

S T A T E

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T E N N E S S E E

(Rev. 12-18-1995)

January 1, 2015

SPECIAL PROVISION

REGARDING

SECTION 730 – TRAFFIC SIGNALS

Delete Subsection 730.05 and add the following:

730.05-Working Drawings. The contractor shall provide detailed technical circuit description and circuit schematic information applicable to the operation and maintenance of the controller and associated auxiliary equipment. Cabinet wiring diagrams with interconnection details, schematics, and maintenance techniques shall be furnished. Information in manual form shall include a materials guide which shall contain the replacement part numbers and description of all components used. All solid-state devices shall be listed by their generic name or in lieu of this, a complete cross-index from manufacturers' numbers to generic number shall be provided and shall be identified on all printed circuit boards or other mounting locations. Parts lists shall be itemized with the respective chassis, module, or circuit wherein parts may be found. A total listing of parts without grouping shall not be acceptable. Schematic circuit drawings shall be furnished that are slow to fade when exposed to sunlight over long periods of time. A developed and fixed printing process, or one of the forms of printing by actual ink transfer, will be acceptable.

Two (2) copies of all the above information shall be provided with the controllers. In addition, three (3) copies of a cabinet wiring diagram, including all auxiliary equipment, shall be supplied with each controller unit. A clear, resealable plastic envelope shall be attached with screws to the inside of each cabinet door for storage of the cabinet wiring prints. This envelope shall be mounted so as to avoid restriction of the circulation of air into and out of the cabinet.

Delete Subsection 730.07 and add the following:

730.07-Training. The Contractor shall provide (with manufacturer personnel), as part of the contract of the signals, a minimum of twenty-four (24) hours of classroom and laboratory instruction on the operation and maintenance of each separate type of controller supplied for three (3) City of Memphis technicians. Instructions shall be on a highly technical level, describing the design and operation of electronic circuitry in great detail as well as demonstrating troubleshooting and repair techniques. The rudiments of dial systems and basic solid-state theory are below the level of the instruction required by this specification. This instruction shall begin at a time requested by the City and approved by the Engineer, and shall be conducted at facilities provided by the Contractor.

Add the following to Subsection 730.16:

Cable Hangers

All cable and conductors running in a pole shall be hung with a strain relief hanger-gripper from the "J" hook in the top of the pole before leaving or after entering the pole through a weatherhead, entering a Mast arm, signal head, push button, or controller cabinet. Cable(s) entering or leaving via the pole foundation shall be hung in a strain relief hanger-gripper if the cable(s) rises more than 2.5 meters (8 feet) above the foundation. The cable and conductors shall be in one or more hanger-grippers with the gripper distributing the weight over a minimum of 300 millimeters(one foot).

Entry Bushings

All entry or exit points through field-drilled holes in poles, pedestals, or mast arms at the point of attachment of vehicle or pedestrian heads shall be tapped and shall have a threaded PVC stub extending 50 millimeters (2 inches) beyond the outside surface to protect the cable and conductors from sharp edges or corners and to maintain cable alignment, in conformance with the Plans.

Delete Subsection 730.19 and substitute the following:

The sealant is intended to protect the detector loop wire against ambient environment and roadway conditions.

General:

1. The sealant shall be a one-part electrometric compound requiring no mixing, measuring or application of heat prior or during its installation.
2. The sealant must provide compressive yield strength to withstand normal vehicular traffic as well as sufficient flexibility to withstand normal movement in asphalt and concrete road pavement.
3. The sealant shall have flow characteristics which insure complete encapsulation of the wires.
4. The sealant shall not run out of the detector saw-cut in sloped areas during or after application.
5. The sealant shall enable vehicular traffic to pass over the properly filled saw-cut immediately after installation.
6. The cured sealant shall be landfill disposable in accordance with environmental protection agency requirements.
7. The sealant shall have the following physical properties:

Physical Properties of the Uncured (wet) Encapsulant

Property	Requirement	Test Procedure	ASTM Reference
a. Weight	1.2-1.27 kg/l (10.0-10.6 lbs/gal)	Kilograms/Liter (Weight/gallon)	D 1875
b. Total solids by Weight	75% min.	Determination of non-volatile content	D 2834
c. Viscosity	5,000-85,000 cps	Viscosity	D 1048B
d. Drying Time	Touch: 24 hrs. max.	Tack-Free Time	D 1640
e. Non-Flow	70% min.	Retention Test	---

Physical Properties of the Cured Encapsulant

Property	Requirement	Test Procedure	ASTM Reference
a. Hardness (Indentation)	60-85	Rex hardness	D 2240
b. Tensile Strength	5515 kPa min. (800 psi min.)	Tensile and Elongation	D 412A
c. Elongation at Break	400-700%	Tensile and Elongation	D 412A

Delete Subsection 730.24 and add the following:

