S T A T E **O F** **T E N N E S S E E**

January 1, 2015
Nashville Metropolitan Government

SPECIAL PROVISION

REGARDING

SECTION 730 - TRAFFIC SIGNALS

Delete Subsection 730.05 and substitute the following:

730.05-Documentation. Documentation packages will be required for:

- Traffic Signal Controllers
- Traffic Signal Controller Cabinet
- Signal Load Switches
- Flash Transfer Relays
- Conflict Monitors

The documentation packages shall contain instructions for modifications within a range of capabilities of the unit such as changes in phasing or sequences, programming matrix boards, etc.

At least two documentation packages shall be supplied with each unit purchased under the specifications.

Documentation packages for each wired signal controller cabinet shall contain a complete wiring diagram of the cabinet giving terminal board connections, connector connections, fan connections, lighting fixture connections, wiring of flash transfer relays, wiring of lightning arrestors and surge protectors, wiring of load switch panels, switch packs, etc.

Complete instructions for field modifications throughout the range of the capabilities of the cabinet such as changes in phasing or signal sequence, flash programming, programming of matrix boards, etc., shall be included.

All components and switches shall be labeled for identification in the wiring diagram.

For each group of controllers and cabinets received, one complete set of reproducible mylar cabinet wiring diagrams for each cabinet type shall be furnished as part of the documentation package. Cabinets shall be assigned a job number. The job number shall be printed or stamped on the cabinet and this same number shall appear on the prints for future reference.

Documentation packages shall contain a schematic diagram that shows all wiring, connections, and every individual component.

The documentation packages shall contain a parts identification that shows the location of every individual component. This includes integrated circuits, transistors, resistors, capacitors, inductors, as well as test points, switches and indicators. Parts identification may be imprinted, stamped or etched on circuit boards in lieu of the pictorial layout, provided such markings are in no way obscured from normal viewing as a result of parts mounting, and shall be referenced to the schematic.

The documentation packages shall contain a parts replacement guide so that any component needing replacement can be identified. It shall be possible to use the parts replacement guide for information to either find an industry standard replacement part or order a needed component from the manufacturer.

Maintenance and troubleshooting procedures shall be included and referenced in the schematic so that a block check can be made to locate any defective components. Point-to-point voltages and wave forms shall be included that are pertinent to proper servicing. Test points must be easy to locate and contact with test instrument probes.

A complete physical description of the unit to include at least the physical dimensions of the unit, weight, temperature rating, voltage requirements, power requirements, material of construction, and so on shall be included.

All applicable warranties and guarantees shall be included. All documentation must be delivered to the Metropolitan Government.

Successful bidder shall furnish one complete parts list for each five controllers or fraction thereof. Parts list shall include generic name of each component and a cross-reference part number of at least two manufacturers for each solid state device in the controller and other hardware.

Successful bidder may be required to demonstrate at the Traffic and Parking Commission offices, complete units, including cabinet, similar in design and construction to the units described by the vendor in the invitation to bid. This shall be done at no cost to The Metropolitan Government and within 30 working days after notification.

There shall be a Programmable Read Only Memory (PROM) or equal test equipment for installation in the controller to exercise all electronic components of the controller. It shall be possible to use this PROM to inspect all controllers, four through eight phases. The PROM shall be a troubleshooting aid to the technician. The vendor shall provide one PROM and two complete instruction manuals for every ten or fraction thereof controllers purchased.

Delete the second sentence of the first paragraph of Subsection 730.07 and substitute the following:

The training session will last for a minimum of two normal working days unless the maintaining agency determines a lesser time is adequate.

Delete the first sentence of the fourth paragraph of Subsection 730.24 and substitute the following:

Signal heads shall be fabricated from die-cast aluminum bodies.

Delete Subsection 730.25 and 730.26 and substitute the following:

730.25-General Requirements.

Cabinet Construction - The cabinet shall be of weathertight construction fabricated from sheet aluminum sheet (3 millimeter (0.125") thick Type 5052-H32) or cast aluminum alloy. Cabinets fabricated from aluminum sheet shall not require painting unless the final finish presents an unsightly appearance. All welds on fabricated cabinets shall be internal and continuous; spot welding is not acceptable.

