative from the equipment manufacturer. Visual and mechanical inspection of electrical installation, initial BBS startup and operational training shall be performed. A signed service report shall be submitted after equipment is operational.

   2. The following inspection and test procedures shall be performed by field service personnel during the BBS startup:

      a. Visual Inspection
         i. Ensure that shipping members have been removed.
         ii. Ensure that interiors are free of foreign materials, tools and dirt.
         iii. Check for damage (dents, scratches, frame misalignment, damage to panel devices, etc)
iv. Check doors for proper alignment and operation.

b. Mechanical inspection
   i. Check all the power wiring connections for tightness.
   ii. Check all the control wiring connections for tightness.

c. Electrical Inspection
   i. Check input and bypass for proper voltage.
   ii. Check battery for proper voltage and polarity

d. Start-up
   i. Energize the BBS.
   ii. Check the DC output voltage and inverter output voltage.
   iii. Check the inverter output voltage on battery operation.
   iv. Perform manual transfers and returns.
   v. Perform auto transfers.

633.4 **MEASUREMENT:** This Item will be measured as each Battery Backup System furnished, installed, and tested, including the enclosure cabinet, cabinet mounted BBS components, batteries, and cabling between cabinet and batteries. All components will be furnished, installed, and tested.

633.5 **PAYMENT:** The work performed and materials furnished in accordance with this Item, and measured as provided under “Measurement” will be paid for at the unit price bid for “Battery Backup System” as specified. This price is full compensation for all equipment, cables and connectors, documentation, and testing; and for all labor, materials, training, warranties, and incidentals necessary to complete the work.

633.6 **BID ITEM:**

Item 633.1 - Battery Backup System - per each
SPECIAL SPECIFICATION 6007

REMOVING TRAFFIC SIGNALS

6007.1 DESCRIPTION:
This item governs the removal, storage, and salvage of traffic signals.

6007.2 CONSTRUCTION:
Traffic signals must remain in operation during construction until their removal as directed. The Contractor will not be responsible for maintenance of the signals during this period of operation.

Remove existing electrical services, pedestal poles, strain poles, mast arm pole assemblies, luminaires, signal heads, controllers, cables, and other accessories. Remove materials so that damage does not occur. Remove and store items designated for reuse or salvage at locations shown on the plans or as directed.

Remove abandoned concrete foundations to a point 2 ft. below final grade. Backfill hole with material equal in composition and density to the surrounding area. Replace surfacing material with similar material to an equivalent condition.

Accept ownership of unsalvageable materials and dispose of in accordance with federal, state, and local regulations.

6007.3 MEASUREMENT:
This Item will be measured as each signalized intersection removed. A signalized intersection is a group of signals operated by a single controller.

6007.4 PAYMENT:
The work performed and materials furnished in accordance with this Item and measured as provided under “Measurement” will be paid for at the unit price bid for “Removing Traffic Signals.” This price is full compensation for removing the various traffic signal components; removing the foundations; disposal of unsalvageable material; hauling; and equipment, labor, tools, and incidentals.

6007.5 BID ITEM:
Item 6007.1 – Removing Traffic Signals – per each
8100.1 DESCRIPTION:

Furnish and install Intelligent Transportation Systems (ITS) Traffic Monitoring Cameras to allow remote monitoring of traffic flows and incidents on arterial streets, intersections, and highways.

8100.2 MATERIALS: Provide components necessary for ITS Traffic Monitoring Camera installation. A ITS Traffic Monitoring Camera installation shall consist of the following components: digital IP camera unit (1), surge protection equipment (1), and all associated equipment required to set up and operate in a field environment including software, Ethernet communications ports, cabling, electrical connectors, and mounting hardware.

Camera should be completely configurable with current Advance Traffic Management System version the City of San Antonio is operating. Any additional configuration necessary to allow video feed to be displayed by ATMS will be verified before acceptance. Video feed should be playable from a standard Android, IOS or Windows portable device with no additional software necessary.

