ITEM 733 TRAFFIC SIGNAL CONTROLLER MATERIAL

733.01 References and Definitions.

"NEMA TS-2," "Type TS-2/A2," refers to equipment manufactured in conformance with the National Electrical Manufacturers Association (NEMA) Standards Publication No. TS-2.

"NEMA TS-1" and "Type TS-1" refers to equipment manufactured in conformance with the National Electrical Manufacturers Association (NEMA) Standards Publication No. TS-1.

733.02 Controller Units.

A. General Requirements. Provide each controller unit with internal time based coordination and, if used in a hardwired coordination system, provide an internal communication device or transceiver for connection to interconnect cables or wireless system including multi-conductor 120 volt cables, twisted pair low voltage cables, coaxial cables, or fiber optic cables as shown on the plans.

If used in a closed loop system, provide the local intersection controller with all of the software features necessary to operate with the system requirements given in 733.06 and 733.07. Provide the necessary dial-up communications capability for isolated local intersections if part of the monitoring and control system, as described in 733.08.

If the plans require a pre-timed operation for the signal timing and phasing configuration, provide the controller unit meeting all requirements of this section and capable of configuration in a pre-timed, sequential phase, fixed interval mode.

Provide nonvolatile controller memories not requiring batteries or other sources of energy to retain data while removing power from the controller.

B. Software. Provide a communication port for connection to a laptop computer for database upload/download. Provide software for the personal computer to completely program all features of the controller unit. Unless otherwise shown on the plans, provide the controller unit with software with the following features even if not used by the signal phasing operation shown on the plans:

1. NEMA 8 phase, dual ring capability with four pedestrian movements, 4 overlaps, and the ability to program an exclusive pedestrian movement. Provide the controller capable of programming for sequential phasing operation.
2. Volume density functions
3. Secondary coordination plans
4. Time of day/day of week scheduler
5. Time based coordination, minimum 3 dials, 3 offsets, 3 splits
6. Internal preemption for railroad and emergency vehicles
7. Operator selectable single or dual entry in dual ring use
8. Security access codes
9. Detector features including delay timing, carryover (extension) timing and detector switching

10. Simultaneous gap out feature

11. If operated in a system, communication capabilities to interface with hardwired masters or dial up modems

12. Data upload and download capability to a personal computer

13. Storage of detector counts utilizing phase detectors for a minimum 24 hour period in 15 minute increments

14. Detector failure monitoring and logging features for constant calls and absence of calls

Provide the greater of either 60-month warranties or the manufacturer's standard warranty for the following equipment:

1. NEMA Controller Equipment
    a. TS-2/A-2 Controller Units
    b. TS-1 Conflict Monitors

Provide warranties with the period beginning on the date the Contractor places the controller into service for permanent, uninterrupted operation. Attach a permanent label or stamp on each unit indicating the date of shipment.

B. Type TS-2/A2. Provide a controller unit meeting NEMA TS-2 specifications and suitable for shelf mounting. Provide a controller unit with all ports and input/output connectors for complete interchangeability between NEMA TS-1 and TS-2 cabinets. Provide controller settings programmable through a keyboard on the front panel. Provide an eight-line by 40-character display on the front panel.

Provide materials in accordance with the City QPL.

733.03 Cabinet. Provide all cabinets complying with the requirements of this Section. Equip all NEMA specified cabinets as follows:

Supply two through four phase controller operation with a minimum eight position backpanel, configured for two pedestrian movements and two overlaps, with a six channel NEMA TS-1 conflict monitor.

Supply five through eight phase controller operation with a minimum 12 position backpanel, configured for four pedestrian movements and no overlaps, with a 12 channel NEMA TS-1 conflict monitor.

For signal phasing configurations that require a larger capacity backpanel or conflict monitor, supply a 16 position backpanel with a 16 channel NEMA TS-1 conflict monitor.

Provide each cabinet main door with a sturdy, permanently lubricated lock covered with a weatherproof tab. Key the project locks to the City of Columbus master #2 key (1R 6380). Supply two keys with each lock. Also, equip the small door-in-door with a lock keyed to the City of Columbus master R4266 key. Provide the door-in-door lock with a lock keyhole cover.

