

SUPPLEMENTARY SPECIFICATION

Section 16704 (S)

The following supplement adds to Specification Section 16704. Add the following requirements for a Model 336S Traffic Signal Controller Cabinet Assembly and Harnesses without Timer Unit to Section 16704.

MODEL 336S TRAFFIC SIGNAL CONTROLLER CABINET ASSEMBLY
AND HARNESES WITHOUT CONTROLLER TIMER UNIT

TABLE OF CONTENTS

| | <u>PAGE NO.</u> |
|------------------------------------|-----------------|
| 1.0 DESCRIPTION | 2 |
| 2.0 REFERENCE DOCUMENTATION | 3 |
| 3.0 EQUIPMENT SPECIFICATIONS | 4 |
| 3.1 Cabinet Features | 4 |
| 3.2 Cabinet Wiring..... | 7 |
| 3.3 Conflict Monitor..... | 10 |
| 3.4 Surge Protection | 16 |
| 4.0 DOCUMENTATION/SUBMITTALS | 20 |
| 5.0 TESTING..... | 23 |
| 6.0 WARRANTY | 24 |

| | <u>No. of Pages</u> |
|--|---------------------|
| Figure 1 Model 336S Output File | 1 |
| Figure 2 Model 336S Surge Protection Panel | 1 |
| Table 1 C1: Harness#1 Wiring List for 336S Cabinet | 1 |
| Table 2 C4 Harness #1 & #3 Wiring List for Output File | 1 |
| Table 3 Input File Layout..... | 1 |
| Figure 3 Meter Cabinet..... | 1 |
| Figure 4 Meter Cabinet..... | 1 |

SPECIFICATION
FOR
MODEL 336S TRAFFIC SIGNAL CONTROLLER CABINET ASSEMBLY
AND HARNESES WITHOUT CONTROLLER TIMER UNIT

1.0 DESCRIPTION:

- 1.1 This specification defines the minimum requirements for the Contractor to provide and deliver a complete Model 336S Traffic Signal Controller Cabinet Assembly and harnesses, without Controller Timer Unit, to be used by the City of Houston, Texas. These specifications describe the materials necessary to provide standardized rack type Model 336S Traffic Signal Controller Cabinet Assemblies defined by the California Department of Transportation (CALTRANS) Transportation Electrical Equipment Specifications (TEES) to CITY OF HOUSTON.
- 1.2 This specification sets forth the minimum acceptable electrical and mechanical design requirements within which all equipment operates satisfactorily and reliably, and the means by which the equipment shall be tested to determine that it functions properly.
- 1.3 The Contractor shall be responsible for furnishing fully tested and operational equipment.
- 1.4 One (1), Model 336S cabinets shall be provided forty-five (45) days after the Contractor has NTP.
- 1.5 Cabinet dimensions shall be 46"H x 24"W x 22"D.
- 1.6 A complete Model 336S cabinet shall consist of:
- 1 - Set of rails for mounting controller unit
 - 4 - Model 252 AC Isolators
 - 2 - Model 204 Flashers
 - 12-Intelligent Switch Packs
 - 2 - Conflict Monitors

- 1 - Input Files (I)
- 1 - Output File
- 1 - Pull Out Drawer
- 2 - PDA #2 with 206 power supplies
- 4 - Flash Transfer Relays for Output file
- 1 - C1 Harness

2.0 REFERENCE DOCUMENTS

2.1 All equipment furnished shall be new and in addition to the requirements designated elsewhere in this specification, the materials, fabrication and testing of the Model 336S cabinets shall conform to the applicable requirements of the latest issues and addenda, in effect on the date of Notice to Proceed with manufacture of prototype of the following industry codes and standards:

| <u>DOCUMENT IDENTIFICATION</u> | <u>TITLE</u> |
|---|--------------------------------------|
| National Electrical Manufacturer's Association (NEMA) | As Applicable |
| Publication No. TS1-1989 Parts 2, 5, 6, 8, 13, and 15 | Traffic Control Systems |
| Military Specifications MIL-W-16878D Type B/N PVC with Nylon Jacket | |
| TxDOT Materials and Tests Division Manual of Testing Materials | As Applicable |
| American Society of Testing and Materials (ASTM) ASTM A320 B8F | As Applicable Stainless Steel Pin |
| Texas Manual of Uniform Traffic Control Devices (TMUTCD) | As Applicable |
| Electronic Industry Association (EIA) | As Applicable |

| <u>DOCUMENT IDENTIFICATION</u> | <u>TITLE</u> |
|--|---------------|
| Standard RS-232 | As Applicable |
| TxDOT Standard Specifications | As Applicable |
| Underwriter's Laboratory Incorporated (UL) | As Applicable |
| National Electric Code (NEC) | As Applicable |
| American National Standards Institute (ANSI) | As Applicable |
| International Municipal Signal Association (IMSA) | As Applicable |
| California Department of Transportation Transportation Electrical Equipment Specifications | As Applicable |