Camera should support a minimum of 100 onboard preset viewing positions with automatic pan and tilt speeds greater than 360 degrees per second. Camera should have configurable password protection and support a minimum of 32GB of on board storage.

Cameras should include all outdoor enclosures and mounting hardware for installation on a standard traffic signal pole. Cameras must support high definition video (1080p or greater) with minimum 30X zoom, H.264 MJPEG multi-streaming, Day/Night switching and be manufactured to support installation in harsh weather environments. Cameras shall be capable of panning 360º and tilting 180º. No separate encoder shall be required to transmit video to remote location. Cameras must support at a minimum RTP, RTSP, UDP, TCP, IP, IGMPv2, ICMP, ARP protocols. Camera control shall support ONVIF, Pelco-D, or COHU protocols.

8100.3 CONSTRUCTION: Install ITS Traffic Monitoring Camera in accordance with the details shown on the plans and the requirements of this item.

A. Manufacturing and Testing

The ITS Traffic Monitoring Camera shall undergo a rigorous sequence of operational testing to ensure product functionality and reliability

B. Installation and Training

1. When requested by COSA personnel or purchasing agency, the supplier of the ITS Traffic Monitoring Camera shall supervise the installation and testing of the radar equipment.

2. If requested by COSA personnel or purchasing agency, up to two days of training shall be provided to personnel of COSA in the operation, setup, and maintenance of the ITS Traffic Monitoring Camera. Instruction and materials shall be provided for a maximum of 20 persons and shall be conducted at a location selected by COSA. COSA or purchasing agency shall be responsible for the cost of training.
3. Instruction personnel are required to be certified by the equipment manufacturer. The User’s Guide is not an adequate substitute for practical, classroom training and formal certification by an approved agency.

4. Formal levels of factory authorized training are required for installers, contractors, and system operators. All training must be certified by the manufacturer.

C. Warranty, Maintenance, and Support

1. The ITS Traffic Monitoring Camera shall be warranted to be free of defects in material and workmanship for a period of 2 years from date of shipment from the supplier’s facility. During the warranty period, the supplier shall repair with new or refurbished materials, or replace at no charge, any product containing a warranty defect or fails to operate properly after installation provided the product is returned FOB to the supplier’s factory or authorized repair site. Product repair or replaced under warranty by the supplier will be returned with transportation prepaid. This warranty does not apply to products damaged by accident, improper operation, abuse, serviced by unauthorized personnel or unauthorized modification.

2. If an ITS Traffic Monitoring Camera fails with no visible or physical damage to any electronic/electrical component of the system or its wiring, then the unit is considered to have failed under normal operating conditions. A blown fuse or surge protection device failure shall be considered to have failed under normal operating conditions. Acts-of-God will not be accepted as excusable unit failures of the ITS Traffic Monitoring Camera.

3. Repair or full replacement will be required if an ITS Traffic Monitoring Camera fails to operate as specified under normal operating conditions. Repaired or replaced components of the ITS Traffic Monitoring Camera will be provided at no cost to COSA. The replaced or repaired units will inherit the remainder of the failed unit’s warranty.

4. During the warranty period, technical support shall be available from the supplier via telephone within 4 hours of the time a call is made by a user, and this support shall be available from factory certified personnel or factory certified installers.

5. Ongoing software support by the supplier shall include firmware updates for the ITS Traffic Monitoring Camera and external software needed to set up and operate the ITS Traffic Monitoring Camera. These updates shall be provided free of charge during the warranty period. The update of the ITS Traffic Monitoring Camera software shall be tested and approved by COSA before installation.

6. The supplier shall maintain a program for technical support and software updates following expiration of the warranty period. This program shall be made available to COSA in the form of a separate agreement for continuing support.

7. The supplier shall maintain an adequate inventory of parts to support maintenance and repair of the ITS Traffic Monitoring Camera system.