Provide a NEMA 3R cabinet of standard size with a complete back panel, as shown in the plans, providing ample space for housing the controller unit and all associated

electrical devices furnished with it, together with any other auxiliary devices, as specified. Provide a cabinet with sufficient shelf space to accommodate all existing, proposed, and designated future equipment. Provide space to accommodate the appropriate controller unit frame as designated in NEMA TS-1, Section 14.

Construct the cabinets of 5052 marine grade .125-inch thick sheet aluminum with a 32 hardness, drawn or formed, with aluminum support and stiffening of members provided as necessary. Provide a smooth exterior with no sharp edges. All exterior seams shall be either continuously welded, tack welded, sealed with a 15 to 20 year silicone sealer, and/or overlapped such that water does not enter the cabinet. Provide a rigid cabinet designed to support all components. Provide a cabinet capable of withstanding the application of the following loads without breakage, deformation, or loss of weatherproof qualities: a 100-pound load applied to any 1-inch square surface of the cabinet or door (open or closed), in any direction; or a 300-pound load applied vertically downward to any 4-inch square of the top surface or to the top edge of the closed and latched door.

Provide cabinet exterior surfaces of bare aluminum. When the plans specify a cabinet color, prime and finish all cabinet exteriors with two coats of high-grade enamel paint of the specified color. Paint the cabinet interior surfaces flat white. Treat the interior surfaces of the cabinet with a three (3) stage iron phosphate coating and a zinc chromate primer coating. Apply a baked white alkali enamel finish. Apply and dry all coatings of the inside white paint to prevent peeling for a guaranteed period of two (2) years.

Provide the cabinet with at least one rain-tight louvered vent equipped with a replaceable filter. Install vents to allow for the release of excessive heat and any explosive gases that might enter the cabinet.

Provide cabinets with a functional design having a door in the front providing access to substantially the full interior area. Double flange the cabinet door frame opening on all four sides. Attach a gasket of elastomeric neoprene material to the cabinet or door to form a weatherproof seal. Provide a heavy gauge continuous door hinge with a stainless steel hinge pin. Bolt the hinge to the cabinet for removal of the door. Make the bolts and nuts of stainless steel, tamperproof, and securely fastened to prevent vibrations from loosening the nuts. Equip the door with a three (3) point latching mechanism and a handle that will take a padlock. Provide a door stop to retain the door in an open position at 90, 135, and 180 degrees.

Include a small, hinged, and gasketed door-in-door (police door) on the outside of the main controller door. Provide the cabinet with a door-in-door design not allowing entrance to the controller mechanism nor to exposed electrical terminals, but provides access to a small switch panel and compartment (police panel).

Fit the cabinet with the necessary provisions for mounting, with a bottom conduit connection provided for pole-mounted cabinets. Provide suitable hardware and equipment for each cabinet mounting method, including bolts for drilled and tapped holes on metal supports, pole attachment clamps, and pedestal slipfitter.

Directly place all equipment designed for shelf mounting on a shelf except for loop detector units (amplifiers) and similar devices designed for stacking on each other. Arrange components on shelves and devices on the door so that a 1-inch minimum space

separates for the door in a shut position. Do not allow plugs, wires, controls, or similar items to compromise this space.

Reserve a minimum 4-inch clear area on the bottom of the cabinet for the routing of cables. Do not locate panel mounted equipment in the bottom 6 inches (150 mm) of the cabinet. Do not locate shelves or components within 6 inches of the bottom of foundation mounted cabinets.

Arrange all equipment for easy withdrawal and replacement, without the necessity of disturbing adjacent equipment. Permanently locate devices within the cabinet to allow free circulation of air and not to restrict air flow from fan ducts or vents.

Provide auxiliary equipment capable of operating within a weatherproof cabinet at ambient temperatures between -30 and 165 °F.

For terminals and panel mounted devices with exposed electrical contact points located next to shelf mounted equipment, provide spacers, shelf lips, or other means to prevent accidental movement of component units into contact with any exposed electrical terminal points.

Provide for ready accessibility to load switches, relays, flashers, fuses, switches, terminal blocks, and other equipment mounted or plugged into the back or side panels. Provide visibility and easy operation to switches, controls, and indicator lights without moving the components from their normal shelf positions.

Provide materials in accordance with the City QPL.

A. Accessory Equipment

1. Ventilating Fan. Equip all cabinets with a forced air ventilating fan. Provide a fan that provides a capacity of at least 100 cubic feet per minute. Provide a fan thermostatically controlled and adjusted to start at cabinet temperatures above 120 °F and to stop at a temperature below 100 °F.

