

ROAD COMMISSION FOR OAKLAND COUNTY

SPECIAL PROVISION  
FOR  
**DIGITAL / ITS TYPE NEMA TS2 CABINET**

RCOC/TOC:JJ

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ORG:05-07-21

**a. Description**

This special provision outlines the Road Commission for Oakland County's specifications for the traffic signal cabinet. The traffic signal cabinet must meet or exceed all requirements of the NEMA Standard TS2-2003 specification. Sections A. through K., as detailed below, are exceptions to the NEMA Standard TS2-2003 specification and are specific to the Road Commission for Oakland County.

**b. Materials**

1. Transfer Switch Assembly.

Each control cabinet must be provided with a transfer switch assembly completely wired.

A. Transfer Switch Compartment.

The compartment door must be flush mounted to the outside of the cabinet, located near the top of the right-hand side wall of the cabinet. The compartment door is to be hinged at the top with provisions that allow the generator cord to be plugged in with the door closed. The door will incorporate a piano type hinge utilizing stainless steel hinge pins. The hinge is to be attached in such a manner that no rivets or bolts are exposed. The door must be equipped with a lock, which can be operated by the main cabinet door key. The door opening must be a minimum 9" high by 6" wide to facilitate plugging in the generator cable. The door must include a slot with a sliding cover plate to allow the generator cable to remain plugged in while the door is closed and locked.

B. Transfer Switch Wiring.

A 30 Amp (minimum) rocker-type switch must be provided and installed in the generator transfer switch compartment. When in the "Utility" position power from the load side of the Main circuit breaker is to be routed to the line side of all secondary circuit breakers. When the transfer switch is in the Generator position, power from the transfer switch compartment generator inlet is to be routed to the line side of all secondary circuit breakers except any designated for illuminated signs. An indicator lamp within the compartment must be included and wired such that it is illuminated only if the transfer switch is in the Generator position and Utility power is supplied to the cabinet. A 30A twist-lock flanged inlet with a NEMA rating for L5-30P must be installed in the generator transfer switch compartment.

## 2. Cabinet Lifting Ears.

Each control cabinet must include a pair of removable lifting ears. The lifting ears are to have the same finish as that provided on the control cabinet. They are to be provided installed on the top right-hand side and top left-hand side of the cabinet in such a manner as to support the cabinet in an upright position when lifted. Each lifting ear must be attached by a single 9/16" (or larger) stainless steel carriage type bolt with nut and washer located on the inside of the cabinet. This is to facilitate rotation of the lifting ear into the storage position without complete removal of the fastening hardware.

## 3. Cabinet Fan Quantity.

The size M30 cabinet is to be equipped with one fan; the size 6 cabinet is to be equipped with two fans. All fans to be provided per NEMA Standard TS2-2003 Section 7.9 specifications. All cabinets must be equipped with an electric heater system. The heater must be a 150W, touch-safe heater, with no motors, convection style heater. The heater must be controlled by a hygrostat that can sense the ambient temperature and humidity in the cabinet.

## 4. Cabinet Ventilation Filter Type.

The filter must meet UL Class 2 filter requirements and include a disposable cardboard type filter. The cabinet must include a louvered metal cover over the air filter. The louvers must be pointed down to direct any incoming water away from the cabinet equipment.

## 5. **Power Distribution.**

Panel must be provided as follows:

### A. Circuit Breakers.

Provisions must be made for mounting and wiring up to nine circuit breakers in the terminal facility. A quantity of nine circuit breakers must be provided with ampacity as noted in table 1. Circuit breakers are to be installed on the power panel near the top, arranged from left (Circuit Breaker 1) to right.

**Table 1: Power Panel Circuit Breakers**

<b>Circuit Breaker ID</b>	<b>Size (Amps)</b>	<b>Label</b>	<b>Function</b>
1	30	MAIN	Service Connection
2	20	LOAD SWITCH	Signal Bus
3	20	FLASHER	Flash Power
4	15	ELECTRONIC	CU and MMU
5	15	MISC	Fans, heater, cabinet lights
6	15	ENCLOSURE	Digi/External Enclosure/Other
7	15	PWR STRIP	Power Strip/Other
8	15	AUX	Illuminated Signs/Other
9	15	AUX	Illuminated Signs/Other

The main circuit breaker must be wired to protect the entire facility and must be identified as the "MAIN" breaker. The load side of the Main circuit breaker must feed the "Utility" termination of the transfer switch (if used) and the line side of the Aux circuit breakers. The Load Switch breaker is connected to the load side of the solid-state bus relay and must provide power to the load switches. The Flasher breaker must have the flasher connected to its load side. The miscellaneous breaker must have the cabinet fan, light, and door mounted duplex GFCI receptacle connected to its load side. The AUX breakers must be available to powering auxiliary devices such as illuminated signs. The circuit breakers must be capable of manual operation with markings to indicate rating and whether it is in the open or closed position. Square D series QO circuit breakers (or approved equal) are to be used and mounted on a QON2ACL (or approved equal) breaker block.

Provide an encapsulated 3-electrode gas tube surge arrestor, engineered to protect equipment from lightning and induced surges. The 3-electrode gas tube surge arrestor must be installed in a line arrestor line fashion. The arrestor must have a current rating of 40,000 amp (8/20 impulse).