Cast aluminum cabinets shall be properly cleaned, primed with two coats of zinc chromate primer and two coats of non-smudge aluminum paint.

The cabinet shall be equipped with properly rated circuit breaker(s) conforming to the National Electrical Code to accept #6 AWG wire.

A. There shall be two properly rated circuit breakers for the following:

1. One breaker shall provide service for the controller, conflict monitor, load switches, fan, and other controller appurtenances.
2. One breaker shall provide service for the flasher and flash circuits.

The cabinet shall be of suitable size to allow access to all cabinet terminals for installation and maintenance with shelf space for all provided equipment and one detector amplifier per phase.

The cabinet shall have a field test panel equipped with the following switches.

A. Per phase detector simulation for momentary and locked call;

B. Per phase pedestrian call for momentary and locked call;

C. Stop timing per controller. When in Stop Timing, shall apply Stop Timing to both rings of the controller;

D. Cabinet light on/off;

E. Signals on/off. When in Off position, shall remove AC power to load switches and all signal output indications;

F. Internal Advance switch wired through the Stop Timing switch to apply Internal Advance to the controller only when Stop Timing switch has been enabled;

G. Flash switch. When in On position, will put intersection to flash and controller will continue to cycle.

The cabinet shall have a police subpanel equipped as follows:

A. Main AC power on/off switch which, when in Off position, will remove all AC power in the controller cabinet. Switch must be properly rated as the cabinet requires.

B. An auto/flash switch shall provide for normal controller operation when in Auto position. When placed on Flash position, will place intersection on Flash and apply Stop Timing, and controller power will remain on. When returned to normal operation from Flash, shall cause the controller to initialize into start-up sequence.

C. An auto/manual switch, when in Manual position, shall enable Manual Control Enable, and the controller shall time all clearance intervals as the Internal Advance input is activated.

D. A two-position terminal strip with No. 6 screws for future installation of a manual pushbutton. These shall be terminated by the Manual Control Enable and shall be wired through the Auto/Manual switch.

E. Door lock keyed for standard Econolite #9452273PO1 or Eagle E7322 or equal; two keys per cabinet to be supplied.

The cabinet shall be wired for vehicle and pedestrian NEMA lamp indicating load switches according to the following:

A. A.Four-phase controllers shall be wired for four vehicle phases, two overlaps, and two pedestrian phases. Eight NEMA load switches and positions shall be provided per cabinet, four for vehicle phases, two for overlap use, and two for pedestrian use. It shall be possible to change the pedestrian load switch positions to overlap use, or vice versa, by changing the appropriate cabinet wiring at the terminal strips.

B. Eight-phase controllers shall be wired for eight vehicle movements and four pedestrian phases. Twelve NEMA load switches and positions shall be provided, eight for vehicle phases and four for pedestrian use. It shall be possible to change the pedestrian load switch positions to overlap use by changing the appropriate cabinet wiring at the terminal strips.

The load switches shall have input indicators mounted on the front panel of the switch. The load switches shall be the "cube" type, or approved equal. Load switches made from discrete components shall not be acceptable.

The cabinet shall be provided with a minimum of two 12-position copper ground strips to accept #10 AWG wire.

All cabinet wiring shall be neatly routed, laced and permanently secured. All cable anchors shall be secured to the panel, where practical, or to the cabinet wall with screw-mount anchors. If drilled through the wall, anchors shall be finished to match the existing outside cabinet surface.

All inputs to and outputs from the controller and other equipment, whether used or not, shall be terminated in barrier type terminal strips. All terminals strips and wires shall be clearly marked with fade resistant terminals. All unused wiring shall be terminated at a terminal strip position.