2. Load Switches. Provide all cabinets with solid state, triple-signal load switches complying with NEMA TS-1, Section 5. Additionally, provide all load switches having both input and output indicators.

3. Conflict Monitor. Provide all cabinets with a separate solid-state conflict monitor device. Provide cabinet wiring that transfers the signals to a flashing condition during a monitor disconnection. Provide conflict monitors complying with NEMA TS-1, Section 6. Additionally, provide conflict monitors capable of causing the signals to flash as a result of the following events:

a. All burned out red lamps associated with a load switch;

b. Within one second after the display of red and green, or yellow and green color pairings on the same phase;

c. The absence of a minimum yellow interval.

Provide a monitor capable of indicating the exact load switch output channel where the failure event occurred. Provide conflict monitors capable of storing a minimum of nine fault events (event logging feature). Provide a monitor utilizing an LCD display and including an RS-232 port for connection to a laptop computer. Provide software and connector cables to diagnose the conflict monitor.

4. Flashers. Provide solid-state flashers complying with NEMA TS-1, Section 8. For signals having a normal stop-and-go sequence that includes flashing, provide controller unit that generates the flashing display or provides flashers. For this purpose, provide separate flashers from those provided for emergency back-up. Provide flashers designed with two circuits of at least 10 amperes each.

Equip each controller cabinet with terminals wired to allow the interchange of jumpers and arrange the flashing operation to display either flashing yellow or flashing red on the vehicular signals.

5. Relays. Provide completely wired relays required for proper operation of the specified equipment.. Provide readily replaceable, enclosed relays designed for one-million operations without failure or need for adjustment.

6. Surge Protection Devices. Provide surge protection on incoming power lines, interconnect lines, and detector leads.

Provide an EDCO SHA-1250 primary surge protection device (SPD)or approved equal. Use a plug-in base to hold the device. Attach all wiring connections to the base and maintain appropriate cabinet clearances to allow replacement of the SPD module by hand without the use of tools.

Provide loop detector lead-in cable protection consisting of devices installed in each detector circuit where the lead-in connects to the terminal block. House each device in a case consisting of two stages; a 3-electrode gas tube arrestor and a semiconductor circuit. Provide an arrestor that shunts to ground a common mode transient with a 1,000 ampere peak and an 8/20 microsecond wave-shape, ionizing at 400 volts within 100 nanoseconds when subjected to a 1,000 volt per microsecond transient. Provide a semiconductor circuit that clamps a differential transient to 30 volts within 40 nanoseconds of the appearance of the transient, and a common mode transient to 30 volts within 500 nanoseconds of the ionization of the gas tube arrestor. Provide a second stage capable of withstanding a peak current of 13 amperes. Provide a device with impedance characteristics compatible with the detector unit to prevent false calls or increase the loop impedance above the sensitivity of the detector unit.

Provide pedestrian pushbutton inputs with the same protection as specified for the loop detector lead-in cables.

Protect interconnect cable against transients by devices across each conductor of the cable and ground. Use either 2 or 3-terminal devices. If using 3-terminal devices, connect two conductors and ground to the same device. Provide a protection device consisting of a gas tube arrestor with a maximum ionization voltage of 1000 volts on a 10,000 volt per microsecond transient or a maximum ionization voltage of 950 volts on a 3000 volt per microsecond transient. Allow the maximum time from beginning of the transient to ionization of 1.1 microseconds on a 10,000 volt per microsecond transient. Provide a device not ionized by normal voltage variations on a 120-volt AC line. Provide a device capable of withstanding a 10,000 ampere peak with an 8/20 microsecond waveshape.

7. Main Power Breaker. Provide an incoming AC+ power line controlled by a main circuit breaker rated at 240 volts and an auxiliary breaker, with capacity and wiring as specified in NEMA TS-1, Section 10.3.2.2 and Figure 10-4.

For a power service disconnect switch located before the controller cabinet, do not connect the neutral (AC-) and the grounding bar in the controller cabinet as shown in NEMA TS-1, Figure 10-4.

8. Radio Interference Filter. Provide an incoming AC+ power line containing a radio frequency interference (RFI) filter installed between the main circuit breaker and the solid state equipment. Also, provide RFI filtering for the load switches and flasher, unless the equipment furnished provides signal and flasher circuits switching at the zero voltage point of the power line sinusoid wave form.