730.24-Signal Heads. The Contractor shall provide and install vehicle and pedestrian signals as shown on the Plans. Each signal face shall consist of one or more signal sections, each containing an optical unit, lens, main housing, door and visor and designed and constructed so as to fit rigidly and securely together, one above the other to present a clean appearance and provide a weathertight enclosure for the optical and electrical equipment. These signal heads shall meet the requirements of the latest Institute of Transportation Engineers Standards for "Adjustable Face Vehicle Traffic Control Signal Heads," the "Adjustable Face Pedestrian Signal Head Standard," the National Electrical Code, and the Manual on Uniform Traffic Control Devices where applicable. Each signal head assembly shall be supplied complete with an incandescent traffic signal lamp bulb and ready for operation with the connection of field wiring. Signal heads shall be covered or "bagged" on installation until all work at the intersection has been completed, tested, accepted, and the signal turned on for traffic. At the time of turn-on of the signal, any old signals shall be covered or immediately removed.

Materials

The housing and door of each signal section shall be fabricated from corrosion-resistant U.V. stabilized Polycarbonate resin material. The moldings shall be a minimum of 2.3 millimeters (0.090 inches) thick and be ribbed for additional strength at point of high stress. Additional thickness shall be provided as necessary to eliminate light transmission through the housing, door, visor, or backplate.

Visors and backplates shall be fabricated from corrosion-resistant U.V. stabilized Polycarbonate resin material. Visors shall have a 2.5 millimeters (0.100-inch) minimum thickness. Backplates shall have a 3.2 millimeters (0.125-inch) minimum thickness.

Construction

Wiring. Signal head leads shall be 0.82 square millimeter (No. 18 AWG) stranded with 105 degrees C Thermoplastic insulation. A separate white (common) lead shall be wired to each socket shell; and a colored lead, corresponding to the color code specified in the Plans, shall be wired to each socket terminal. Leads shall be of sufficient length to allow connection to the terminal block specified herein. Each complete signal head shall be provided with a minimum 4-point terminal block, properly mounted in a signal section. Stud type terminal blocks shall have not less than 6 millimeters (1/4") edge clearance to any portion of the stud. Exterior wiring shall have a 360 degree drip loop in advance of entering the head.

Housing. The housing of each section shall be a one-piece, corrosion-resistant, Polycarbonate resin molding with integral sides; top and bottom; free of voids, cracks, inclusions, or blow holes; and furnished with provisions for mounting of a backplate. The top and bottom of the housing shall have an opening 50 millimeters (2-inches) in diameter to accommodate standard 38 millimeter (1-1/2 inch) pipe, with no other opening in the top or bottom of the housing. Individual signal sections shall be fastened together, one above the other into a complete signal face, by means of plated nuts, bolts, and washers in such a manner that any section may be rotated about a vertical axis and positioned at an angle with respect to an adjacent section. The opening hub shall have 72 circumferential serrations to secure each section in its orientation, adjustable in 5-degree increments, and prevent its inadvertent rotation. A six-position labeled barrier terminal block shall be provided in each signal face for the purpose of field connections. The barrier terminal shall be installed in the circular yellow or yellow arrow section of each signal face. If the face has neither of these sections, the terminal block shall be installed in the uppermost section of the head. There shall be provisions for the attachment of a 6 millimeters (1/4-inch) tether line to the bottom of each span wire-mounted signal head employing a wire rope clip (Crosby #G450, Oliver #9072, Chance #6480 or equal) attached to the pinnacle. A pinnacle shall be provided to close all 50 millimeter (2-inch) openings in each housing which will not otherwise be sealed from the weather when installed with the specified mounting hardware.

Door. The housing door of each signal section shall be a one-piece, corrosion-resistant Polycarbonate resin molding; free of voids, cracks, inclusions, or blow holes. The outer

face of the door shall have four (4) holes equally spaced about the circumference of the lens opening to accommodate the secure mounting of the signal head tunnel visor. The visor shall fit flush against the door, and no light shall leak between the door and the visor. Two stainless-steel hinge pins shall attach the door to the housing, one in the upper left corner and one in the lower left corner of the door. Two stainless-steel wing nuts or screws, one in the upper right corner and one in the lower right corner of the door, shall be used for opening the door and closing it tight against the housing. The wing screws or nuts shall be installed to prevent their accidental removal or falling out. The removal of the hinge pins and the operation of the wing nuts or screws shall not require the use of tools.