All barrier terminal connections shall utilize space-type connectors No "feed-through" terminals blocks shall be acceptable. Minimum terminating screw size for barrier terminal strips shall be according to the current level of the terminated wire and shall be subject to the following restrictions:

A. NEMA level functions - #6 screw;

B. AC level, 0-10 ampere rating - #8 screw;

C. AC level, greater than 10 ampere rating - #10 screw;

All terminals in the cabinet shall be of the barrier type. The following field connector terminals shall be provided:

A. A.Five positions per controller phase and three positions for wired overlaps for field wires

B. Ten positions per phase for vehicle loop detectors

C. One position per phase for pedestrian detector inputs

All of the above terminals shall be designed to accept terminal connections 10 millimeters (0.4 inches) in width.

The cabinet shall be equipped with all necessary terminals, harnesses, and wiring to connect power, signals, detectors, controller monitor, and coordination inputs.

The cabinet shall be wired for and include a NEMA flasher mounted on the back panel. All controllers shall have two circuit flashers. The flashers shall have output indicators mounted on the front of the flasher case.

The cabinet flash sequence shall be accomplished via jumper straps or wires. It shall be possible to program or omit flash on one circuit per vehicle and overlap phase.

All relay circuits shall have adequate noise suppression devices.

Each cabinet shall include a thermostatically controlled fan. The fan shall have permanently lubricated bearings. There shall be noise suppression devices on the fan. The thermostat must be adjustable from 38 to 65 degrees C (100 degrees F to 150 degrees F). The air intake must be at or near the bottom of the cabinet and be covered to a standard replaceable filter. Fan must be mounted at top interior of cabinet and be easily removable for replacement or repair by using common hand tools. No outside roof mounting is acceptable.

No especially manufactured fans will be allowed. Fan must be available from two or more manufacturers.

Fan must have a flow rate of such volume that it will evacuate cabinet volume at least three times per minute. Thermostat shall be located at top of the cabinet next to fan. The filter must be located in the lower portion of the cabinet. Filter must be located in the lower portion of the cabinet. Filter must be of a type that can be replaced by commercially available size and must be replaceable without any special tools or equipment.

The cabinet main door shall have a cylinder lock to accept Automatic Signal Division key #2. Two keys shall be provided per cabinet.

All doors shall have an extruded neoprene seal.

The cabinet shall include a light and fused duplex receptacle which can be used when main circuit breaker is off.

The cabinets shall be wired with all phase modules to accomplish the full signal sequence as permitted by the controller (4- or 8- phase) specified. Where a sequence of fewer phases is shown in the plans and/or the bid documents, it shall be possible to upgrade the cabinet to the full 4- or 8-phase sequence with only the addition of the appropriate field connections.

All relays external to the controller or appurtenances shall meet the following requirements:

A. Flash transfer relays shall be AEMCO #136-4962, Midland Ross #187-02T)A1 or equal; 10 amp contacts, 8-pin Cinch-Jones base.

B. Other control relays shall be Potter Brumfield KREPA, Midland Ross 159 Series, or equal; 5 amp contacts, 8 pin octal base.

Cabinet shall have a door stop self-latching mechanism, which will provide a positive retention of door when open. This will locate at the bottom of the cabinet, and have a minimum of two locked positions, 90 and 120 degrees.

A three-point locking mechanism shall be provided to secure the door at three points: top, center and bottom.

All cabinets shall be provided with a minimum of two shelves, fabricated with the same material as the cabinet. They shall be adjustable vertically, and be mounted to the cabinet wall with U-channel mounting strips with spring-retained nuts and machine screws. The lower shelf shall provide mounting space for the loop detector amplifiers. The upper shelf shall be installed with a minimum 175 millimeter (seven-inch) clearance above the bottom shelf, and provide space for controller, monitor, and communications unit. There shall be a minimum of 50 millimeter (two-inch) clearance between the cabinet wall and any device located on the shelf. A minimum of 20 percent of the cabinet interior volume and 20 percent of the shelf space, but not less than 300 millimeters (12"), shall be available for future City use.