The M30-ITS and the 6- ITS cabinets will include an additional 30-amp circuit breaker mounted on the main cabinet power panel, utilizing a single phase of the AC power to power the ITS compartment devices. Two 15 Amp and one 10 Amp circuit breakers will be provided in the ITS compartment, wired to the load side of the 30 Amp breaker. This 30 Amp breaker will have a separate surge protection device wired to its load side. The breakers in the ITS portion of the cabinet must be mounted in a way so that there are no exposed electrical connections.

**B. Service Connections.**

The incoming AC power service must terminate in compression fittings capable of accepting a #4 AWG or #6 AWG conductor for AC+ and AC- and accepting a #8 AWG conductor for safety (Earth/Chassis) ground. The AC+ line must terminate directly to the main circuit breaker. The AC- and safety ground lines must terminate directly to their respective bus bars.

**6. Detector Assembly.**

All cabinets must include a 20-channel detector assembly that meets NEMA Standard TS2-2003 Section 5.3.4 specifications as a minimum. The detector assembly must accommodate 16 channels of vehicle detection and an additional 4 channels of pedestrian detection push button isolation, or 4 channels of emergency vehicle priority control cards.

**A. Detector Rack.**

The BIU must be located in the first (furthest to the left) slot in the detector rack. The 16 channels of vehicle detection must be located immediately to the right of the BIU. The four channels of pedestrian detection (or emergency vehicle preempt card(s)) must be located in the last (furthest to the right) slot positions.

**B. Detector Panel.**

The detector panel must be provided installed on the lower left wall of the cabinet with components mounted on 1/8-inch (0.125-inch) sheet aluminum. Components on the detector panel include a modular detector input printed circuit card, push button terminal block, ground bus, common bus, and I/O expander harness. All components are to be accessible for ease of maintenance.

(1) The detector panel printed circuit card must have termination points for 16 loop inputs, a DB37F connector that mates with the detector cable, cabinet power supply inputs, and jacks that accept loop detector surge arrestors.

(2) The push button terminal block(s) must be provided located near the bottom of the detector panel. 30-amp terminal blocks are to be provided for push button terminations, with a minimum of 4 positions available for push button common and 2 positions for each of the 4 channels of inputs. A minimum 30 amp 4 position terminal positions must be provided to connect the push button isolator outputs to the BIU pedestrian detector inputs. On the M30 facility, isolator outputs 1 thru 4 are to be wired to BIU pedestrian detector inputs 1 thru 4 respectively. On the Size 6 facility, isolator outputs 1 thru 4 are to be wired to BIU pedestrian detector inputs 2, 4, 6, and 8 respectively. Provisions must be made to easily convert the 4 channels of push button isolation to 4 channels of emergency vehicle priority control.

(3) A ground bus bar is to be provided below the push button terminal block that will accept 4 – 16 American Wire Gage (AWG) copper conductors. This bus bar must be connected to the ground bus on the power panel with an 8 AWG conductor. A minimum of 12 open termination positions to be available for field wiring ground connections.

(4) A common bus bar is to be provided below the push button terminal block that will accept 4 –16 American Wire Gage (AWG) copper conductors. This bus bar must be insulated from the cabinet and be connected to the common bus on the power panel with an 8 AWG conductor. A minimum of 12 open termination positions must be available for field wiring common connections.

(a) Wiring to be provided from the push button terminal block to an I/O expander harness for a minimum of push button inputs 5, 6, 7, 8 to terminal facility BIU #2.

#### **7. Flash-Normal Switch.**

A flash-normal switch must be provided in a panel on the inside of the front cabinet door. The switch and wiring must provide flashing operation as defined for police panel flash-normal switch. This switch must be labeled "flash-normal".

#### **8. Cabinet Lighting Fixture.**

Install two LED lighting panels to illuminate the cabinet.

A door switch to activate the light(s) when the door is opened and off when door is closed must be provided. Install one lighting panel above the top shelf and install the second to the bottom of the lower shelf's storage drawer. Each panel must provide at least 450 lumens of light and consume no more than 15W of power. Install a third LED lighting panel in the ITS compartment, if an ITS compartment is required.

Wire the switches and lights to the Miscellaneous circuit breaker.

#### **9. Load Resistors.**

Size 6 cabinets must include a .125-inch-thick panel installed on the side wall of the cabinet with surface/panel mount power resistors installed. Provide 50 watt, 3,000 ohm, resistors wired to load switch 1, 3, 5, 7, 13, 14, 15, and 16 green and yellow outputs. A clear heat resistant panel is to be provided over the resistors.

#### **10. Auxiliary Input/Output Assembly.**

When called for on the plans an Input/Output assembly is to be provided, consisting of a Bus Interface Unit (BIU), rack, and interface panel with harness.

##### **A. BIU.**

A BIU must be provided that meets Section 8 of NEMA Standard TS2-2003 specifications.

**B. Rack.**

A 2 position BIU rack with address easily programmable is to be provided. The rack must be shelf mounted and not exceed 5" H, 6" W, and 8" deep.

**C. Interface Panel.**

A modular printed circuit type interface panel with wiring harness is to be provided to access all inputs/outputs available on terminal facility BIU 3 and 4 as specified in NEMA Standard TS2-2003 Section 5.3.1. The panel is to be provided with # 8 size terminal blocks for termination of input/output.

**11. SDLC Patch Panel.**

To facilitate SDLC communications among devices in the control cabinet, a 6-position printed circuit patch panel and cabling is to be provided installed in each cabinet. The patch panel is to be mounted to the left-hand side wall of the cabinet. A quantity of 5 SDLC communications cables are to be provided complete with 15 pin connectors and latching clips to connect from each device to the patch panel. Communications cable must meet NEMA Standard TS2-2003 Section 5.3.3 specification.