Optical System. The optical system shall consist of a lens, reflector, and lamp socket. The system shall be designed to minimize sun phantom and eliminate light spillover. Prefocused, incandescent lamps shall be the light source for all signals. Signal lamps for 200 millimeter (8 inch) lenses shall be clear, 595 rated initial lumen output, with a minimum life of 6,000 hours. Signal lamps for 300 millimeter (12 inch) lenses shall be clear, 1750 rated initial lumen output, with a minimum life of 6,000 hours. All vehicle signal lenses shall be glass and shall conform to the latest standards of the Institute of Transportation Engineers and American National Standards Institute optical specification. All reflectors shall be of ALZAK aluminum construction. The lamp socket shall be of Bakelite construction. Lamp replacement shall be accomplished without the use of tool or the removal of the lens or reflector. The socket shall be fixed-focus and permit its rotation a full 360 degrees to any position to orient bulb filament openings. The socket shall be securely held in the reflector so as not to loosen, rotate, or fall out under vibration of traffic and wind movement of the signal head. The lamp socket shall be provided with two coded 0.82 square millimeter (#18 AWG) copper wire leads. The leads shall be fitted with insulated spade wire terminals and be of sufficient length to make field connections at the barrier terminal block.

The vehicular and pedestrian signal lens, signal lamp socket, and reflector shall form a sealed module with molded neoprene gaskets holding the sealed optical module securely in the signal door. The gasket shall provide a seal to prevent moisture, dust, and road film contamination from entering the optical module and the signal housing.

Visors. Each signal door shall be fitted with a corrosion-resistant Polycarbonate resin tunnel visor. 200 millimeter (eight-inch) signals shall have visors a minimum of 175 millimeters (7-inches) long; 300 millimeter (12-inch) signals shall have visors a minimum of 240 millimeters (9-1/2 inches) long. The visor shall be flat black inside and outside. The visors shall be attached to the door at four equally spaced locations with four plated screws or four bayonet-type self-locking tabs integrally formed with the visor. The visor shall be preformed into a fixed cylindrical shape of the proper diameter to be installed around the lens.

Directional Louvers. Where shown on the Plans, louvers shall be furnished and installed in the hoods of the signal head sections designated. Directional louvers shall be so constructed as to have a snug fit in the signal hoods. The outside cylinder and vanes shall be constructed of a non-ferrous metal or galvanized sheet

steel. Louvers shall be painted with two coats of black enamel as specified in these specifications.

Backplate. Each signal head assembly, so required by the Plans, shall be equipped with a backplate with a minimum width of 125 millimeters (5-inches) with rounded corners. Stainless-steel screws shall be provided for mounting to the signal housing. The backplate shall consist of one or more pieces fabricated from corrosion-resistant, flat Polycarbonate resin material colored flat black front and back.

Legends. Pedestrian heads shall be fitted with lenses that, when illuminated, shall provide a Portland Orange "DONT WALK" in the top section and a Lunar White "WALK" in the bottom section, all conforming to the I.T.E. Standard for "Adjustable Face Pedestrian Signal Heads." The remainder of the lens shall be black and opaque. When not illuminated, the legends shall not be distinguishable.

Traffic signal lenses shall be circular, red, yellow, or green in color and 200 or 300 millimeter (8-inch or 12-inch) nominal diameter, as specified. No legend shall be permitted. Arrow lenses shall be circular, 300 millimeters (12-inches) in diameter, green or yellow in color, and be opaque except for the arrow legend. If an arrow lens is only applicable for one orientation; i.e., left, straight, or right, this information shall be indicated in a permanent and appropriate manner on the lens but without impairing the optical properties of the lens.

Mounting Hardware. Spanwire suspension fitting with cable entrance shall be a one piece malleable iron casting, minimum wall thickness 5 millimeters (3/16-inch), and free of flash and voids. The cable entrance shall have a plastic bushing with a minimum inside diameter of 32 millimeters (1-1/4 inches). The suspension fitting shall provide six separate, clevis pin positions for balancing the signal assembly. The thickness of the solid casting in this suspension area shall be a minimum of 16 millimeters (5/8-inch). A hex head threaded malleable iron lock nipple shall be provided for attaching the signal head to the bottom of the suspension fitting for one-face signals or to the top bracket of multiface signal brackets.

The mounting hardware for each signal face shall include a nylon, serrated, 72-tooth lock ring with full locking pins and a circular neoprene gasket for weather sealing.

All openings in signal heads, top or bottom which are not otherwise utilized for signal mounting, shall be closed with a hex ornamental pinnacle assembly complete with circular neoprene gasket and malleable iron hex lock nut. No conduit lock nuts are permitted.

Spanwire Suspension Clamp Assembly, where required, shall consist of a galvanized, malleable iron spanwire clevis saddle, 16 millimeters (5/8-inch) diameter plated steel clevis pin with cotter key, two 13 millimeters (1/2-inch) plated steel "U" bolts with nuts and washers (no "J" bolts are permitted), and a galvanized malleable iron cable locking bar, all fitted to the diameter of the guy span as specified in the Plans. Galvanizing to meet ASTM A 153.

Balance Adjustor required for each spanwire suspended signal head shall be supplied with a malleable iron balance adjustor complete with steel I-bolt and steel clevis pin with

cotter key to be installed between the spanwire suspension clamp and the suspension fitting with cable entrance.