9. Convenience Outlet and Light. Wire a convenience outlet into the cabinet for use by electrical maintenance equipment. Provide the outlet with at least one standard duplex three-wire plug receptacle of the ground-fault circuit-interrupting type. Provide and mount a standard incandescent lamp and socket in the upper portion of the cabinet. Provide a door switch to control the convenience light.

10. Manual Control and Pushbutton. When required by the plans, provide intersection controller units with the capability to switch to manual operation of interval timing from automatic interval timing. Provide for manual operation capable of the same interval sequence as for the automatic operation.

Obtain manual interval timing by a momentary pushbutton contact switch mounted on a 5-foot minimum flexible weatherproof extension cord. Store that switch and cord behind the small door-in-door.

11. Switches. Provide completely wired switches required for proper operation of specified equipment. Clearly and permanently label switches according to function and setting position, and make accessible without the necessity of moving components.

a. Signal Shutdown Switch. Provide a cabinet with a signal shutdown switch for turning off the power to the signals at the intersection. Provide a switch only affecting the power to the signals, and allowing the controller to continue in operation. Locate the switch in the panel behind the small door-in-door (police door).

b. Auto/Flash Switch. Provide a cabinet with a flash control switch for activating the flashing of vehicular signals in a preselected emergency flash display. Ensure that the operation of the flash control switch causes a flashing display even under conditions of controller unit malfunction or of its removal from the cabinet. Ensure that the operation of the switch overrides any operation commands from a local or remote time switch. Locate the switch in the panel behind the small door-in-door (police door).

Program the transfer to and from flashing operation, when called remotely or by a local time switch, to occur only at points in the cycle allowed by the OMUTCD.

c. Automatic/Manual Transfer Switch. Provide a cabinet with an automatic/manual transfer switch. In the automatic position, make the controller unit automatically sequence the signal head displays. In the manual position, make the signal phase or interval sequencing occur only upon manual activation of the manual control pushbutton. Locate the switch in the door-in-door (police door). Allow switching from manual to automatic operation, or vice versa or making any time adjustments to occur at any time.

d. Run/Stop-Time Switch. Provide a cabinet with a run/stop-time switch capable of activating the controller stop-time feature when in the "stop-time" position. Locate the run/stop-time switch on a switch panel in the cabinet.

e. Controller Shutdown Switch. Provide a cabinet with a controller shutdown switch capable of cutting off power to the controller unit, conflict monitor, and detector units. Do not allow the controller shutdown switch to cut power to those components required to maintain flashing operation. Locate the controller shutdown switch on a switch panel in the cabinet.

f. Coordinated/Free Switch. Provide controllers operated in a coordinated system with a coordinated/free switch. Provide a switch allowing the choice of operating the controller under the supervision of a coordination device or operating the controller independently of coordination control. Locate the coordinated/free switch on a switch panel in the cabinet.

g. Detector Test Switches. Provide momentary contact switches capable of entering a vehicular or pedestrian call for any actuated phase. Provide a switch for each actuated phase vehicular and pedestrian detection input. Conveniently group and label the switches.

12. Terminal Blocks. Provide cabinets that include terminal blocks mounted on panels on the walls of the cabinet. Place the blocks in locations not obstructed by shelf-mounted devices. Provide sufficient terminal sets for each individual harness wire as well as for contacts of signal load switches, flasher transfer relays, flasher, and other components. Also, provide separate terminal sets for field wiring connections, including power, signal, interconnection, and detector lead-in cables. Group terminal sets to separate higher voltage (120 VAC) from lower voltage, and arrange them into logical groups. Protect terminal blocks from accidental contact during the installation and removal of shelf-mounted equipment. Locate the blocks no closer than 4 inches (100 mm) from the bottom of pole and pedestal mounted cabinets, and no closer than 6 inches (150 mm) from the bottom of foundation mounted cabinets.

Provide the terminal points UL listed as suitable to carry the rated loading. Provide the capacity and size of the terminals as specified in NEMA TS-1, Section 10.2.5. Provide terminal points for signal field wiring for each circuit capable of accommodating at least four 12 AWG conductors with spade type terminals.

Provide terminal points for incoming power wiring capable of accepting either spade terminals or bare stranded wire, and suitable for either aluminum or copper conductors.