Panels will be located in cabinet as described below:

A. Communications/Coordination	Upper Left Wall
B. Detectors	Lower Left Wall
C. AC Power	Lower Right Wall
D. Auxiliary/Police Switches	Door
E. Load Bay	Back Wall

The load bay shall be hinged on the bottom for fold-down inspection of rear terminals. All interior panels shall be adjustable vertically through the use of U-channels mounted on the walls of the cabinet. All panels shall contain only discrete wiring to the terminal strips; no printed circuit boards will be allowed.

All cabinets shall be supplied with a Signal Conflict Monitor (SCM) which meets the NEMA Standards. The SCM for all controller cabinets with three or more phases shall be the 12-channel type, and shall have the following features:

1. Liquid Crystal Display to show all data in English language format.
2. Shall monitor all Green/Yellow/Red/Walk field display outputs.
3. Shall monitor the Controller 24 VDC output and be user programmable to have this monitor function Latch on.
4. Shall monitor the Controller Voltage Monitor output, and be user programmable to have this monitor function Latch On.
5. Per Channel monitoring of Phase Yellow Clearance Interval, and shall cause flash operation if Yellow Clearance is less than the SCM programmed time (2.7 - 9 seconds).
6. Front panel mounted over-current protection (no internally mounted fuses are acceptable).
7. Front panel mounted reset switch.
8. Fault logging features:

   The SCM shall log all faults as to the:

   a. Date of fault;
   b. Time of fault;
   c. The fault condition;
   d. Power failure;

   and store these fault conditions in no-volatile memory for user retrieval. The monitor shall be able to store at least 10 such faults. The internal time clock shall automatically adjust for Daylight Savings Time changes. There shall be a keyboard method for the user to display and clear the stored event log.
9. There shall be an RS-232 port on the SCM to allow the user to print all data stored in the SCM. The printer shall interface with the SCM via a standard RS-232 cable. Printer to be supplied by others.
10. The SCM shall detect the following conditions and place the cabinet in the flash mode by De-energizing the Flash Transfer Relays:

    a. Absence of an active AC input on a channel;

b. Green/Yellow both active on a channel;

c. Yellow/Red both active on a channel;

d. Green/Red both active on a channel;

e. Green/Green active on conflicting channels;

f. Green/Yellow active on conflicting channels;

g. Green/Walk active on conflicting channels;

h. Low 24 VDC sample;

i. Controller Voltage Monitor active;

j. Clearance time less than programmed.

11. On circuits where all field outputs are not used (such as left-turn phases) unused circuits shall be terminated at a load resistor and the monitor plus features shall function
12. No functional field display shall be permitted unless monitored by the SCM
13. The SCM sampling inputs shall be terminated at the closest tie point to the field termination

Lightning Protectors and Interference Suppressors - Ample lightning protectors to provide effective defense against high transient voltages caused by lightning discharges or other sources shall be provided. Each controller cabinet must be furnished with the following surge protection devices:

1. Main power suppressor for all but flasher or remote detector cabinets shall have the following characteristics:

A. Peak surge current	20,000 Amperes
B. Clamp Voltage	250 Volt
C. Response Time	Voltage NEVER exceeds 250 Volts
D. Continuous Current	10 AMPS at 120 VOLTS AC

2. Power Protector for Controller Flasher, Flashing Beacon, and Remote Detector Cabinets:

A. Peak Current	15,000 Amperes
B. Power Dissipation	15 Watts
C. Peak Voltage	212 Volts

3. Loop detector input terminals, vehicle and pedestrian controller input terminals shall be provided with the following devices:

A. Peak Surge Current	400 Amps Differential Mode 1000 Amps Common Mode
B. Response Time	40 Nanoseconds
C. Input Capacitance	35 pf typical
D. Clamp Voltage	30 Volts Max (either mode)

4. Auxiliary Relays and Fan shall be provided with a resistor/Capacitor or diode suppression circuit, as appropriate, to suppress generated noise.
5. RF Filter shall be provided in controller cabinets and shall provide filtering of RF noise over the range of 60 hertz through 20 Megahertz. The RF filter may be incorporated as part of the Main Power Suppressor.

Pole Mounted Cabinets - All provisions for the cabinet construction listed above shall apply to pole mounted cabinets.