Brackets, where required, shall consist of a malleable iron center outlet body, schedule 40 pipe, elbows, serrated fittings, and other hardware as required to provide a multiface signal head assembly with internal wiring raceways to each face as specified.

Spanwire Bottom Bracket, where required, shall consist of 65 x 3 millimeter (2-5/8" x 1/8") steel brace with an arm fitted with a pinnacle, neoprene washer, and malleable iron hex lock nut for each signal face to be accommodated (conduit lock nuts not acceptable). An attachment fitting for 6 millimeter (1/4-inch) tetherwire shall be mounted at the center of the bracket.

Polycarbonate Side of Pole Bracket, where required, shall be one-piece molding with internal wiring raceway for banding or lag screw attachment to steel or wood poles. Brackets shall be designed to withstand 160 km per hour (100 mph) wind loading on it and the signal head. Each bracket shall have an integrally molded 72-tooth serrated ring for signal head positioning and come complete with 38 millimeter (1-1/2 inch) nipple, hex lock nut, pinnacle, neoprene washer, and one 1/4-inch interlocking shim for plumbing signals.

Elevator Plumbizer, where required, shall be malleable iron or bronze alloy for mast arm installation, with internal wire raceway, sized to fit a 38 millimeter (1-1/2 inch) tenon, complete with three set screws and one through bolt with nuts and lock washer, complete with serrations to lock signal position to be installed between the red and yellow signal sections.

Slip Fitter Collar, where required, for top post mounting shall be malleable iron, including one vertical 38 millimeter (1-1/2 inch) nipple with hex lock nut; two 38 millimeter (1-1/2 inch) threaded horizontal entrances; and three set screws for attachment to the post. All horizontal entrances not used for attaching signal brackets shall be closed with a pinnacle and neoprene washer.

Color, Finish, and Painting

Polycarbonate resin hardware shall have color impregnated throughout the material. The finish shall be smooth and unflawed. Signal head parts shall be colored as follows:

a. Vehicle Head:

- Housing - Federal Yellow
- Door - Flat Black
- Tunnel Visor - Flat Black inside and out
- Backplate - Flat Black front and back
- Pole Bracket - Federal Yellow

b. Pedestrian Head:

Housing - Federal Yellow

Door - Black

Tunnel Visor - Flat Black inside and out

Pole Bracket - Federal Yellow

All metal hardware, except those specified as galvanized, plated, or stainless steel shall be painted Federal Yellow. The metal parts shall be painted with a primer coat and a finish coat of the best quality oven-baked enamel. Lenses, reflectors, gaskets, and Polycarbonate parts shall not be painted.

Signal Head Installation - Signal heads shall be installed with the faces completely covered until the entire installation is ready for operation.

Delete the section under Controller Cabinets in Subsection 730.25 and substitute the following:

Cabinet

Cabinets shall be provided for each controller installed by the Contractor. The cabinet installed by the Contractor shall be equipped with a radio interference filter installed at the electric service line input. The filter shall provide a minimum electrical noise attenuation of 50 decibels over the range of 200 kilohertz to 75 megahertz.

Surge Protection. The controller assembly shall conform to requirements of NEMA TS 1, part 2 - "Environmental Standards and Test Procedures". No cabinet surge protection or line filters shall be considered in providing the required transient protection of NEMA Part 2 (Reference note on NEMA Part 2, Page 6, Figure 2-2). Each 120 VAC electromechanical relay in the cabinet, flash transfer, signal monitor, etc., shall be suppressed with a 150-volt, 20-amp Varistor across it to ground.

The Cabinet AC service must be provided with the following surge protection:

1. Unit must be a series hybrid type rated at 20,000 amps (8 x 20 microsecond) 20 times.
2. The protector must be provided with terminals as defined below:
 - a. Main line (AC line first stage terminal)
 - b. Main neutral (AC neutral input terminal)
 - c. Equip line in (AC line second stage input terminal, 10 amps)
 - d. Equip line out (AC line second stage output terminal, 10 amps)
 - e. Equip neutral out (neutral terminal to protected equipment)
 - f. GND (earth connection)

3. The equip line in and quip line out terminals must be separated by a 200 microhenry (minimum) inductor rated to handle 10 amps AC service.
4. The first stage clamp must be between main line and GND terminals.
5. The second stage clamp must be between equip line out and equip neutral.
6. Main neutral and equip neutral out are connected together internally and must have a gas discharge tube rated at 20 KA between main neutral and GND terminals.
7. Main line and equip line terminals are isolated internally.
8. If gas discharge tubes are utilized for the first stage clamps, each tube must have a minimum of 0.15 OHM follow-current limiters in series.
9. Peak clamp voltage; 350 volts at 20 KA (voltage measured between equip line out and equip neutral out terminals. Current applied between main line and GND terminals with GND and main neutral terminals externally tied together).
10. Response time: voltage in 9 above can never exceed 350 volts.
11. Protector must be epoxy encapsulated in a flame retardant material.
12. Continuous service current: 10 amps @ 120 VAC RMS.