Space terminal sets for easy wiring. Provide at least six reserve terminal sets for controllers. Harnesses may terminate on the back of terminal blocks using through-panel terminals. Clearly mark terminal sets for ready identification including through-panel terminals identified on both sides. Make the contact between adjacent terminal points by bus bar, or by wire jumpers having spade type terminals securely attached to each end.

13. Terminal Buses. Provide a cabinet with supply terminal buses fed from the line side of the incoming 120 VAC power line, after the phase wire has passed through the main power switch. Use radio interference filters in accordance with Item 8 of this section, with the buses supplying load switches and with flashers filtered when required.

Provide a signal bus relay controlling power to the bus supplying power for the signal load switches.

The following requirements override NEMA requirements for signal bus relays. Use a solid-state relay for the signal bus relay. Maintain output from the signal bus relay equal to or above the rating of the cabinet main overcurrent protection device over the NEMA TS-2 Environmental Operating Range of -50 to +185 degrees F.

Provide a common terminal bus for the connection of the neutral wire of the incoming 120 VAC power line. Provide a common bus with sufficient terminal points to accommodate all potential cabinet wiring as well as field wiring. Use a separate common terminal, insulated from the panel, for the interconnect common.

Provide bus terminal points complying with Item 12 of this section for conductor accommodation, attachment, and identification.

14. Grounding System/Bus Bars. Provide a cabinet that includes a grounding system as specified in NEMA TS-1, Section 10.3.2.1 with an adequate number (minimum of three) of ground terminal points.

15. Wiring. Neatly organize and route the harnesses and wiring bundles to individual terminals. Use harnesses providing a wire for each pin or contact of the device. Connect each wire to a marked terminal position. Use labeled spade type terminals or plug connections on all harness wiring. Group and lash or restrain wire bundles to not interfere with the access to components, terminal blocks or buses, or the legibility of terminal identification. Provide harnesses of sufficient length to reach any point within the cabinet. Provide capability to easily trace the cables and harness bundles through the cabinet to their terminations.

Wire the cabinet so that controller pin connections associated with a given phase number match the phase number assigned to the specified traffic movement as shown on the plans.

Provide all wiring with stranded conductors. Provide adequate wiring for the voltage and load representing the ultimate load of the devices connected. Provide wires with the ampacity rating as specified in NEMA TS-1, Section 10.3.3.1. Color code the wiring as follows:

a. Solid white, AC common.

b. Solid green or green with yellow stripes, equipment ground.

c. Solid black, AC line side power (AC+).

16. Loop Detector Units. Provide loop detector units complying with the requirements of NEMA TS-1, Section 15, with the following modifications:

a. Provide shelf mounted loop detector units powered from 120 volts.

b. Provide a unit using solid-state isolated output devices.

c. Provide conductors twisted three to five times per foot in the cable harness for loop input pins.

d. Provide detector unit electrical connection plugs or wiring harness designed to allow replacement of any multi-channel shelf mounted detector unit with

single channel detector units. Provide only units with the connector type required for single channel shelf mounted detector units, or wire the controller back panel to single channel wiring harnesses plug connected to an adapter harness and mated to the multi-channel connector of the detector unit.

e. When shown on the plans, supply delay and extension timing capability on the detector unit; otherwise, provide these features with the controller unit software in accordance with requirements of 733.02.

f. Provide a harness with a wire for each pin or contact of the device.

g. Provide loop detector unit with an LED or LCD display indication of call strength (ΔL/L or equivalent). Provide a display with a bar graph or numerical display with at least eight (8) discrete levels indicated.

If required by the plans, provide vehicle detector types other than "loop" detectors, by separate bid item.

Provide TS-1 cabinets in accordance with the City QPL.

733.04 Cabinet Risers. Provide the type (size and shape) of cabinet riser compatible with the type of controller cabinets specified for the project.

Provide an aluminum riser capable of raising the NEMA cabinet either 12 inches or 30 inches above the concrete foundation, as shown on the plans. Bolt the bottom of the riser to the standard cabinet foundation (anchor bolts not included with the riser) and the top of the riser bolts to the bottom of the cabinet. Provide attachment hardware for connecting the riser to the cabinet.

Construct the riser in a minimum of two pieces to allow raising the existing cabinet off the foundation without disconnecting the field wiring and inserting the riser below the cabinet. Provide hardware for rigidly connecting the riser sections together.