**12. TRAFFIC CONTROL CABINET****A. Scope.**

This section defines the minimum acceptable requirements for a series of cabinets that differ in size, to house the CU and related devices. Provide the base mounted size 6 cabinet unless the plans indicate otherwise. Cabinets to be supplied meeting NEMA Standard TS2-2003 Section 7 specifications.

**B. Outline Dimensions.**

Minimum outline dimensions are shown in Table 1. These dimensions are outside dimensions exclusive of hinges, handles, overhang(s), vent housing, and adapters. Cabinet heights are measured to the lowest point of the top surface of the cabinet. The combined overhangs of the four sides of the cabinet must not exceed 4 inches.

**TABLE 1: Minimum Outline Dimensions (larger dimensions are acceptable upon written approval)**

<b>Size</b>	<b>Height (inches)</b>	<b>Width (inches)</b>	<b>Depth (inches)</b>
M30	51	30	16
M30-ITS	61	30	16
6	56	44	25.5
6-ITS	66	44	25.5

### C. Cabinet types and mountings.

#### (1) Base Mounted (Size 6 and 6-ITS).

The size 6 cabinet must be constructed so that it can be mounted on a 30 inch by 48 inch foundation. Anchor bolt mounting provisions for four 3/4 inch bolts on 40 3/4 inch centers (side-to-side) on 18 1/2 inch centers (front-to-back).

#### (2) Pole Mounted/Base Mounted (M30 and M30-ITS).

Cabinets intended for side of pole mounting must be provided with any necessary adapter, exclusive steel banding, to permit mounting to a 4 1/2 inch or larger diameter pole. The adapter must accommodate lag bolts up to 3/8 inch and steel banding up to 1 inch wide. Mounting points must be provided at or near the top and bottom of the cabinet. The adapter must have provisions for two holes spaced horizontally, which will have a center-to-center distance of 3 1/2 inches. Cabinets must be furnished without conduit holes. In addition, the cabinet must be provided with a removable bottom to enable it to be pole or base mounted.

### D. Materials.

The traffic control cabinet must be constructed of aluminum alloy. The aluminum material must be a minimum of 1/8 inch alloy sheet, ASTM B 209, 5052-H32 or equivalent.

### E. Finish and Surface Preparation.

(1) Both the cabinet and base extension are to be unfinished both inside and outside, unless the plans indicate a finishing treatment.

### F. Top Surface Construction.

The cabinet must be manufactured to prevent the accumulation of water on its top surface.

### G. Conduit Entrances.

All conduit entrances must be sealed with a non-toxic, non-corrosive, non-staining non-hardening pliable duct seal compound. The duct seal compound must be moisture resistant and prevent the infiltration of moisture, dust and debris. The duct seal compound must be sufficiently applied to fully seal the conduit entrance. Cap any unused conduit entrances.

## H. Doors.

### (1) Main Cabinet Door.

The cabinet must have a main door which permits access to all equipment within the cabinet. Doors must be hinged on the right side of the cabinet as viewed from the outside facing the cabinet door opening. They must have a handle made of one piece construction and swing away from the locking mechanism.

### (2) Hinges.

All cabinet doors must incorporate a piano type hinge utilizing stainless steel hinge pins.

### (3) Door Stop.

The cabinet door must be provided with a door stop which holds the door open as a minimum at 90 degrees and 180 degrees ( $\pm 20$  degrees).

### (4) Latches and Locking Mechanism.

(a) All cabinets must incorporate a main door lock, Corbin No. 15481RS or Pelco (Type II) SM-1025 or equivalent, constructed of nonferrous or stainless materials, which must operate with a Traffic Industry conventional #2 key, Corbin No. 1R6380 or Pelco (Type II) SM-0198-2 or equivalent. A minimum of two keys must be included for the main door of each cabinet.

(b) The cabinet door(s) must be provided with a three-point latch. The top and bottom must have rollers to secure the door in a closed position.

(c) When in the locked position, the lock must prevent the movement of the three-point latching mechanism.

(d) The cabinets must be provided with a means of externally padlocking the latching mechanism. A minimum of 3/8 inch diameter lock shackle must be accommodated.

### (5) Door Opening.

The main door opening of all cabinets must be at least 80 percent of the area of the side which the door closes, exclusive of the area of plenums.

### (6) Switch Compartment.

(a) A hinged switch compartment door must be mounted to the outside of the main cabinet door. The door must permit access to a switch panel but must not allow access to exposed electrical terminals or other equipment within the cabinet.



(b) In order to allow for the switch controls and storing of the manual control cord (if used), the switch compartment with the door closed must have minimum internal dimensions of 3 1/2 inches high, 7 1/2 inches wide, and 2 inches deep. Additionally, the volume must not be less than 70 cubic inches.

(c) Switch compartment doors must be equipped with a lock, which can be operated by a police key, Corbin Type Blank 04266 or Pelco type SM-0200 long keys, or equivalent. A minimum of two keys must be included for the switch compartment of each cabinet.

#### I. Shelves.

The cabinet must be provided with two shelves for supporting the control equipment. The shelves must be at least 10 inches in depth. All cabinets must have a provision for positioning shelves to within 12 inches of the bottom of the cabinet and to within 6 inches of the top of the cabinet in increments not more than 1/2 inch.