8100.4 MEASUREMENT: This item will be measured as each ITS Traffic Monitoring Camera installed, tested, and made operational including the digital IP camera unit, surge protection equipment, and all associated equipment required to set up and operate in a field environment including software, Ethernet communications ports, electrical connectors, and mounting hardware.
The communication and power cable(s) will be measured by the linear foot of the cable type furnished.

8100.5 **PAYMENT:** The work performed and materials furnished in accordance with this item and measured as provided under “Measurement” will be paid for at the unit price bid for each item listed in Section 8001.6, “Bid Items”. These prices are full compensation for furnishing, placing, and testing all materials and equipment, and for all tools, labor, equipment, hardware, operational software packages, supplies, support, personnel training, shop drawings, documentation, and incidentals.

These prices also include any and all interfaces required for the field and remote communications links along with any associated peripheral equipment, including cables; all associated mounting hardware and associated field equipment; required for a complete and fully functional ITS Traffic Monitoring Camera.

8100.6 **BID ITEMS:**

Item 8001.1 – ITS Traffic Monitoring Camera – per each

Item 8001.2 - ITS Traffic Monitoring Camera Cable – per linear foot
SPECIAL PROVISIONS

All work shall conform to the 2008 Edition of the “Standard Specifications for Construction” published by the City of San Antonio as modified by these Special Provisions.

ITEM 101. PREPARING RIGHT-OF-WAY
The Contractor shall be responsible for obtaining all permits required to complete the task order.

ITEM 308. DRILLED SHAFTS AND UNDER-REAMED FOUNDATIONS
An additional 2” schedule 40 PVC stub out shall be installed at each pole foundation. Stub outs shall be one-foot in length and appropriately capped below grade for future use. This shall be subsidiary to the bid items.

ITEM 502. CONCRETE SIDEWALKS
The installation of curb ramps shall be in compliance with the Texas Department of Transportation “PED-18 PEDESTRIAN FACILITIES – CURB RAMPS” standard. Curb ramps shall be measured by the area defined in the standards as “Ramp Limit of Payment” and shall include the ramp(s), landing, and detectable warning surface. Proposed concrete surfaces adjacent to the ramp area will be paid as concrete sidewalk.

Section 502.7 is amended with the following bid items:

Item 502.21 – Concrete Sidewalks (Ramps) (Type 1) – per square foot (SF)
Item 502.22 – Concrete Sidewalks (Ramps) (Type 2) – per square foot (SF)
Item 502.23 – Concrete Sidewalks (Ramps) (Type 3) – per square foot (SF)
Item 502.25 – Concrete Sidewalks (Ramps) (Type 5) – per square foot (SF)
Item 502.27 – Concrete Sidewalks (Ramps) (Type 7) – per square foot (SF)
Item 502.41 – Concrete Sidewalks (Ramps) (Type 21) – per square foot (SF)
Item 502.42 – Concrete Sidewalks (Ramps) (Type 22) – per square foot (SF)

ITEM 530. BARRICADES, SIGNS & TRAFFIC HANDLING
The Contractor shall be responsible for setting and removing all barricades and temporary traffic control devices.

ITEM 531. SIGNS
The Contractor shall provide the signs, supports, and all the necessary hardware for mounting. This item is used for ground mounted signs only. Signs shown on the plans to be mounted on the mast arm are to be provided by the Contractor subsidiary to ITEM 680.

ITEM 533. CLEANING AND REMOVAL OF PAVEMENT MARKINGS AND MARKERS
Removal of existing pavement markings will be measured by the linear foot of lane line including any conflicting markers or by each symbol or word removed. Payment shall be according to the quantities measured for each bid item. This item is only used for removal of markings that are not being replaced. Removal of markings being replaced by new markings is subsidiary to the bid items in ITEM 535.