2.2 In case of conflict with any of the above referenced documents, this specification shall take precedence.

3.0 EQUIPMENT SPECIFICATIONS:

In addition to the requirements of the CALTRANS TEES Specifications, the cabinet assemblies shall conform to the following requirements:

3.1 Cabinet Features

3.1.1 Finish

All Model 336S cabinets shall exhibit a "bare" aluminum finish.

3.1.2 Locks

All main cabinet door locks shall accept No. 2 Corbin keys. All police panel doors shall accept a police master key. Two (2) Corbin and one (1) police master key shall be provided with each cabinet.

3.1.3 Power Supply

All Model 336S cabinets shall be equipped with two (2) PDA 2 power distribution assemblies to generate AC and DC power for all electronic components.

3.1.4 Mounting

Mounting shall be as shown on the plans. Any necessary adapter or mounting hardware shall be included.

3.1.5 Cabinet Pull-Out Drawer

Each Model 336S cabinet shall be equipped with an aluminum storage compartment mounted in the rack assembly with the following dimensions (+/- 1/2 inch): 16 inches wide, 14 inches long, 1-3/4 inches deep. This compartment shall be mounted directly under the controller and shall have telescoping drawer guides to allow full extension from the rack assembly. When extended, the storage compartment shall open to provide storage space for cabinet documentation and other miscellaneous items. The storage compartment shall be of adequate construction to support a weight of forty (40) pounds when extended. The top of the storage compartment shall have a non-slip plastic laminate attached, which covers a minimum of ninety (90) percent of the surface area of the top. The pull-out storage drawer shall be mounted below the space reserved for the controller unit.

3.1.6 Cabinet Light and Door Actuated Switch

Each model 336S cabinet shall include two (2) 15 watt fluorescent lighting fixtures inside the top portion of the cabinet. One (1) lighting fixture shall be mounted in the front and one (1) shall be mounted in the back. The front fixture shall be installed in a manner that maximizes the illumination of the front panels of the rack mounted equipment and minimizes the light shining in the technician's eyes. The back fixture shall be installed in a manner that maximizes the illumination of the back of the rack mounted equipment and minimizes the light shining in the technician's eyes. Door-actuated switches, installed for each cabinet door, shall control each light. The door-activated switch shall provide an input to Pin 54 of the C1 connector to provide an alarm to the controller when the door is open.

3.1.7 Police Panel

3.1.7.1 Model 336S cabinets shall be furnished with a police panel. The police panel shall include a DPDT toggle switch labeled "MANUAL/AUTOMATIC" and a manual push-button switch on a three (3) foot cord. The manual activated switch shall provide an input to Pin 53 of the C1 connector for manual enable. Strain relief shall be provided on the cord to prevent the cord from being pulled loose from the connections. The toggle switch shall have contacts rated for 15 amperes at 120 volts AC. Depressing the manual push-button while the switch is in the "MANUAL" position shall cause the controller to advance to the next interval. Pin 80 of the C1 connector shall provide the interval advance input. It shall be possible to store the manual push-button and cord inside the police panel and close and lock the police panel door without damaging the cord. A FLASH "ON/OFF" DPDT toggle switch shall also be installed on the police panel. No SIGNAL "ON/OFF" switch shall be installed in the police panel.

3.1.7.2 Model 336S cabinets shall have a police panel box 14.25" wide, 4.25" high and 2.25" deep.

3.1.8 Test Switches

Each Model 336S cabinet shall be furnished with a detector test panel consisting of sixteen (16) momentary switches for each detector circuit including eight (8) local detector switches for phases 1 through 8, four (4) pedestrian phases, and four (4) unassigned circuits. The switches shall provide the capability of placing a momentary call on the controller circuit. The detector test panel shall not interfere with the cabinet mounted controller equipment when the door is in the closed position. Detector test switches shall be mounted above the space reserved for the controller unit.