#### J. Ventilation and Heater System.

All cabinets must incorporate a ventilation system to provide for the circulation of external air through the enclosure to remove excess heat, fumes, or vapors.

##### (1) Fan System

(a) Fan Type. The electric fan used in the cabinet must have a capacity of at least 100 cubic feet of air per minute. The fan must be rated a minimum of 100 ft<sup>3</sup> per minute as designated by NEMA Standard TS2-2003, Section 7.9.1.

(b) Fan Controls. All cabinets must have a thermostat device to control the operation of the fan(s). The device switch-on point must be manually adjustable at least in the range from 80 degrees Fahrenheit to 120 degrees Fahrenheit. The device must have a differential between its switch-on point and its switch-off point. This differential must not be greater than 25 degrees Fahrenheit. The device must be located in the inside of the top of the cabinet not lower than 6 inches from the top of the cabinet.

(c) The filter size will be according to the provisions for the type of cabinet as stated in NEMA Standard TS2-2003, Section 7.9.2.3 and must be a replaceable pleated air filter with a Minimum Efficiency Reporting Value (MERV) rating of 5 or higher as defined by the ASHRAE 52.2-1999 specification.

## (2) Heater System

(a) Provide a DIN Rail mounted touch-safe 150 W Convection style Heater for all cabinets.

(b) The heater must be operated via an electrical hygrotherm device. The hygrotherm device must have an adjustable temperature range from 32 to 140 degrees Fahrenheit, adjustable humidity range from 50 to 90% RH. The output relay must have a rate of 6 amps resistivity with a SPDT relay type.

(c) Mount the heater within 18 inches of the cabinet bottom away from any warm temperature sensitive equipment.

## K. Intelligent Transportation System (ITS) Compartment

(1) When called for on the plans include a hinged compartment door mounted to the outside front of the cabinet, above the main door. The door will provide access shelf and DIN rail mounted ITS devices and electrical power components to power these devices.

(2) The ITS compartment door will have a minimum opening size of 8" high by 27" wide for the M30-ITS cabinet and 8" high by 41" wide for the 6-ITS cabinet. The depth of the compartment will be the full depth of the cabinet.

(3) The ITS compartment door is to be equipped with a Type 2 lock, cut for the Traffic Industry standard #1 key. A minimum of two keys must be included for the ITS compartment.

(4) Accommodations will be made to allow free air movement from the ITS compartment to the lower signal controller compartment.

(5) The ITS compartment will include U-channels mounted to the side of the compartment for mounting panels and DIN rails. Provide 2 channels on each side wall and on the back wall.

(6) Flexible conduit must be field installed from the bottom of the main signal cabinet section to the upper ITS compartment. The flexible conduit must be installed in such a way that wires and cables can be run in to the ITS compartment from the outside of the cabinet without accessing the main signal compartment.

## L. Terminals and Facility.

### (1) Scope.

This section defines the minimum acceptable requirements for terminal and facilities to interconnect the related devices within a traffic control cabinet. The terminal facility must conform to NEMA Standard TS2-2003 Section 5, Type 1 specifications.

### (2) Mechanical Construction.

The terminal facility must conform to the following mechanical requirements.

#### (a) Terminal Identification.

All terminals must be permanently identified in accordance with the cabinet wiring diagram. Where through-panel terminal blocks are used, both sides of the panel must have the terminals properly identified with the terminal position number.

Identification must be permanently attached and close as possible to the terminal strip and must not be affixed to any part which is easily removable from the terminal block panel.

Each input or output terminated on a terminal block must be identified on the front of the panel by position number and function terminology (e.g., Ph 1 Red, Ph 2 Hold, etc.). The same identification must be used consistently on the cabinet wiring diagram.

#### (b) Component Identification.

All components which make up the basic terminal facility must be permanently identified in accordance with the cabinet wiring diagram. The following components are considered part of the basic terminal facility:

- (i) Load Switch Sockets.
- (ii) Flash Transfer Relay Sockets.
- (iii) Flasher Socket.
- (iv) Main and Auxiliary Circuit Breakers.
- (v) Radio Interference Suppressor and Surge Protector.
- (vi) Solid State Signal Power Relay.
- (vii) Power Terminal Bus Bars.

Where through-panel components are used, both sides of the panel must have the components properly identified by relative symbols (e.g., FRI, LS1, etc.).

Identification must be permanently attached and as close to the component as possible and must not be affixed to any part which is easily removable from the panel.

Each component must be identified on the front of the panel by symbol and function terminology (e.g., LF1 Filter, BR1 Signal Bus, etc.).

(c) Load Switch and Flasher Support.

Load switch and flasher bases must be so designed and constructed as to receive all such devices which may be manufactured to the maximum size requirements permitted under the NEMA TS2-2003 Standards Publication. All support(s) must be provided so that, as a minimum, it is supporting the flasher and load switch of the maximum size at some point(s) between 3 inches and 7 inches from the panel. At least 90 percent of the area beneath the load switch or flasher must be open to allow for the free flow of air across the load switches or flasher. There must be no obstruction within 1 inch above or below the units within the open area.

(d) Load Switch, Flasher, Flasher Transfer Relay, BIU Positions.