ITEM 535. HOT APPLIED THERMOPLASTIC PAVEMENT MARKINGS
Section 535.7 is amended with the following bid items:

Item 535.30 – Pavement Marking (Median Nose) – per square foot (SF)
Item 535.31 – 24 inch wide yellow line (Solid) – per linear foot (LF)
ITEM 600.  TRAFFIC SIGNAL GENERAL CONDITIONS
All work shall comply with the City of San Antonio Right of Way Ordinance and the Utility Excavation Criteria Manual.

Trenches for the electrical service conduit left overnight for the purpose of inspection by the utility company shall be adequately covered or platted and barricaded with reflective standard barricades equipped with warning flashers or as directed by the Engineer. Any reusable backfill material shall be removed and stored off-site until the utility company approves the conduit installation.

Any other trenches left overnight as well as any foundations that do not have poles sitting on them or any other such hazard to the public shall be adequately covered and barricaded with reflective standard barricades equipped with warning flashers or as directed by the Engineer. This work will not be paid directly and is considered subsidiary to applicable items specified for the project.

ITEM 618.  CONDUIT
Proposed conduit shown under existing street pavement and driveways shall be installed by horizontal, directional bore. No trenching or conventional jacking or drilling shall be permitted except as allowed by the Engineer.

Conduits installed under roadways, driveways, or any other areas where it is possible for vehicles to drive presently or with future development shall be placed at a minimum depth of 30 inches.

The Contractor shall place warning tape in all trenches where new conduit is placed. All warning tape shall be placed at a depth of 6 to 8 inches below final grade. Conduit warning tape shall be a 4 mil inert plastic film specially formulated for prolonged use underground. All tape shall be highly resistant to alkalis, acids, and other destructive agents found in soils. Tape shall have a continuous printed message warning of the location of underground conduits. The message shall be in permanent ink specifically formulated for prolonged underground use and shall bear the words “caution – electric line buried below”, or other such approved phrase, in black letters on a yellow or red background.

ITEM 624.  GROUND BOXES
Ground boxes and covers shall be provided and installed by the Contractor.

The installation of the traffic signal ground box in new controller cabinet foundation shall be subsidiary to item 655.01, Type 332 Controller Foundation.

ITEM 628.  ELECTRICAL SERVICES
Upon receipt of the electrical permit for each intersection, the Contractor shall email a scanned copy to Marc Jacobson at marc.jacobson@sanantonio.gov.

The Contractor shall supply and install the address in permanent numbers and letters to the street side of the service enclosure. Said address shall also be recorded and given to the City Inspector for the City’s records.

The City will be responsible for applying for the installation of the Electrical Service and will pay any necessary fees to CPS Energy for service installation. The Contractor shall be responsible for paying all fees and obtaining the permits required from the City of San Antonio Development Services Department to inspect the electrical service once the Contractor has installed it.

Section 628.7 is amended with the following bid item:

Item 628.21 – Electrical Service Disconnect – per each (EA)

ITEM 633.  BATTERY BACKUP SYSTEM FOR TRAFFIC SIGNAL
The Contractor shall furnish and install an external Battery Backup Systems that meet the requirements of Item 633 Special Specification.
ITEM 655. **CONTROLLER FOUNDATION AND PEDESTAL POSTS**
The foundation for new traffic signal controller cabinet assembly shall not include an in-ground battery-box.

ITEM 680. **INSTALLATION OF HIGHWAY TRAFFIC SIGNALS**
The project shall consist of furnishing and installing all materials and equipment required for a complete traffic signal installation. Upon project completion, fully operational traffic signal systems will be required. Items required but not shown on the plans are the responsibility of the Contractor and shall be subsidiary to the applicable bid item.

Permanent traffic signs will be provided by the Contractor. Contractor shall install all permanent signs mounted on signal equipment, as shown on the plans. The Contractor shall provide all necessary hardware for mounting. In accordance with item 680, the cost of installing these signs shall be subsidiary to this same item. Ground mounted signs will be paid for under item 531.

The controller cabinet, traffic signal controller, and anchor bolts shall be provided by and installed by the Contractor.