Pole-mounted cabinets shall be provided with all necessary pole mounting hardware. Hardware shall be sufficient strength to securely hold the cabinet, and shall present a workmanlike appearance.

The bottom center of the cabinet shall be constructed so that up to a 100 millimeter (4-inch) conduit can be attached to the cabinet without having to cut or punch through any supporting ribs or reinforcing members.

Unless otherwise stated in the bid documents, all 4-phase controllers shall be provided in pole-mounted cabinets.

Pole-mounted cabinets shall have minimum outside dimensions of 700 millimeters (28 inches) (width) by 375 millimeter (15 inches) (depth) by 1200 millimeter (48 inches) (height).

All pole-mounted cabinets shall have interior welded support plates for attachment of mounting hardware. The plate shall be a minimum sizes of 50 x 108 millimeters (2" X 4" 1/4"), located on the vertical centerline, 150 millimeter (six inches) from the top and 150 millimeter (six inches) from the bottom.

Base-Mounted Cabinets - All provisions for the cabinet construction listed previously shall apply to base-mounted cabinets.

Unless otherwise stated in the bid documents, all eight-phase controllers shall be provided in base-mounted control cabinets.

All necessary installation hardware and templates shall be provided.

Base-mounted cabinets shall conform to a base of 1100 millimeters (45 inches) (width) by 625 millimeters (25 inches) (depth) with bolt spacing of 1035 millimeters (40-3/4 inches) on centers (width) by 480 millimeters (19 inches) on centers (depth). Minimum outside

dimensions of cabinet shall be 965 millimeters (38 inches) (width) by 600 millimeters (24 inches) (depth) by 1350 millimeters (54 inches) (height).

730.26-Controllers. The controller shall meet or exceed all requirements set forth by the Institute of Transportation Engineers, the Manual on Uniform Traffic Control Devices, latest edition, and the NEMA TS1-Standards and all adopted revisions. The successful bidder shall provide private laboratory certification that equipment to be provided is in compliance with the NEMA standards.

All circuit components such as transistors, diodes, integrated circuits, resistors, capacitors, etc., shall be computer-grade quality. No vacuum tubes, relays or stepping switches shall be permitted. All components shall be identified with at least two manufacturers' part numbers for availability. No custom components, except for software and programmable chips, shall be permitted.

Overlaps shall be internally generated. Overlaps shall be user selectable using a standard NEMA program overlap card and wire jumper straps located within the controller unit in accordance with NEMA TS 1, Figure 14.3-6.

There shall be complete phase skip capability of any phase without a valid detector call, subject to the following:

When the controller is serving a phase, and an opposing phase receives a call and the phase in service terminates to the clearance interval, then the phase next will be served a minimum green interval even if the phase next demand ceases. This provision shall not override phase skip capability.

The controller shall be capable of accepting a call from any standard vehicle or pedestrian detector without the use of special external isolation devices.

All timing shall be based on the 60 Hz frequency.

All components on printed circuit boards shall have their identification permanently labeled on the circuit board in a manner so as not to be obscured by component mounting.

All operating voltages into and out of the controller shall be NEMA level DC voltages, except for AC power (Connector A, Pin p and U).

All required programming parameters required by this specification shall be user entered by means of front panel keyboard(s). The signal operating sequence shall not be alterable via the keyboard.

The controller shall be furnished as a complete unit ready for installation with all timing entry devices and user programmable devices as an integral part of the controller.

Programming of the controller shall be according to Standard NEMA sequence charts, unless otherwise stated by the Plans.

The controller shall be designed to operate in a standard traffic control cabinet without the need for environmental control devices other than a standard cabinet fan ventilation vents in the controller housing and cabinet.

The controller shall be modular in design and shall house the following or equivalent modules.

A. Power Supply

B. Signal Timing Module

C. Signal Sequence Module

D. Input/Output Information Modules

E. Time Based Coordination Module

F. Mainframe with parallel master board layout. No timing components shall be mounted to the mother board.

All modules used in four-phase controllers shall be interchangeable with modules used in the eight-phase controllers.