Pin Connectors. Electrical connections between the control unit and the cabinet wiring harness(es) shall be accomplished using one or more "MS" type multiple pin connectors at the controller (NEMA type) and insulated spade wire terminal connectors at the cabinet terminal blocks. The pin connectors and function pin assignments shall be in accordance with Tables 1, 2, and 3. All functions developed within the control unit for existing or future expanded phasing, up to the maximum capability of the controller, shall be available at the cabinet terminals for greatest operational flexibility. All functions and pin assignments required by NEMA shall be provided as a minimum. Additional functions and features, either required by these specifications or offered by the manufacturer, shall be provided through the pin connector on otherwise spare positions.

TABLE 1

CONNECTOR A

Alphabetical Listing of Pin Assignments

Pin	Function	Pin	Function
A	Spare 1	f	Phase 1 Vehicle Call Det
B	+24V DC External	g	Phase 1 Ped Call Det
C	Voltage Monitor Output	h	Phase 1 Hold
D	Phase 1 Red Driver	i	Force Off Ring 1
E	Phase 1 Don't Walk Driver	j	Ext Min Recall All Phases
F	Phase 2 Red Driver	k	Manual Control Enable
G	Phase 2 Don't Walk	m	Call to Nonactuated I
H	Phase 2 Ped Clear	n	Test Input A
J	Phase 2 Walk	p	AC+
K	Phase 2 Vehicle Call Det	q	Spare 3
L	Phase 2 Ped Call Det	r	Coded Status Bit B Ring 1
M	Phase 2 Hold	s	Phase 1 Green
N	Stop Timing Ring 1	t	Phase 1 Walk
P	Inhibit Max Term Ring 1	u	Phase 1 Check
R	External Start	v	Phase 2 Ped Omit
S	Interval Advance	w	Omit All Red Clear Ring 1
T	Spare 2	x	Red Rest Mode Ring 1
U	AC-	y	Spare 4
V	Chassis Ground	z	Call to Nonactuated II
W	Logic Ground	AA	Test Input B
X	Flashing Logic Output	BB	Walk Rest Modifier
Y	Coded Status Bit C Ring 1	CC	Coded Status Bit A Ring 1
Z	Phase 1 Yellow	DD	Phase 1 On
a	Phase 1 Ped Clear	EE	Phase 1 Ped Omit
b	Phase 2 Yellow	FF	Ped Recycle Ring 1
c	Phase 2 Green	GG	Max 2 Selection - Ring 1
d	Phase 2 Check	HH	Spare 5
e	Phase 2 On		

TABLE 2

CONNECTOR B

Alphabetical Listing of Pin Assignments

Pin	Function	Pin	Function
A	Phase 1 Next	f	Phase 4 Next
B	Spare 1	g	Phase 4 Omit
C	Phase 2 Next	h	Phase 4 Hold
D	Phase 3 Green Driver	i	Phase 3 Hold
E	Phase 3 Yellow Driver	j	Phase 3 Ped Omit
F	Phase 3 Red Driver	k	Phase 6 Ped Omit
G	Phase 4 Red Driver	m	Phase 7 Ped Omit
H	Phase 4 Ped Clear Driver	n	Phase 8 Ped Omit
J	Phase 4 Don't Walk Driver	p	Overlap A Yellow Driver
K	Phase 4 Check	q	Overlap A Red Driver
L	Phase 4 Veh Call Det	r	Phase 3 Check
M	Phase 4 Ped Call Det	s	Phase 3 On
N	Phase 3 Veh Call Det	t	Phase 3 Next
P	Phase 3 Ped Call Det	u	Overlap D Red Driver
R	Phase 3 Omit	v	Spare 4
S	Phase 2 Omit	w	Overlap D Green Driver
T	Phase 5 Ped Omit	x	Phase 4 Ped Omit
U	Phase 1 Omit	y	Spare 5
V	Ped Recycle Ring 2	z	Max 2 Selection - Ring 2
W	Spare 2	AA	Overlap A Green Driver
X	Spare 3	BB	Overlap B Yellow Driver
Y	Phase 3 Walk Driver	CC	Overlap B Red Driver
Z	Phase 3 Ped Clear Driver	DD	Overlap C Red Driver
a	Phase 3 Don't Walk Driver	EE	Overlap D Yellow Driver
b	Phase 4 Green Driver	FF	Overlap C Green Driver
c	Phase 4 Yellow Driver	GG	Overlap B Green Driver
d	Phase 4 Walk Driver	HH	Overlap C Yellow Driver
e	Phase 4 On		