The Contractor shall demonstrate to the Engineer's satisfaction that the field wiring is properly installed and labeled. Only then, the Contractor shall install the controller assembly on the completed foundation. City forces will connect the field wiring to the controller, set up, and turn on the controller.

Until the project is completed and accepted, the Contractor will be responsible for the maintenance of the traffic signals. The Contractor shall ensure that all elements of the traffic signals remain in operation at his expense. The Contractor shall complete any repairs to the traffic signals within four hours after notification. The City of San Antonio shall retain the responsibility of the operation of the traffic signals.

The locations shown on the plans for signal pole foundations, controller foundations, conduit and other items may be varied to meet local conditions, subject to prior approval by the Engineer. The Contractor shall be responsible for adjustments in project construction, which may be necessary because of conflict with utilities.

Final adjustment of heads, as required by the Engineer, shall be done by the Contractor and shall be subsidiary to the various bid items.

All traffic signal equipment, including span wire, installed shall maintain a minimum clearance of 10’ radius from neutral overhead electrical lines and 15’ radius from primary overhead electrical lines. Additional clearance requirements shall be as directed by the electrical utility company.

ITEM 681. **TEMPORARY TRAFFIC SIGNALS**
Additional vehicular signal heads, mounting assemblies, and back plates required shall be provided and installed by the Contractor. Reconfiguration of vehicle signal heads shall be as directed by the City.

ITEM 682. **VEHICLE AND PEDESTRIAN SIGNAL HEADS**
Vehicular and pedestrian signal heads and mounting assemblies and back plates shall be provided and installed by the Contractor.

ITEM 684. **TRAFFIC SIGNAL CABLES**
All proposed signal cable shall be #14 AWG solid copper.

ITEM 686. **TRAFFIC SIGNAL POLE ASSEMBLIES (STEEL)**
Traffic signal poles and mast arms shall be provided and installed by the Contractor.

Section 686.7 is amended with the following bid items:

Item 686.124 – Traf. Signal Pole Assem. (Single 24’ MA) ILSN – per each (EA)
Item 686.132 – Traf. Signal Pole Assem. (Single 32’ MA) ILSN – per each (EA)
Item 686.140 – Traf. Signal Pole Assem. (Single 40’ MA) ILSN – per each (EA)
Item 686.148 – Traf. Signal Pole Assem. (Single 48’ MA) ILSN – per each (EA)
Item 686.228 – Traf. Signal Pole Assem. (Single 28’ MA) ILSN & Lum – per each (EA)
Item 686.240 – Traf. Signal Pole Assem. (Single 40’ MA) ILSN & Lum – per each (EA)
Item 686.244 – Traf. Signal Pole Assem. (Single 44’ MA) ILSN & Lum – per each (EA)

ITEM 687. PEDESTAL POLE ASSEMBLIES
All materials shall be provided and installed by the Contractor. The Contractor shall be responsible for drilling and pouring the foundation.

ITEM 688. PEDESTRIAN DETECTORS AND VEHICLE LOOP DETECTORS
Pedestrian push button and signs shall be provided and installed by the Contractor.

ITEM 693. INTERNALLY LIGHTED STREET NAME SIGN ASSEMBLIES
Internally lighted street name signs shall be provided and installed by the Contractor as directed by the Engineer.

Section 693.7 is amended with the following bid items:

Item 693.6 – Internally Lighted Street Name Sign (LED) (6 FT) – per each (EA)
Item 693.8 – Internally Lighted Street Name Sign (LED) (8 FT) – per each (EA)

ITEM 695. EMERGENCY VEHICLE TRAFFIC SIGNAL PRIORITY CONTROL SYSTEM
Emergency vehicle preemption detectors, mounting hardware, and cable shall be provided and installed by the Contractor as directed by the Engineer.

ITEM 696. RADAR VEHICLE DETECTION DEVICES (RVDD)
The Contractor shall furnish and install all radar vehicle detectors, mounting hardware, and cable unless noted in the task order as directed by the Engineer.