Wired load switch, flasher, flash transfer relay, and BIU sockets must be provided on the main load bay in the quantities listed below:

**TABLE 2: Load Switch, Flasher, Flash Transfer Relay and BIU Socket Quantities**

<b>Configuration</b>	<b>Load Switch</b>	<b>Flasher</b>	<b>Flash Transfer</b>	<b>TF BIU</b>
M30 and M30-ITS	12	1	6	2
6 and 6-ITS	16	1	8	2

The flasher socket must be wired for a Type 3 solid state flasher conforming to Section 6.3 of NEMA Standard TS2-2003 specifications. Flashing of even numbered load switch output indications must be placed on one circuit and flashing for odd numbered load switch output indications must be placed on the other circuit. It must be possible to flash either the amber or red indication on any load switch outputs. It must be possible to easily change the flash indication from the front side of the panel using simple tools without the need to unsolder or re-solder connections.

Rack style mounting must be provided on the main panel to accommodate the two required terminal facility BIU's, consisting of a dual-row 64-pin female DIN 41612 Type B connector for each BIU rack position and card

guides for top and bottom edges of the BIU. Terminal Facilities BIU mounting must be an integral part of the main panel.

(e) Terminal Blocks.

Terminal blocks must have mechanical characteristics to properly support the wiring connected without warping the terminal block. All materials including screws and threaded portions used in terminals and terminal blocks must be stainless steel or nickel plated brass.

(i) Field Terminal Blocks.

Field terminal blocks for all inputs and outputs for a fully expanded CU must be included. These blocks must be either single terminal type with through-panel connection on the rear side of the mounting panel or double binder head screw terminals. Either type of terminal block used must be of the correct ampacity for the application. Minimum acceptable ratings are 30 amperes, 300 V, with 10 - 32 binder head screws.

(ii) Control Terminal Blocks.

Control terminal blocks for inputs and outputs of the CU, MMU, flash transfer relays, load switches, etc., must be included. These blocks must be either single terminal type with through-panel connections or double binder head screw terminals. Either type of terminal block used must be of the correct ampacity for the application. Minimum acceptable ratings are 15 amperes, 250 V, with 6-32 x 1/4 inch pan or binder screws.

Control terminal blocks for controller unit inputs and outputs must be provided on the main terminal facility panel and must be single terminal type with through-panel connections with a minimum acceptable rating of 15 amperes, 250 volts, with 6-32x1/4 pan or binder screws

Terminal blocks for monitor control circuits and main terminal facility panel electrical distribution must be provided on the main terminal facility panel and be a single terminal type with through-panel connections with minimum acceptable rating of 15 amperes, 250 volts, with 6-32x1/4 pan or binder screws. These terminals must be organized in a logical manor on the right-hand side of the load switches.

(iii) Detector Terminal Blocks.

Detector terminal blocks for loop and push button inputs must be included. These blocks must be either single terminal type with through-panel connections or double binder head screw terminals. Either terminal block must be of the correct ampacity for the application. Minimum acceptable ratings are 20 amps, 250 V with 8 - 32 pan or binder screws.

(f) Wiring Harnesses.

The CU, Cabinet Power Supply, and MMU harnesses must be neatly arranged and provided with the flexibility for the connectors to reach at least 40 inches from the top of the terminal block panel which must be mounted directly below the CU shelf. The harness connectors must not have any sharp edges and the stress relief attachment screws must not extend greater than 1/4 inch beyond the stress relief.

Terminal positions must be provided, completely wired and neatly arranged, providing access to inputs and outputs in the MMU. All MMU inputs must be terminated. Type select and port one disable inputs must be terminated.

Terminal positions must be provided, completely wired and neatly arranged, providing access to all inputs and outputs for the cabinet power supply.

Terminal positions must be provided, completely wired and neatly arranged, providing access to all inputs and outputs defined in NEMA Standard TS2-2003 Section 5.3.1 for Type 3 and Type 4 facilities. Additionally Input/Output terminal positions must be provided for quantity 8 pedestrian detect inputs.

Terminal positions must be provided, completely wired and neatly arranged, providing access to the CU TS2 inputs and outputs including AC line, AC neutral, Ground, Logic Common, and Fault Monitor. This harness is to be wired to a 55 position MSA type socket for connection directly to the controller unit without the need for an adapter.

(g) Power Distribution panel must be provided per NEMA Standard TS2-2003 Section 5.4.1 The panel must contain one 10-ampere circuit breaker to provide overload protection to the CU, MMU, BIU, +12/24 VDC cabinet power supply, and detection devices. It must also contain one main circuit breaker of 35 or 40 ampere, to provide over-load protection to the signal and flash buss load. All breakers must have line and load terminals clearly labeled.

The signal bus must be connected to the incoming AC line through a mercury contact switch or a solid-state control device functionally equivalent to the NEMA Standard TS2-2003 Section 5.4.2.3 specified contact switch. The terminals for AC line and AC neutral to the cabinet must be capable of accepting a No. 6 wire. With the CA 10 ampere and Main 35-40 ampere circuit breakers off (tripped), all units inside the cabinet and the intersection display must be off. With the 10-amp breaker on and main 35-40 ampere circuit breaker off, the signal output must be off and the major units within the cabinet must function. With the 10-amp breaker off and main 35-40

ampere circuit breaker on, the intersection must be in flash mode and all units within the cabinet will be off.

(i) Cabinet Surge Protection and Filtering.

A RFI Line Filter must be installed on the power panel per NEMA Standard TS2-2003 Section 5.4.2. The ampacity of the filter must be equal to or greater than the ampacity of the main circuit breaker. The filter must attenuate signals both line to load and vice versa. The attenuation in both directions to be a minimum of 50 decibels over the frequency range of 200 kHz to 75 MHz.