TABLE 3

CONNECTOR C

Alphabetical Listing of Pin Assignments

Pin	Function	Pin	Function
A	Coded Status Bit A Ring 2	i	Phase 5 Green Driver
B	Coded Status Bit B Ring 2	j	Phase 5 Walk Driver
C	Phase 8 Don't Walk Driver	k	Phase 5 Check
D	Phase 8 Red Driver	m	Phase 5 Hold
E	Phase 7 Yellow Driver	n	Phase 5 Omit
F	Phase 7 Red Driver	p	Phase 6 Hold
G	Phase 6 Red Driver	q	Phase 6 Omit
H	Phase 5 Red Driver	r	Phase 7 Omit
J	Phase 5 Yellow Driver	s	Phase 8 Omit
K	Phase 5 Ped Clear Driver	t	Phase 8 Veh Call Det
L	Phase 5 Don't Walk Driver	u	Red Rest Mode Ring 2
M	Phase 5 Next	v	Omit All Red Ring 2
N	Phase 5 On	w	Phase 8 Ped Clear Driver
P	Phase 5 Veh Call Det	x	Phase 8 Ped Green Clear Driver
R	Phase 5 Ped Call Det	y	Phase 7 Don't Walk Driver
S	Phase 6 Veh Call Det	z	Phase 6 Don't Walk Driver
T	Phase 6 Ped Call Det	AA	Phase 6 Ped Clear Driver
U	Phase 7 Ped Call Det	BB	Phase 6 Check
V	Phase 7 Veh Call Det	CC	Phase 6 On
W	Phase 8 Ped Call Det	DD	Phase 6 Next
X	Phase 8 Hold	EE	Phase 7 Hold
Y	Force Off Ring 2	FF	Phase 8 Check
Z	Stop Timing Ring 2	GG	Phase 8 On
a	Inhibit Max Termination Ring 2	HH	Phase 8 Next
b	Spare 1	JJ	Phase 7 Walk Driver
c	Coded Status Bit C Ring 2	KK	Phase 7 Ped Clear Driver
d	Phase 8 Walk Driver	LL	Phase 6 Walk Driver
e	Phase 8 Yellow Driver	MM	Phase 7 Check
f	Phase 7 Green Driver	NN	Phase 7 On
g	Phase 6 Green Driver	PP	Phase 7 Next
h	Phase 6 Yellow Driver		

TABLE 4

CONNECTOR D

Alphabetical Listing of Pin Assignments

Pin	Function	Pin	Function
1	TBC On Line (Sys Det #1)	20	Set Clock (Sp Status #5)
2	Dial A (Sys Det #7)	21	Dimmer (Sp Status #6)
3	Dial B (Sys Det #8)	22	Dial A (Sys Out 7)
4	Split A (Sys Det #5)	23	Dial B (Sys Out 8)
5	Split B (Sys Det #6)	24	Split A (Sys Out 5)
6	Offset 1 (Sys Det #2)	25	Split B (Sys Out 6)
7	Offset 2 (Sys Det #3)	26	Offset 1 (Sys Out 2)
8	Offset 3 (Sys Det #4)	27	Offset 2 (Sys Out 3)
9	Remote Flash	28	Offset 3 (Sys Out 4)
10	Preempt 1	29	Flash (Sys Out 1)
11	Preempt 2	30	Auxiliary 1
12	Preempt 3	31	Auxiliary 2 or any Preempt
13	Preempt 4	32	Auxiliary 3 or Det Reset
14	Conflict Flash Status	33	Logic Ground
15	Manual Flash Status	34	Optional Serial Comm. 1
16	Alt Seq A (Sp Status #1)	35	Optional Serial Comm. 1
17	Alt Seq B (Sp Status #2)	36	Optional Serial Comm. 2 Reserved-1
18	Alt Seq C (Sp Status #3)	37	Optional Serial Comm. 2 Reserved
19	Alt Seq D (Sp Status #4)		

Signal Conflict Monitor

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 9 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

Cabinet Material

Pole mounted cabinets (required for two and three phase non-expandable controllers) shall be fabricated from cast aluminum or welded sheet aluminum or a combination of both. All welds shall occur on the inside surfaces of the cabinet to maintain a clean appearance.

Base mounted controller cabinets shall be installed as shown and fabricated from welded sheet aluminum or welded, copper bearing, 14 gauge (min.) sheet steel painted inside and out with zinc chromate primer and two coats of high grade aluminum paint. All welds shall occur on the inside surfaces of the cabinet to maintain a clean appearance.

1. Front Door.

The cabinets shall have a right-hinged front-opening door, which shall include substantially the full area of the cabinet front and one auxiliary police door-in-door for access to emergency controls. The main door shall be equipped with a positive hold-fast device to secure the door in at least two open positions--one position being approximately 90 degrees open and the other at 120 degrees or more. The hold-fast device shall be easily secured and released without the use of tools. Each door shall be furnished with a neoprene rubber door sealing gasket to assure the weatherproof integrity of the cabinet doors when closed. The main cabinet door shall employ two or three heavy duty hinges which shall be welded to the cabinet and door with hinge pins of 6 millimeter (1/4-inch) diameter (minimum) stainless steel. No "piano" hinges or riveted construction shall be acceptable. The police panel door shall employ hinges meeting the above requirements.