Fabricate the riser from 0.125-inch sheet aluminum with flanges on the top and bottom to provide rigidity. Provide mounting flanges as necessary to connect with the controller cabinet and foundation anchor bolts. Provide the outside surface of the riser with a smooth, uniform, natural finish.

Provide materials in accordance with the City QPL.

733.05 Flasher Controller. Provide a solid-state flasher complying with NEMA TS-1, Section 8, and having two circuits, each rated at 10 amperes. Provide a cabinet conforming to applicable requirements of 733.03.A, except for the following items not required: a small door-in-door (police door), shelves, and a fan. Provide a cabinet size of not less than 12 inches high by 10 inches wide by 6 inches deep. Provide cabinets designed for pole mounting with a 1-1/2 inch or larger conduit opening in the bottom. Include the following auxiliary equipment: on-off power switch with integral 20-ampere circuit breaker, lightning protection devices on incoming power lines, interference filters, terminal blocks, and a ground bus bar.

Provide materials in accordance with the City QPL.

733.06 Controller, Master, Traffic Responsive.

A. Description. The traffic responsive master controller consists of one component of a distributive processing, traffic responsive, control, and monitoring "closed loop"

system. The master controller's principal operational task consists of selecting and implementing traffic signal timing plans in response to both actual traffic conditions or time based events. The master controller monitors, in real time, local intersection activity, and overall system performance, reporting failures and status conditions to the Remote Monitoring Station.

The City typically locates the master controller in a local intersection cabinet; however, in special circumstances the City will locate the master controller at a Remote Monitoring Station site. The master controller has the capability of uploading/downloading information to local intersection controllers and the Remote Monitoring Station.

B. Functional Requirements.

1. Design. Provide a solid state, digital microprocessor master controller design. Provide a controller using menu driven prompts.

Provide a master controller having an RS-232 port for connection to a laptop computer or printer. Provide software and connector cables for communication with a laptop.

2. Local Controllers. Provide each master controller capable of supervising and communicating with at least 24 local intersection controllers.

3. System Detectors. Provide each master controller capable of analyzing traffic sensor data from at least 32 system detectors. Distribute system detectors up to eight per intersection, but do not exceed the total system sensor capacity.

Provide the detectors assignable to each of the computational channels in each group, with the channels representing cycle selection, directionality (offset), non-arterial flow (split), and special congestion indicators of queue or occupancy.

Provide a master controller capable of monitoring and detecting system detector failure and removing failed detectors from volume and occupancy calculations. Upon resumption of satisfactory sensor operation, design sensors to automatically resume input to volume and occupancy calculations.

4. Timing Patterns. Provide each master controller with a minimum of 16 selectable patterns. Design each pattern to consist of a combination of cycle, offset, and split numbers for each intersection in the system.

Provide a master controller capable of implementing a "free" mode allowing all intersection controllers to operate without system coordination and a "flash" mode allowing all intersection controllers to operate in a flashing operation.

5. Operational Modes. Provide each master controller with the capability to operate in the following modes of operational control:

a. Traffic responsive mode; pattern selection based on dynamic traffic conditions as measured by system sensors located in the control area. As a minimum, base the pattern selection on the quantitative traffic flow parameters of volume, occupancy, and directionality of the arterial traffic.

Base transfer of patterns on programmable threshold values. Provide system sensors capable of selective weighting.

b. Time of day/day of week (time base) mode; pattern selection based on a preprogrammed event scheduler with automatic adjustments for seasonal daylight savings time changes. Provide this mode of operation with capability to call or override traffic responsive mode.

c. Manual override mode; pattern selection made by operator control at the Remote Monitoring Station or master controller site.

Select the system coordination control for each master controller on a priority basis. Choose the priority from highest to lowest as follows:

a. Manual control entry or remote command

b. Time base control

c. Traffic responsive control

6. Reports. Provide each master controller with the capability to monitor and format intersection and system information for immediate output to the Remote Monitoring Station or for storage for a minimum period of 48 hours. As a minimum, generate the following types of reports:

a. A local intersection activity log showing the time, date and activity of all monitored local intersection failure conditions.

b. A system sensor failure log including time, sensor location, and type of failure.

c. A system log with pattern changes.

d. A system sensor data log including volume and occupancy for all system sensors.