A Line Arrestor device must be installed and wired on the power panel per NEMA Standard TS2-2003 Section 5.4.2. The line arrestor is jack mounted using a 12 pin Beau type connector for ease of replacement and includes two LEDs for failure indicators. This device must be rated for 20,000 amps peak current, less than 3 nanosecond response time, and provide a minimum of 15 amps continuous current filtered power.

Provide a switched, surge protected, metal enclosed outlet strip. For the M30-ITS and 6-ITS include an additional outlet for the ITS compartment. This outlet strip is to provide a minimum 3,300 joule suppression rating and is wired to the load side of one of the 15 amp compartment breakers. Ensure the outlet strip is mounted on the rails on the back of the cabinet in the compartment.

Provide a 3-electrode gas tube surge arrestor to the line of the compartment breakers which will be used for miscellaneous or auxiliary uses. The gas tube arrestor must be rated at 40,000 amps (8/20 impulse) with a 300-500 VDC break down voltage.

(ii) Solid State Signal Power Relay.

The terminal facility must include a SPST-NO signal power relay wired to provide power from the main circuit breaker and RFI filter to the AC signal power bus bar and load switches. The solid-state relay must be energized to provide power to the signal bus and have ampacity of 75 amps. It must provide zero voltage switching from 47 - 63Hz. The Signal Power Relay must be mounted on a panel on the lower right side of the controller cabinet and easily accessible for replacement.

(iii) AC-Common Bus Bar.

The AC-common (Neutral) must be terminated on a solid metallic multi-terminal bus bar that will accept 4 - 16 American Wire Gage (AWG) copper conductors. This bus bar must be insulated from the cabinet. Separate wires must be run from this bus bar to each unit or group of similar units in the terminal facility which requires AC-common

connection. A quantity of one conductor only must be allowed in each termination position. A minimum of 12 open termination positions must be available for field wiring common return connections. A single lug attached to the Common Bus that accepts 2 AWG conductors must be provided.

(iv) Safety Ground Bus Bar.

The safety (Earth/Chassis) ground must be terminated on a solid metallic multi-terminal bus bar that will accept 4 - 16 AWG copper conductors. This bus bar must be connected to the cabinet. A quantity of one conductor only must be allowed in each termination position. A minimum of 12 open termination positions must be available for field wiring ground connections. Separate wires must be run from this bus bar to each unit or group of similar units in the terminal facility which requires safety ground connection. A single lug attached to the Ground Bus that accepts 2 AWG conductors must be provided.

(v) In addition to the three breakers and surge protected outlet strip, ensure the upper ITS compartment includes: GFI outlet wired to the load side of one of the 15 amp ITS compartment breakers, a minimum 6 position ground bus, LED lighting mounted above the air plenum above the door power via a door switch and the 10 amp ITS compartment breaker, and a minimum 12" long piece of DIN rail mounted across the channels on the back of the cabinet.

(h) Conductors.

All conductors used in the terminal facility wiring must be #22 AWG, or larger, with a minimum of 19 strands. Conductors terminated on the AC-Common Bus Bar and Safety Ground Bus bar must be tinned and a minimum size of #16 AWG. Conductors must conform to Military Specification MIL-W-16878, Type B or D. The insulation must have a minimum thickness of 10 mils and must be nylon jacketed polyvinyl chloride or must be irradiated cross-link polyvinyl chloride. Conductors #8 AWG must be UL Type THHN. All conductors used in the terminal facility wiring must conform to the following color-code requirements:

(i) The AC-common conductor of a circuit must be identified by a continuous white color.

(ii) The safety (Earth/Chassis) ground conductor of a circuit must be identified by a continuous green color or a continuous white color with one or more green stripes.

(iii) The AC line power conductor of a circuit must be identified by a continuous black color.



(iv) The low-level DC (+24 or less) conductor of a circuit must be identified by a continuous blue color.

(v) Other conductors, not conforming to one of the above, must be identified by any continuous color not defined above.

(i) Wiring (Power Distribution within the Facility).

All terminal facility wiring must be neat, firm, and routed, where practical, to minimize crosstalk and electrical interference.

All terminal facility conductors must be of sufficient size to carry the maximum current of the circuit or circuits they are provided for. They must be sized based on the ampacity ratings as follows:

**Table 5: Terminal Facility Conductor Size**

<b>AWG Wire Size</b>	<b>Ampacity Rating</b>
#22	5 Amps
#16	10 Amps
#14	15 Amps
#12	20 Amps
#10	30 Amps
#8	50 Amps

The ampacity ratings are calculated based on the current required to raise the temperature of a single insulated conductor in free air (86 degrees Fahrenheit ambient) to the limit of the insulation and applying a bundle de-rating factor of 0.5 for wires #22 AWG through #10 AWG and a de-rating factor of 0.7 for wires #8 AWG and #6 AWG.

The conductor feeding power from the main circuit breaker to the auxiliary breakers, solid state signal power relay, primary and secondary SPD terminal blocks, and AC+ signal power bus bar must have an ampacity of 40 amps.

The conductor feeding power to the flasher socket must have, as a minimum, an ampacity of 30 amperes.

The conductor feeding power from the AC+ signal power bus bar to each load switch socket must have an ampacity of 10 amperes and must be capable of being easily programmed to supply the load switch from another point or interrupt AC+ signal power to an individual load switch for special applications.