All user-entered data shall be stored in EEPROM devices which shall preclude the need for any battery or battery-operated device. Only the real-time clock for the time-based coordination shall utilize a battery. All user-entered data stored in the EEPROM shall be permanently stored in the devices. Loss of controller operating power shall not alter the values stored in EEPROM.

The controller shall have error entry codes and a data entry procedure to minimize the probability of data entry by unauthorized personnel.

The following front panel indicators shall be provided:

A. Phase in Service (Per Phase);

B. Phase Next in Service (Per Phase);

C. Detector Call (Per Phase);

D. Pedestrian Call (Per Phase);

E. Gap Termination (Per Ring);

F. Max Green Termination (Per Ring);

G. Max Green Two in Effect (Per Ring);

H. Termination by Force Off (Per Ring);

I. Interval in Effect (Per Ring);

J. Interval Value (Per Ring);

K. Det Lock/Non Lock (Per Ring);

L. Hold (Per Ring).

There shall be means for user entry of the following via front panel switches on the keyboard:

A. Per Phase Selection of:

1. Minimum Recall
2. Maximum Recall
3. Pedestrian Recall
4. Phase Non-Actuated
5. Detector Lock/Non-Lock

B. Per Unit Programming of the Initialization format to determine the start-on condition of the controller upon application of AC power, or the activation of External Start Input:

1. Phase(s) which shall initialize as on;
2. Start-on display indication of the start-on phase(s): red, yellow, or green.

The bidders shall be required to provide a list of programmable integrated circuits utilized in the controller and the cost of the unit necessary to program such devices.

Bidder shall be required to provide a list of and cost for any specialized equipment required to maintain the controllers.

Delete item five of Subsection 730.28 and substitute the following:

5. The signal shall be actuated by a key switch. There shall be a one-hour timer operable over a time range of zero to sixty minutes, in five minute increments. The timer shall be removable from the electrical panel without the need for removing any other device or attachment. The timer shall be energized by a springloaded key lock, Chicago Lock Co., key number 2382 only. Two keys will be furnished with each cabinet.

Delete Subsection 730.30 and 730.31 and substitute the following:

730.30-Coordination. - Unless otherwise specified in the plans and/or bid document, controllers shall be furnished with coordination capability contained internally within the controller unit.

The coordination capabilities shall provide as a minimum three (3) cycles, three (3) offsets, and three (3) splits.

It shall be possible to implement coordinated operation by two methods: either by AC hardwire interconnect or by time-based commands stored in the controller unit.

Force-off and begin/end yield points shall be programmable by the user with respect to the local or system cycle as appropriate. There shall be a minimum of two permissive yield periods available.

The phases which are to be the coordinated phases shall be programmable by the user and are to be independently selectable in each ring.

The external coordination inputs which shall be accepted by the controller unit through the addition of a fourth or "D" connector shall be as follows:

- Cycle 2
- Cycle 3
- Offset 1
- Offset 2
- Offset 3
- Split 2
- Split 3
- Interconnect Common

The coordination cable for the fourth or "D" connector on the controller unit shall be terminated on a termination panel containing the required number of barrier terminal strips. This panel shall be mounted on the left side wall of the cabinets. All terminals shall be clearly numbered.

The coordination cable shall be terminated at the controller end with a 63 position, 1/4 turn twist lock metal connector. If the fourth connector on the controller does not mate directly with the above referenced harness connector, the supplier shall furnish an adapter harness which shall permit the interconnection of the fourth "D" connector on the controller to the specified coordination harness connector. The "D" connector functions are shown in table A-1.

730.31-Time-Based Coordination Operation.

Background Cycle

Time-based coordination operation shall be provided with at least three (3) independently programmable background cycles. The background cycles shall be settable in fixed increments, which do not exceed one (1) second. The repeatability of the cycle time shall not deviate by more than plus or minus 100 milliseconds from the programmable value.

Offsets

Offset is defined as the time difference, expressed in seconds of cycle length, from a system time reference point (usually time zero of the background cycle) to the beginning or end of the coordinated phase green interval.