2. Front Door Lock.

The main door shall have a pin-tumbler cylinder lock, conforming to the City of Memphis Master Key as registered with the Corbin Lock Company. The Memphis Key Code shall be furnished with the approval of the equipment. The auxiliary police door shall be furnished with a standard police subtreasury lock. One (1) key for each lock shall be provided with each controller cabinet.

3. Frame.

- a. Base mounted cabinets shall be furnished for multi-phase controllers which have a frame capable of providing four (4) to eight (8) phases. All controllers supplied with railroad preemption equipment shall be furnished in base mounted cabinets. All hardware for mounting on a concrete foundation shall be furnished including Hot Dip Galvanized anchor bolts, nuts, washers, and template. All other controllers shall be furnished in pole-mounted cabinets.
- b. Pole mounted cabinets for two phase and three phase non-expandable controllers shall be equipped with brackets for stainless steel banding to either wood or steel pole mounting.

4. Ventilation.

All cabinets shall be furnished with a thermostatically operated, roof mounted electric exhaust fan. Pole mounted cabinet fans shall be capable of moving 5.6 cubic meters (200 cubic feet) of air per minute at cabinet temperature above 37 degrees C (100 degrees Fahrenheit). Base mounted cabinets shall have fans rated at 5.6 cubic meter per minute at 37 degrees C (200 CFM at 100 F). The fan shall be equipped with long lasting permanently lubricated bearings for constant unattended operation. The exhaust fan shall be mounted in a rain-tight housing attached to the cabinet top. The thermostat shall be adjustable from 20° C to 70° C (70° F to 160° F).

For pole and base mounted cabinets the inlet ventilation openings, located in the lower part of the cabinet, shall be screened and fitted with a fiberglass, furnace-type, replaceable air filter of adequate size and capacity to pass a volume of air equal to or greater than the rated capacity of the fan. The air filter supplied shall be a type and size which is readily available commercially.

5. Dimensions.

All cabinets for the controllers shall be consistent with the following minimum and maximum dimensions and equipment locations:

- a. Top Shelf positioned to allow a minimum of 100 millimeters (4-inches) above controller to top of cabinet and 100 millimeters (4-inches) on each side of controller to the sides of the cabinet.
- b. Second Shelf positioned approximately 200 millimeters (8 inches) below the top shelf to allow for a 150 millimeter (6-inch) high amplifier with a 50 millimeter (2-inch) space between top of amplifier and bottom of top shelf
- c. Width of Cabinet must allow at least 50 millimeters (2-inches) clearance on each side of the set of amplifiers from the terminal strips mounted on the sides of the cabinet.
- d. Third Shelf (optional) required if the top and second shelves will not accommodate the conflict monitor, amplifiers, pre-emptor (if required), and other equipment as required. The third shelf shall allow for the same top and side clearances as on the second shelf.
- e. Load Switches to be mounted below the bottom shelf at the left rear of the cabinet. With the load switches in their bases, a minimum clearance of 50 millimeters (2-inches) shall be maintained below the bottom shelf and from the terminal blocks mounted on the sides of the cabinet.
- f. Field Connectors to be made at the bottom rear of the cabinet on horizontal terminal strips. Terminal strip blocks shall be positioned not less than 50 millimeters (2-inches) nor more than 100 millimeters (4-inches) from the cabinet bottom.

- g. Field Loop Connections to be made on terminal strips located on the left wall of the cabinet below the bottom shelf.
- h. Loop Amplifier Cabinet Connections to be made on terminal strips on the left wall of the cabinet at the same level as that of the loop amplifier shelf with connections available for AC+, AC-, logic common, and the appropriate input to the controller for each module.
- i. Cabinet Power Connections to be made on the right wall of the cabinet below the bottom shelf and 50 to 100 millimeters (2 to 4-inches) above the bottom of the cabinet.
- j. The Maximum Outside Dimensions of a base-mounted cabinet (exclusive of mounting flanges) shall not exceed 1425 millimeters (56-inches) in height, 1020 millimeters (40-inches) in width, and 760 millimeters (30-inches) in depth.