The conductors feeding power from the load switch to the field signal terminals must have an ampacity of 10 amperes.

The conductors feeding power from the flasher socket to the flash transfer relay sockets, which feed flashing power to same, must have an ampacity of 15 amperes. The remaining wires to and from the flash transfer relay socket, which are in the circuit between the load switch socket and the field signal terminals, are covered in the previous paragraph.

(j) Control Circuits.

(i) Flash Transfer Control.

The control circuit to the flash transfer relay sockets must be such as to provide flashing operation when the MMU or optional auxiliary equipment calls for flash (e.g., police panel flash switch and/or maintenance panel). The flash transfer control must also conform to the following:

The flash transfer relay socket must be wired so the coil of the relay(s) must be de-energized for flashing operation. The flash transfer relay sockets must be located in close proximity to the load switches, flasher, and field signal terminals.

(ii) MMU Control.

The MMU must be wired to provide flashing operation when the fault relay de-energizes or if the MMU is disconnected. It must also provide AC line power to the CU by via the Start Delay contacts.

(iii) Logic Common, +24 volts, and AC common must be wired from the source in a "loop" to each load switch so that an open fault at any one point will not prevent the load switches from working properly.

AC common and 120 volts AC to the coils of the Flash Transfer relays must be wired in a "loop" from the source so that an open fault at any one point will not prevent the relays from working properly.

(3) Field Wire Terminal Locations.

The terminal facility must provide Field Wire Terminals located to conform to the following requirements:

- (a) AC Service Hookup. Incoming AC power service must terminate on the right side of the cabinet on the power distribution panel.
- (b) Signal Hookup. Signal wires must terminate on terminal blocks on the back of the cabinet at least 3 inches but not over 6 inches from the bottom of the cabinet.

Signal terminals must be directly accessible from the front of the cabinet. One terminal must be provided for each load switch output.

- (c) All cabinets must incorporate a 16-channel detector rack and panel, configuration #2, as per NEMA Standard TS2-2003 Section 5.3.4

#### (4) Auxiliary Equipment.

- (a) The terminal facility must include provisions for the following equipment in a panel accessible from a police door on the front of the cabinet.

- (i) Signals On-Off Switch.

- A signals on-off switch must be included, installed, and wired. The switch and wiring must energize or de-energize the solid-state signal power relay. AC signal power must not be routed through this switch. The switch must be labeled "Signal-Off". When in the "Off" position, all signal field terminal must be de-energized and the Red Enable input to the MMU must be inactive.

- (ii) Flash Normal Switch.

- A flash-normal switch must be included. When in the Flash position, the flash transfer relays and solid-state signal power relay must be de-energized, resulting in flash being displayed to traffic. Neither AC signal power nor flashing power must be routed through this switch. The switch must be labeled "flash-normal". When the switch is returned to the "Normal" position, the signals must return to the initialization phase and begin cycling.

Operation of the signal-off switch must override this switch. That is, when in the "Off" position, the signal-off switch prevents flashing operation as called for by all flash control circuits.

- (b) Maintenance Panel Options.

- (i) Stop Time Switch.

- A stop time switch must be provided in a panel on the inside of the front cabinet door. The switch and wiring must provide three modes of operation which are:

- 1) Normal.

- "Stop time" to the CU must be provided as required by the MMU.

2) Run.

"Stop time" is prevented from being applied to the CU from other devices.

3) Stop.

"Stop time" is applied to the CU.

This switch must be labeled "Stop-Run-Normal".

(ii) Duplex Receptacle.

A duplex receptacle of a three-wire ground fault interrupter (GFI) type must be provided in a panel on the inside of the front cabinet door per NEMA Standard TS2-2003 Section 5.4.2.6.

(c) Cabinet Lighting.

(i) An LED lighting panel with door actuated switch per NEMA Standard TS2-2003 Section 5.4.2. is to be provided. The LED lighting panel must have an operating temperature range of -40 to 150 degree Fahrenheit. The panel must operate at not more than 9 watts and produce not less than 115 lumens per watt and be rated for a minimum of 90,000 hours of continuous operation.

(5) Prints, Functional Data, and Parts List.

The manufacturer must supply each of the following items with each cabinet:

(a) Two complete set of schematic and wiring diagrams of the cabinet and terminal facilities.

(b) Cabinet mounting diagram.

(c) Complete parts list of cabinet and accessories.

Each of these items must apply directly to the cabinet with which it is applied. One set is to be put in the installed cabinet, and one set is to be furnished to the maintaining agency.

## 2. Traffic Control Cabinet Accessories

A. Scope.

This section defines the minimum acceptable requirements for plug-in accessories for the traffic controller assembly within a traffic control cabinet. Accessories are to be provided in quantities listed in table 6 below.

**Table 6: Accessory Quantities (ea)**

<b>Cabinet</b>	<b>CPS</b>	<b>MMU</b>	<b>Flasher</b>	<b>Flash Relay</b>	<b>Load Switch</b>	<b>BIU</b>
M30 and M30-ITS	1	1	1	4	12	3
6 and 6-ITS	1	1	1	6	16	3

B. A shelf mount Cabinet Power Supply (CPS) is to be provided with each controller assembly and is to adhere to the guidelines of NEMA Standard TS2-2003 Section 5.3.5. The power supply must be encased on all sides so that no circuitry is exposed to the user.