7. Alarms. Provide each master controller with capability to continuously monitor intersection and system information for various systems and user defined critical conditions. Upon detection of an alarm condition, design the master controller to attempt to transmit alarm information to the Remote Monitoring Station or a preprogrammed telephone number. In case of failure to connect to the central software, design the master controller to continue to periodically retry reporting to the Remote Monitoring Station.

8. Communications. Provide a master controller supporting two-way dial-up communications to a Remote Monitoring Station computer for control, monitoring, data collection, and for timing pattern updating purposes. Through continuous, 7 days/week, 24 hours/day system monitoring, design the master controller with the capability to automatically dial-up the Remote Monitoring Station computer upon detection of user defined critical alarm conditions.

Provide a master controller including any communication devices or modems necessary to interface with the local intersection controllers within its control area.

9. Security. Provide a master controller with a user specified security code before altering any data. To view any parameter, do not require a security code entry. Provide a master controller capable of disabling security code requirements, allowing for perpetual access without requiring hardware changes.

733.07 Remote Monitoring Station.

A. Description. The Remote Monitoring Station consists of a distributive processing, traffic responsive, control and monitoring "closed loop" system. The system monitors, in real time, local intersection activities, and overall system performance, reporting failures and status conditions both automatically and by operator request. In order to meet current and future traffic control needs, the system also provides extensive control monitoring, data collection, reporting, and analysis functions.

For complete user flexibility, the system provides full access of each local system intersection controller from the Remote Monitoring Station site. Full access includes the capability to upload all time settings, operation parameters, and status information, as well as the capability to download all time settings and operation parameters.

B. System Architecture. The system consists of four principal elements:

1. Local intersection controller (see 733.02)
2. Communication links
3. Traffic responsive master controller (see 733.06)
4. A Remote Monitoring Station consisting of computer equipment and software

C. Local Intersection Controllers. Provide controller units conforming to Section 733.02 for the type of controller shown on the plans. Provide a controller having internal communication capability compatible with the type of interconnect cable shown on the plans. Provide a local system controller capable of processing controller and detector data and provide all necessary intersection control functions.

D. Communications. Provide communication between the Remote Monitoring Station and the master controller through an auto-answer/auto-dial external modem on standard dial-up telephone service. Provide telephone service at the Remote Monitoring Station site by the maintaining agency, unless otherwise shown on the plans. Provide telephone service at the master controller or the isolated local intersection location by separate bid item as specified for "Telephone Service".

Include error checking in the software to ensure transmission and reception of valid data between the local controller, master controller, and the Remote Monitoring Station.

E. Equipment. Provide the equipment for each Remote Monitoring Station location as shown on the plans and, as a minimum, consisting of the following items:

1. Microcomputer with monitor
2. Software
3. Modem
4. Printer
5. Accessory Items

F. System Functional Requirements. Provide the system software in a simplified user friendly, color menu format at the Remote Monitoring Station. Design this control and monitoring system to allow the user to fully access and operate with no special computer programming skills.

1. Graphical Representation. Provide system software enabling the operator to display in color, the vehicular signals, pedestrian signals, and detector actuations in a real time mode. Design with the capability for the user to construct an intersection layout graphically by using predetermined intersection shapes.

2. System Capacity. Provide a Remote Monitoring Station software having the capacity to monitor and control at least 24 traffic responsive masters. Design the central software with the capability of monitoring and controlling isolated system controllers.

Provide a system software having the capability to manually select any timing plan, free mode or flash mode.

Design the system software with the capability of accepting, formatting, and processing data from at least 32 system detectors from each master controller.

3. Data Transfer. Ensure that it is possible to upload/download the signal timing database, including coordination, and preemption settings, between the Remote Monitoring Station and the master controller or local intersection.

Provide a Remote Monitoring Station with the capability to compare a currently uploaded timing database with a previously developed database stored in the Remote Monitoring Station memory. Provide the capability to report differences in the databases.

During either uploading or downloading operations, include the capability to run normal traffic control operations without suspension.

4. Security. Provide a Remote Monitoring Station allows inputting a user specified security code before altering any data. Maintain controller access procedures from the Remote Monitoring Station allowing the user full security control of all system components from a remote location.

733.08 Telephone Service. Provide for connecting to a standard dial-up telephone service capable of supporting 2400 baud data transmission. Provide a Hayes compatible external modem with an auto-answer/auto-dial unit with all connections, cables, and lightning protection on the incoming wires provided.