Other cabinet facilities shall be furnished as follows:

- a. A minimum of two, fully adjustable metal shelves with brackets to support controller, signal monitor, detector amplifiers, and other accessory equipment. The shelves shall be capable of vertical adjustment through virtually the full height of the cabinet.
- b. Electric service line terminals for 6-gauge copper with 30-ampere circuit breaker line protection.
- c. 120-volt duplex convenience receptacle with separate 30- ampere circuit protection.
- d. Insulated barrier terminals to be used for detector field connections, AC power supply for amplifiers, and controller inputs from amplifiers.
Quantities of terminals shall be for the above connections as follows:

2 phase controller - 24 terminal positions

3 & 4 phase controllers - 36 terminal positions

5 to 8 phase controllers - 48 terminal positions

- e. Grounded neutral buss with multiple screw terminals for 12- gauge copper signal neutrals and 4-gauge copper earth connection.
- f. Insulated barrier terminals (two positions per phase module) for connection of 12-gauge copper pedestrian detector field wires. A 36-volt zener diode shall be installed across each pedestrian detector field terminal to ground.
- g. Insulated barrier terminals (five positions per phase module) for connection of 12-gauge copper signal display field wires. A 150-volt, 20-amp Varistor shall be installed across each signal field terminal to ground.
- h. Insulated barrier terminals (four positions) for connection of 12-gauge copper system interconnect lines. A 150-volt, 20-amp Varistor shall be installed across each system interconnect terminal to ground.

- i. Insulated barrier terminals for internal wiring interconnection of all other cabinet accessories and circuitry.
- j. All barrier terminal blocks shall consist of twelve (12) terminal pairs using a minimum ten 32-size screws with the minimum center-to-center distance between terminal pairs being 16 millimeters (5/8-inch). Terminal blocks shall be furnished with an engraved or indelibly printed numbering strip attached with screws to the terminal block. This type and size terminal block shall be provided for all applications including controller inputs and outputs, field connections, and detector connections.
- k. A 120-vac, 20-watt, fluorescent Light fixture mounted on the cabinet ceiling at the front of the cabinet. Fixture shall employ #F20T12/CW20, 20-watt, fluorescent tube. An on-off switch for the light shall be mounted on the inside of the main cabinet door.
- l. Detector micro-switches shall be provided for placing vehicular and pedestrian calls on each individual phase separately. A sufficient number of switches shall be provided to serve the maximum phase capability of the controller unit. All switches are to be permanently labeled and identified.
- m. An on-off power switch shall be mounted on the inside of the main cabinet door to disconnect all equipment in the cabinet from the 120-vac service line current with the exception of the cabinet light and the duplex convenience receptacle.
- n. An automatic/flashing switch shall be mounted on the inside of the main cabinet door to preempt the normal signal display and initiate the specified flashing display. The controller shall continue to operate during this flashing mode.
- o. All cabinet wiring shall be neatly bundled and attached to the sides and back of the cabinet.
- p. All cabinets shall be furnished with a police compartment accessible through the door-in-door. The back side of the compartment extending into the cabinet shall have all exposed electrical facilities enclosed in a protective housing. The police compartment shall be furnished as follows:
 - (1) On-off power switch to operate same as the main on-off switch, above.
 - (2) An automatic/flashing switch with a flashing position to permit the normal red, yellow, and green signal display to be preempted to the flashing operation. Power shall be removed from the controller unit during this flashing mode. Upon resuming automatic operation, the controller display shall be in the pre-programmed start-up orientation.
 - (3) A normal/manual switch so that, when in manual position, this switch shall stop the automatic sequence of the controller and hold the then existing display until manually advanced into the next interval. When in normal position, the automatic controller sequence shall continue.

- (4) A miniature panel connector for connecting a detachable hand-held push button for manual operation. The connector shall have three (3) male pins and mate with a screw on type, coarse threaded, female connector plug.
- (5) A high quality retractile cord with molded hand-held push button with attached connector plug for engaging the connector described above. The retractile cord shall be capable of an extension of 2.1 meters (7-feet) (minimum) and shall be stored in the police compartment when not in use.

6. Expansion.

The cabinet for four to eight phase controllers shall be furnished of sufficient size to accommodate the control equipment described, a coordinating unit, and eighteen (18) loop detector amplifiers. The cabinet for two and three phase controllers shall be sized as above for eight (8) loop detector amplifiers and a coordinating unit.

The cabinet shall have provisions for all additional equipment associated with the future expansion to full functional capability, including but not limited to load switch bases, complete cabinet wiring, field connection terminals, and detector terminals.

Add the following to the end of Subsection 730.37:

Removal and Salvable Equipment. Utility companies will be responsible for the relocation and/or removal of their poles and equipment. The poles and equipment to be removed by the Contractor have been generally noted on the Plans; however, it is the intent of these Specifications to have the Contractor remove any traffic control-related equipment that is in conflict with the installation of the proposed equipment and deliver to the City of Memphis Traffic Signal Shop. All new or temporary signals, shall be removed and stockpiled in such a manner that the removed equipment will not be damaged. Poles shall be removed complete and undamaged. The pole shall be cleaned of any concrete foundation material. Any damage due to negligence on the part of the Contractor because of lack of proper care of equipment shall be cause for the Contractor to replace in kind. The cost of such replacement shall be borne fully by the Contractor without extra compensation. All such removed and salvageable equipment is now and shall remain the property of the City of Memphis.