C. A Malfunction Management Unit (MMU) is to be provided with each controller assembly. The MMU and must be in accordance with the standards of NEMA Standard TS2-2003 Section 4. The MMU is to be wired to monitor each load switch output.

D. A two-circuit flasher is to be provided with each controller assembly. The flasher will conform to Section 6.3 of the NEMA Standard TS2-2003 Standards Publication. The flasher must be rated at 15 amperes, double pole with a nominal flash rate of 60 flashes per minute.

E. Flash transfer relays must be provided with each cabinet conforming to the requirements of Section 6.4 of the NEMA Standard TS2-2003 specifications. Quantity provided to conform to Table 6.

F. Load switches must be provided with each cabinet conforming to the requirements of NEMA Standard TS2-2003 Section 6.2 specifications. Quantity provided to conform to Table 6.

G. Bus Interface Units (BIU) must be provided with each cabinet conforming to the requirements of NEMA Standard TS2-2003 Section 8 specifications. Quantity provided to conform to Table 6.

### 3. Exceptions

This specification does not include any proprietary items or devices which would preclude any equipment manufacturer from reproducing equipment to meet these specifications. All technical tolerances, ratings, and technically specified criteria contained within these specifications are currently being met by commercially available equipment. The fact that a manufacturer chooses not to produce equipment to meet these specifications, providing the above criteria are met, will not be considered sufficient cause to adjudge these specifications as restrictive.

#### 4. Guarantee

As a minimum, each control cabinet must be guaranteed against defects in materials and workmanship for a period of 18 months from date of shipment. Details of the manufacturer's guarantees and warranties must be supplied with the bid. The warranty offered by the manufacturer must be assigned to the Road Commission for Oakland County.

#### 5. Packing and Marking

Except as otherwise specified in the request for quotation, each control cabinet must be packed separately in such a manner that there will be no injury or defacement to the control cabinet during transportation to the point of destination. Each carton must be legibly marked with the controller description, purchase order number, and vendor's name.

#### 6. Sampling, Testing and Basis of Acceptance

One or more control cabinets may be selected at random from the shipment and tested in accordance with RCOC methods for compliance with the requirements of these specifications. If so notified by RCOC, the vendor must complete one controller for preliminary testing and inspection to determine compliance with these specifications. If this one control cabinet conforms to these specifications, the vendor will be notified in writing and must furnish the remainder of the order, which will be subject to testing in accordance with RCOC methods. If the preliminary sample does not conform to these specifications, either the order will be canceled or the vendor will be notified, in writing, of all deficiencies so that the necessary changes or corrections to all cabinets on the purchase order may be made. The entire order will then be subject to testing in accordance with RCOC methods.

The Basis of Acceptance is at the sole discretion of the Road Commission for Oakland County. If the cabinet is not found to be acceptable, the rejected cabinet a new cabinet must be provided at no additional cost. The Contractor must provide a detailed accounting (cut sheet) of all equipment supplied with the cabinet.

Acceptance - Provide General Certification per the MDOT's *Materials Quality Assurance Procedures Manual* to the Engineer that the materials meet the requirements specified herein.

#### 7. Patented Processes and Materials

The vendor must defend any and all patent infringement suits resulting from the use of any design, device, material or process, or portion or phase thereof, employed in the manufacture or use of said controllers in accordance with the Department's plans and specifications, and must save harmless and indemnify RCOC on account of any and all such suits or claims for royalties, damages, or costs.

8. Delivery

The pay item must include the cost of delivery to the Road Commission for Oakland County, 2420 Pontiac Lake Road, Waterford, MI 48328.

**c. Construction**

All work must be in accordance with the contract documents.

**d. Measurement and Payment**

The completed work, as described, will be measured and paid for at the contract unit price using the following pay item(s).

<b>Pay Item</b>	<b>Pay Unit</b>
Cabinet, Digital Type, RCOC.....	Each
Cabinet, Digital Type, Salv, RCOC.....	Each
Cabinet, Digital Type, Delivered, RCOC.....	Each
Cabinet, ITS Type, RCOC.....	Each
Cabinet, ITS Type, Salv, RCOC.....	Each
Cabinet, ITS Type, Delivered, RCOC.....	Each

**Cabinet, Digital Type, RCOC (Ea) and Cabinet, ITS Type, RCOC (Ea)** will be measured as a unit. The unit shall be as indicated on plans. The contract unit price each shall be payment in full for installing the traffic signal cabinet, and accessories required to provide the traffic signal control operation as shown on the plans and in accordance with the MMUTCD and this special provision.

**Cabinet, Digital Type, Salv, RCOC (Ea) and Cabinet, ITS Type, Salv, RCOC (Ea)** will be measured as a unit. The unit shall be as indicated on the plans. The contract unit price each shall be payment in full for pick up and installing the controller and cabinet complete on the steel or wood pole or on a concrete foundation (if required) and furnishing and installing all necessary equipment, hardware, conduit risers, sealing of conduit entrances, cable, wiring, necessary rewiring of signal head(s) and grounding all as specified herein and as shown on the plans.

**Cabinet, Digital Type, Delivered, RCOC (Ea) and Cabinet, ITS Type, Delivered, RCOC (Ea)** will be measured as a unit. The unit shall be as indicated on plans. The contract unit price each shall be payment in full for furnishing and delivering to RCOC for set-up of the cabinet as specified herein and as shown on plans. The unit price shall include transporting the cabinet from RCOC to the job site for installation.