3.1.9 Model 336S Cabinet Air Filter

Fiberglass filters shall be provided for each ventilated cabinet door. All filters shall be 12"x16"x1".

3.1.10 Power Supply Installation

One PDA-2 24V power supply shall be secured at the front panel so that it will not disconnect from the edge connector if the cabinet is jarred or from normal road vibration. A second unit shall be attached in the area below the output file inside an electrostatic protected package.

3.1.11 Connector Cables

The C1 connector cable shall be a minimum of three (3) feet in length.

3.1.12 Input Files (I)

3.1.12.1 The input file layout shall be in accordance with Table 3 Input File Layout.

3.1.12.2 The input file for the Model 336S cabinet shall be located below the drawer and above the PDA-2.

3.1.13 Output File

The output file for the Model 336S cabinet shall be located below the PDA-2.

3.1.14 Labeling

All equipment furnished in the Model 336S cabinet shall be clearly and permanently labeled. Marker strips on the input file racks and the output file racks shall be part of and located on the subject racks. The strips shall be made of material that can be legibly written on with pencil or ballpoint pen.

3.2 Cabinet Wiring

Each Model 336S cabinet wiring shall be wired according to Tables 1 through 3. (Attached to this specification.)

3.2.1 Monitoring of Unused Phases

Odd-phase reds shall be provided with ballast resistor dummy loads. The cabinet shall

not be wired to monitor pedestrian yellow indications. The wiring from the signal monitor for pedestrian yellow monitoring shall be neatly laced and bundled on the back panel.

3.2.2 Red Monitoring

A connector and terminal assembly, designated for monitoring the absence of reds, shall be an integral part of the output file. This cable shall be clad with a tough outer shielded cladding, including strain relief, to protect the cable from cuts and abrasion and shall be neatly bundled to the side of the cage assembly. The connector shall terminate and be compatible with the cable and "C" connector of a Type 170/2070 Conflict Monitor unit capable of monitoring the absence of red.

3.2.3 Diagnostic Testing Shorting Jack

A phone jack, which shall mate with a Switchcraft Model 190 plug, shall be located in the cabinet for automatic cabinet diagnostic testing. This jack shall be easily accessible with all internal components installed. When the plug is inserted, a reset signal, generated by the controller pin at pin C1-102 of the monitor, shall be routed to the external reset input. The jack shall be mounted on the test panel.

3.2.4 Cabinet Interlock

The interlock circuit, as detailed in the CALTRANS Specifications, shall not be installed in the cabinet.

3.2.5 Intelligent Switch Packs

All Model 336S cabinets shall have output files wired to be compatible with Intelligent Switch Packs. For that purpose, Pin 4 of all load switch sockets shall be wired to DC ground; pin 11 shall be wired to AC ground; and Pin 12 on all load switches shall be wired together and then brought to C1 Pin 75 for Fault Output to the Controller. All switch packs shall use a L.E.D. for input and a L.E.D. for output on each circuit. Each circuit shall be rated for a maximum 15-amp load per circuit.

3.2.6 Field Wiring Terminations

Model 336S cabinets shall have six (6) mm 12 position (Phoenix thru-panel part # 1861251) installed through the back of the output file (See Figure 1, Model 336S Output File, attached to this specification). Twelve (12) 6 position plugs (Phoenix Part #1804946) shall be furnished docked in the output files with two (2) spare six position plugs furnished as spares. The order shall be neat and logical. Final layout of the back of the output file and the termination panel for each cabinet requires approval from CITY OF HOUSTON'S Project Manager or designee prior to fabrication.

3.2.7 Conflict Monitor Wiring

Model 336S Cabinets shall be wired to accept and implement all of the features of the conflict monitor specified in these specifications.

3.2.8 Hardwire Copper Interface

Model 336S Cabinets shall be wired to accept and implement 120 volt hardwire interconnect systems.

- Standard color sequence for wires in positions 1-8 shall be:

White / Blue / Red / Green / Yellow / Black / White Black/ Blue Black

- Install two (2) 8-position slider link blocks labeled SB1, 1-8 and SB2, 1-8 rated (250V / 20 amps) on the J-Panel.
- Install one (1) 8-position fuse block labeled FB, 1-8 rated (250V / 20 amps) with 8-3amp AGU fuses (250V) on the J-Panel adjacent to SB1 and SB2.
- Install #12 AWG jumpers between line side of FB1 to line side of SB1 corresponding terminals 1 through 8. Jumper wires shall be identified according to the standard color sequence.