TABLE A-1. "D" CONNECTOR FUNCTIONS			
	Function	Active Level	Input (I) Output (O)
1	Green Phase 1	AC+	I
2	Green Phase 2	AC+	I
3	Green Phase 3	AC+	I
4	Green Phase 4	AC+	I
5	Green Phase 5	AC+	I
6	Green Phase 6	AC+	I
7	Green Phase 7	AC+	I
8	Green Phase 8	AC+	I
9	Special Function 1	NEMA	O
10	Special Function 2	NEMA	O
11	Special Function 3	NEMA	O
12	Special Function 4	NEMA	O
13	Special Function 5	NEMA	O
14	Special Function 6	NEMA	O
15	Special Function 7	NEMA	O
16	Special Function 8	NEMA	O
17	Detector 1	NEMA	I
18	Detector 2	NEMA	I
19	Detector 3	NEMA	I
20	Detector 4	NEMA	I
21	Coded Status Bits A1	NEMA	I
22	Coded Status Bits B1	NEMA	I
23	Coded Status Bits C1	NEMA	I
24	Coded Status Bits A2	NEMA	I
25	Coded Status Bits B2	NEMA	I
26	Coded Status Bits C2	NEMA	I

27	Walk Phase 2	AC+	I
28	Walk Phase 4	AC+	I
29	Walk Phase 6	AC+	I
30	Walk Phase 8	AC+	I
31	Hold-on-Line	Relay	O
32	Yield/Advance	Relay	O
33	Force-Off 1	NEMA	O
34	Force-Off 2	NEMA	O
35	External Minimum Recall	NEMA	O
36	Flash	Relay	O
37	Flash Monitor	AC+	I
38	Flash Monitor	AC-	I
39	Preempt	NEMA	I
40	Manual	NEMA	I
41	Fan	AC+	I
42	Conflict Monitor	NEMA	I
43	Special Function 1	NEMA	I
44	Special Function 2	NEMA	I

Time-based coordination operation shall be provided with at least three (3) independently programmable offsets per background cycle. The range of programmability shall be from 0 to 99 percent of the background cycle in maximum increments of 1 percent.

The offset transition technique of the time-based coordination unit shall not cause the controller unit to extend the green interval of any phase by more than 25 percent of the background cycle in effects.

Splits

A split is defined as the division of time within the background cycle between the various phases of the controller unit.

Time-based coordination operation shall be provided with at least three (3) splits. Each split shall have eight independently programmable force-off points, one for each phase.

Force-off points shall activate only if the phase controlled by the force-off point is green.

Yield Period

The yield period shall be the time in the background cycle where the coordination phase is terminated, subject to the presence of a conflicting call. Time-based coordination operation shall continually apply an internal hold signal to the controller unit coordinated phase(s), except during the yield period and permissive periods.

The removal of the internal hold during the yield and permissive periods shall be of sufficient time to allow the controller unit to terminate the coordinated phase(s), subject to presence of calls.

Permissive Periods

Permissive periods are defined as programmable intervals in the background cycle that allow the controller unit to leave the coordinated phase(s) and service the phase(s), subject to the presence of calls.

Permissive Period Number 1 allows the controller unit to leave the coordinated phase(s) and service Phase 3 immediately following the coordinated phase(s), subject to a call. All other phases are omitted during permissive period number 1. Permissive period number 1 shall begin timing when the programmed offset time which is in effect has completed timing. The beginning and end of the permissive period number 1 time shall be fully programmable from 0 to 99 percent of the background cycle in maximum increments of 1 percent.

Permissive Period Number 2 allows the controller unit to leave the coordinated phase(s) or the phase being serviced during permissive period number 1 and service 7 phases. All other phases are omitted during permissive period number 2. The beginning and ending times for permissive period number 2 shall be fully programmable from 0 to 99 percent to the background cycle in maximum increments of 1 percent.