733.09 Uninterruptible Power Supply (UPS).

A. Operation. Provide a UPS with a minimum two and one half (2.5) hours of full run-time operation for an "LED-only" intersection with 1000 watts of active output power.

Provide a UPS compatible with all of the following traffic signal equipment; NEMA TS-1 cabinets and Type TS-2/A2 controllers.

Provide for the maximum transfer time, from disruption of normal utility line voltage to stabilized inverter line voltage from batteries, of 65 milliseconds or less. Apply the same maximum allowable transfer time when switching from inverter line voltage to utility line voltage.

Include a means to switch the intersection from full-operation to flashing operation after 2-hours of run-time, for the purpose of conserving battery operation during an extended utility power outage.

Include standard form C relay contacts to trigger an alarm within the controller assembly, informing a technician the system operates on battery backup.

Design for an operating temperature for both the inverter/charger, power transfer relay and manual bypass switch of -35 °F to +165 °F.

Use the power transfer relays and manual bypass switches rated at 240VAC/30 amps, minimum.

Provide a UPS capable of bypassing the utility line power whenever the utility line voltage is outside the following voltage range: 100VAC to 130 VAC, + 2 VAC.

When utilizing battery power, design the UPS output voltage between 110 VAC and 125 VAC, pure sine wave output, 60Hz ± 3Hz.

After restoration of utility line power between 100 VAC and 130 VAC for more than 30 seconds, design the UPS to dropout of battery backup mode and return to utility line mode.

In the event of inverter/charger failure, battery failure or complete battery discharge, provide the power transfer relay with the capability to revert to the NC (and energized) state, for cabinets connected to utility line power.

Do not exceed 10 hours to recharge the battery, from "protective low-cutoff" to 80% or more of full battery charge capacity.

Include all necessary wiring and hardware for mounting (shelf angles, rack, etc).

B. Maintenance, Displays, Controls and Diagnostics. Provide a UPS with a backlit LCD display that includes an event counter, hour meter, line and battery voltages/percentages and fault status. Provide the LCD display with touch keys for changing display statuses and to reset counters, hour meter date and time.

Provide a UPS with lightning surge protection compliant with IEEE/ANSI C.62.41, having remote access via a RS-232 serial interface for laptop communication through Windows system software or for hyperterminal to monitor for making setting changes, and with status, alarm, and event logging, time and date stamped for up to 50 events. Provide printable logs.

Provide two (2) sets of equipment lists, operation and maintenance manuals, and board-level schematic and wiring diagrams of the UPS, and the battery data sheets. Provide a manual conforming to TEES 1999, Chapter 1 Section 1.2.4.2.

C. Battery System. Supply a minimum of four (4) batteries with the UPS system. Use 12VDC batteries rated at 105 Ahrs to achieve the 2.5 hour run time requirement. Provide batteries easily replaced and commercially available off the shelf.

Provide deep cycle, sealed prismatic lead-calcium based AGM/VRLA (Absorbed Glass Mat/ Valve Regulated Lead Acid) batteries.

Provide batteries certified by the manufacturer to operate over a temperature range of -13 °F to +165 °F.

Place all batteries on battery heater mats in the enclosure, designed to extend the life of the batteries.

Design an integral system to prevent the battery from destructive discharge and overcharge. Do not allow batteries to recharge when battery temperature exceeds 122°F+5°F.

D. Enclosure. Provide an enclosure mountable to a standard Model 332, NEMA TS-1 or TS-2 traffic signal cabinet constructed of natural unpainted aluminum. Provide a cabinet size adequate to house "all" the UPS equipment including the controller unit, manual bypass switch, and the (4) batteries. Key the enclosure to the City of Columbus master #2 lock (1R 6380) and include 2 keys.

Provide a base seal for use between the enclosure to the concrete foundation or riser of continuous tape gasket material, minimum 1/8-inch thickness. Completely seal the interface to the adjacent controller cabinet with silicone caulk.

Provide an enclosure with a vent, fan and thermostat as per TEES Chapter 7, Section 2-Housings.

E. Warranty. Provide a two (2) year factory-repair warranty for parts and labor on the UPS from date of acceptance. Warrant batteries for full replacement for two (2) years from date of purchase.

Provide materials in accordance with the City QPL.