- Connect load side of FB to the input file as shown below maintaining the color sequence standard.
 - FB-3 to J12D
 - FB-4 to J12J
 - FB-6 to J11D
 - FB-7 to J11J
- *J11 and J12 pins E and K to Chassis Ground
- Install #12 AWG color sequenced jumpers from line side SB1, 1-8 to line side SB2, 1-8
- All labels shall be machine printed, clearly readable, and of material that shall resist fading, cracking, discoloration, or detaching with age.

3.2.9 Flash Sense and Stop Time

The stop time and flash sense circuit shall be wired to eliminate the use of a DC isolator in 114 slot. It shall route directly from the monitor to the timer.

3.2.10 Opticom

All Model 336S cabinets shall be wired for 3M Opticom™ detection equipment in Slots 12 and 13 of File I of the input file.

3.2.12 Detector Amplifier Communications

DETECTOR AMPLIFIER COMMUNICATIONS: The input file shall support communications with detector amplifiers via the conventions established in Table 6.2 of NEMA TS-2 1998. Input file must be capable of functioning with Naztec 723 TX/I and Canoga 422 T two channel detector amplifiers.

3.3 Conflict Monitors

One unit shall be installed in the rack system. A second unit shall be attached in the area below the output file inside an electrostatic protected package. Each conflict

monitor shall meet the requirements of the CALTRANS Specifications, plus the additional requirements as specified in the following:

3.3.1 Absence of Red Monitoring

The conflict monitor shall be capable of monitoring for the absence of voltage on all of the inputs of a channel (defined here as red, yellow, and green). If an output is not present on at least one input of a channel at all times, the unit shall begin timing the duration of this condition. If this condition exists for less than 700 ms, the unit shall not trigger. If this condition exists for more than 1000 ms, the unit shall trigger as if a conflict had occurred, causing immediate transfer into a flashing mode, and stop time to be applied to the controller. A red signal input shall require the presence of a minimum of 60 (+/-10) V AC to satisfy the requirements of a red indication. The red input signals shall be brought into the conflict monitor through an auxiliary connector on the monitor's front panel. A similar connector shall be provided on the output file, and a removable harness connecting the two (2) shall be provided. An indicator on the front panel of the monitor shall be provided to identify the triggering of the monitor in response to the absence of red condition.

3.3.2 Dual Indication Monitoring

The conflict monitor shall be capable of monitoring the presence of voltage for the green and yellow, green and red or red and yellow inputs of a channel. If an output is present on more than one (1) channel at any one (1) time, the unit shall begin timing the duration of this condition. If this condition exists for less than 250 ms, the unit shall not trigger. If this condition exists for more than 700 ms, the unit shall trigger as if conflict had occurred, causing immediate transfer into a flashing mode, and stop time to be applied to the controller. A red signal input shall require the presence of a minimum of sixty (60) V AC to satisfy the requirements of a red indication. A green or yellow signal input shall require the presence of a minimum of twenty-five (25) V AC to satisfy the requirements of a green or yellow indication. The feature shall be available on a per channel basis with user definable global value.

3.3.3 Short Yellow Monitoring

The conflict monitor shall be able to detect a channel that has not provided an adequate yellow clearance interval during a green to yellow to red sequence. The minimum yellow clearance time shall be adjustable between 3.0 and 4.0 seconds as a minimum. Yellow monitoring shall be on a per channel basis with user definable global value.

3.3.4 Monitor Functions

The conflict monitor unit shall meet all requirements of Chapter 4, Section 1, 2, 3, and 5 of the CALTRANS specifications, and all requirements specified below. The monitor shall have Red Fail, Switch or (Dual Indication) and Yellow Fail (Sequence) capabilities and be designed to operate with a 170, 2070, or ATC controller.

3.3.5 Monitor Display

The conflict monitor shall trip for the following conditions and shall have a display on the front panel that clearly indicates the following tripped conditions:

- 24 V DC Fail
- Conflict
- Watchdog Error
- Switch or Dual Indication
- Red Fail
- Yellow or Sequence Fail

The front panel display may be a L.E.D. or character display.