Permissive Period Number 3 allows the controller unit to leave the coordinated phase(s) or phase(s) being serviced during permissive period number 2 and service 4 + 8 phases. All other phases are omitted during permissive period number 3. The beginning and ending times for permissive period number 3 shall be fully programmable from 0 to 99 percent of the background cycle in maximum increments of 1 percent.

Permissive Period Number 4 allows the controller unit to leave the coordinated phase(s) or the phase(s) being serviced during the permissive period number 3 and service 1 + 5 phase(s). All other phases are omitted during the permissive period number 4. The beginning and ending times for permissive period number 4 shall be fully programmable from 0 to 99 percent of the background cycle in maximum increments of 1 percent.

Permissive Period Number 5 allows the controller unit to service pedestrian phases associated with 4 + 8 phases. The beginning and ending times for permissive period number 5 shall be fully programmable from 0 to 99 percent of the background cycle in maximum increments of 1 percent.

Level of Service

Time-based coordination operation shall be provided with the following minimum features which are designated as level of service:

3 background cycles

3 offsets per background cycle

3 splits per background cycle

5 permissive periods per split

8 force-off per split

Non-Early Release

Time-based coordination operation shall not allow the controller unit to advance out of any actuated (non-coordinated) phase until the force-off point value for that phase has completed timing.

Time-based coordination operation shall be programmable so that any actuated phase can be converted to early release operation, i.e., actuated phase can terminate prior to the completion of the programmed force-off point time.

Timing Requirements

The time controls for programming the background cycle, off-sets, force-off points and permissive periods shall be color or function coded. Timing of all functions shall be digital, with an accuracy of + 100 milliseconds from the programmed value.

The ranges and maximum increments of adjustment for the various timing functions shall be in accordance with the following chart:

Function	Minimum Timing Range	Maximum Increment of Adjustment
Background Cycle	30 to 255 Seconds	1 Second
Offset	0 to 255 Seconds	1 Second
Force-Off Points	0 to 99 Percent of Cycle	1 Percent of Cycle

The clock circuit for time-based coordination may use either the 60 Hz AC power source or a crystal oscillator as the timing reference. If the crystal oscillator is used as the timing reference, the frequency tolerance of the clock circuit shall be + 0.005 percent. The clock circuit for time-based coordination shall be settable to the nearest second.

The time-based coordination module shall display the time of day (hours, minutes, and seconds) in military time.

Time-based coordination operation shall be provided with a programmable feature which automatically changes from standard time to daylight savings time and vice versa.

Battery Power

Time-based coordination shall be provided with a battery to power the clock circuit and memory for a minimum of 100 hours when the 120 volt AC power source is disconnected.

The frequency tolerance of the clock circuit, when operated on battery power shall be + 0.005 percent. Repetative transfer from battery power to 120 volt AC power to battery power, and voltage brownouts (voltage less than 96 volts AC) shall not affect the accuracy of the time-based coordination clock circuit.

Day Programs

Time-based coordination operation shall be provided with a minimum of ten (10) day programs. A day program is used to specify which output circuit will turn on or off during a 24-hour period, i.e., cycle 1, offset 1, split 1, etc. The ten (10) day program shall be provided with a minimum total of 180 changes (ons or offs).

Exception Days

Time-based coordination operation shall be provided with a minimum of thirty (30) exception days. An exception day is used for a certain day of the year instead of the normal day program, i.e., holiday, special event, etc. The thirty (30) exception day program shall be provided with a minimum total of 180 changes (ons or offs).

Week Programs

Time-based coordination operation shall be provided with a minimum of five (5) week programs. A week program is used to specify which day program will be used for each day of the week.

Year Program

Time-based coordination operation shall be provided with one (1) year program. The year program is used to specify which week program will be used for each week of the year.

Manual Override

Time-based coordination operation shall be designed so that the programmed time of day function can be manually overridden to select a different function, i.e., cycle, offset, splits, etc.

Indicator Requirements

Time-based coordination module shall be provided with the following minimum indications:

A. Time of day (hours, minutes, and seconds);

B. Day of week or calendar date;

C. Cycle count (indicates time in background cycle);

D. Day program in effect;

E. Week program in effect;

F. Battery status.