3.3.5.1 The following definitions shall be used to define the tripped conditions:

- 24VDC Fail as defined in the TEES, Chapter 4, Section 2, 4.2.1 through 4.2.7.
- Conflict as defined in the TEES, Chapter 4, Section 5, 5.1.1 through 5.1.8.

- Watchdog as defined in the TEES, Chapter 4, Section 3, 4.3.1 through 4.3.4.
- Red Fail - Monitor will go to a trip condition, the front panel display shall indicate the tripped condition during the absence of an AC signal on the Green, Yellow and Red outputs (Dark Signal Head).
- Switch or Dual indication Fail - Monitor will go to a tripped condition when a green and yellow, red and green, or red and yellow circuit is detected for any one (1) channel. The front panel display shall indicate the tripped condition.
- Yellow Fail or Sequence Failure - Monitor will go to a tripped condition if the yellow interval is skipped or a yellow time shorter than 2.6 seconds. The front panel display shall indicate the tripped condition.

3.3.6 Monitor Operating Ranges

The operating Ranges for the Conflict Monitor are:

- Conflict (typical fault) 350 ms
- VDC failure (typical fault) 400 ms
- Watchdog (typical fault) 1000 or 1500 ms
- Red Fail (typical fault) 800 ms
- Dual Indication (typical fault) 400 ms
- Sequence or Yellow Fail (typical fault) less than 2.6 seconds

The monitor shall disable if the line voltage drops to 98 V AC or less, and enable at 103 V AC or more.

3.3.7 Other Monitor Requirements:

- 3.3.7.1 The conflict monitor shall be microprocessor controlled and use non-

volatile memory devices for firmware and software functions.

- 3.3.7.2 A RS232 port shall be installed on the front panel of the conflict monitor for communicating with a portable upload/download unit, or for communications through a port on the front panel of the controller unit.
- 3.3.7.3 When a conflict monitor trips and a power interrupt occurs after the trip condition, the monitor, when reactivated, shall show the tripped condition.
- 3.3.7.4 The conflict monitor shall be capable of loading the diode matrix into a non-volatile memory device and used in one (1) of the following methods:
- Allow the user to run the intersection without the diode card in place. If this method is used, then the monitor shall be capable of checking memory and going to a fault condition when a bit error occurs.
 - When the diode matrix is loaded into memory, the memory will constantly compare with diode card and a fault condition will occur if memory does not match the diode card matrix.
- 3.3.7.5 When the conflict monitor enables after power-up or from a brown out condition, one (1) of the following procedures shall be performed.
- The monitor shall enable after 103 volts rms is achieved, flash interval of a least four (4) seconds is timed but does not exceed ten (10) seconds, and the watchdog circuit has completed at least five (5) transitions between true and false state.
 - The user shall be capable of programming a delay time from 0-15 seconds or a start-up flash time from 0-15 seconds. The delay/flash time programmed by the user shall start after 103 volts rms is achieved. The start-up interval shall terminate and the monitor shall enable after time out of the delay/flash time.

3.3.7.6 The monitor must come with compatible communications software capable of interfacing with the monitor via the RS232 port on the front panel from a laptop computer or via a RS232 connector cable through the controller unit. The communication protocol for interfacing with the conflict monitor shall be furnished to CITY OF HOUSTON'S Project Manager or designee within one hundred twenty (120) days of notice to proceed.

3.3.7.7 The conflict monitor communications software shall be capable of showing the unit. The communications software shall be capable of displaying the following data:

- A) Fault type
- B) Field status (Must update current status continuously)
- C) AC line voltage (Must update current status continuously)
- D) Status of Red enable
- E) Previous fault date
- F) Program card Matrix
- G) Yellow disable Jumpers (if applicable)
- H) Switch settings per channel (as applicable)
- I) Option switches
- J) Watchdog (enabled or disabled)
- K) Current time
- L) Temperature (Must update current status continuously)

M) Event Logs

- 3.3.7.8 The conflict monitor shall be capable of storing fault conditions into memory as events. When an event is stored into memory, the monitor shall store the fault condition (type), channel status, date, time, temperature and voltage.
- 3.3.7.9 When a power-up or brown out condition occurs, the conflict monitor shall disable without a fault condition occurring on the monitor unit. Monitor shall perform programmed start up procedures for enabling when the above conditions occur and conditions specified in CALTRANS specifications are satisfied.
- 3.3.7.10 The conflict monitor shall be capable of being programmed and set-up for intersection operation without the use of a laptop computer and communications software; programming the monitor via laptop computer shall be a secondary method of set-up.
- 3.3.7.11 The monitor shall be capable of showing the status of red, yellow, and green field outputs via the front panel of the conflict monitor unit.

3.4 Surge Protection

3.4.1 Model 336S Cabinet Surge Protection

Each Model 336S cabinet shall be provided with devices to protect the control equipment from surges and over voltages. The surge protector panel shall be designed to allow for adequate space for a wire connection and surge protector replacement without removal of terminal blocks or panels. The surge Protection Panel shall be a fold down panel mounted directly behind the Input File. Surge protectors shall be provided as detailed below and as shown in Figure 2, Model 336S Surge Protection Panel, attached to this specification. The surge protectors shall meet the following specifications:

3.4.1.1 AC Service Input

Each Model 336S cabinet shall include a modular pluggable surge protection unit on the AC service input that meets or exceeds the following requirement: (EDCO #SHA-1250 or equivalent). The surge arrester shall be a hybrid type power line surge device. The surge arrester shall be installed between the applied line voltage and earth ground. The surge arrester shall be capable of reducing the effect of lightning transient voltages applied to the AC line and provide filtering that conforms to a 50 kHz minimum insertion loss of 50 dB. The arrester shall conform to the following:

- 3.4.1.1.1 Peak surge current for an 8 X 20 microsecond waveform; 20,000 A for 20 occurrences.
- 3.4.1.1.2 Clamp voltage at 20,000 A; 280 V max.
- 3.4.1.1.3 Maximum continuous operating current at 120 V/60 Hz 15 Amps
- 3.4.1.1.4 Series Inductance: AC Line/AC Neutral - Greater than 20 microhenries typical.
- 3.4.1.1.5 Response time: Voltage never exceeds 280 V during surge.
- 3.4.1.1.6 Spike suppression for +/- 700 V spike: +/- 40 V deviation from sine wave all phase angles between 0 and 180 degrees.
- 3.4.1.1.7 The arrester shall have the following terminals:
 - Main Line (AC line first stage terminal)
 - Main Neutral (AC neutral input terminal)
 - Equipment Line In (AC line second stage input terminal, 10A)
 - Equipment Line Out (AC line second stage output terminal, 10A)
 - Equipment neutral out (neutral terminal to protected equipment)
 - Ground (GND) (earth connection)

- 3.4.1.1.8 The arrestor shall be encapsulated in a flame-retardant material.
- 3.4.1.1.9 The equipment line out shall provide power to the controller (170 or 2070).
- 3.4.1.1.10 Temperature range: -40° to +85° C
- 3.4.1.2 AC+ Interconnect Cable Inputs
- Each AC interconnected line shall be protected as it enters the Model 336S cabinet with a surge protection device that meets or exceeds the following requirements:
- 3.4.1.2.1 The unit shall be a three (3) electrode gas tube type of surge arrestor.
- 3.4.1.2.2 The striking voltage shall be 300-500 V DC with a minimum holder over voltage of 155 VDC.
- 3.4.1.2.3 The unit shall be a three (3) terminal device, one (1) of which shall be connected to ground. The other two (2) terminals shall be connected across each input respectively.
- 3.4.1.2.4 The unit shall have the following minimum requirements:
- Impulse breakdown: Less than 100 V in less than 1.1 microsecond at 10 kV/microsecond
 - Impulse breakdown balance: 0.01 microsecond (or less) difference at 10 kV/microsecond impulse
 - Energy application: Withstands 20A AC for one (1) second, applied ten (10) times at three (3) minute intervals on either section.
 - Current rating: 10,000A (8X20 microsecond impulse)
 - Capacitance: 6 picofarads, line to ground
- 3.4.1.3 Inductive Loop Detector Inputs

Each inductive loop detector channel input shall be protected by an external surge protection device meeting or exceeding the following requirements:

3.4.1.3.1 The unit shall be a three (3) terminal device, two (2) of which shall be connected across the signal inputs of the detector. The third terminal shall be connected to chassis ground to protect against common mode damage.

3.4.1.3.2 The unit shall withstand 25-100A surge current occurrences of a 10 X 700-microsecond waveform.

3.4.1.3.3 The unit shall have the following clamp characteristics:

- Maximum break over voltage: 170 V
- Maximum on-stage clamping voltage: 3 V
- Response Time: <5 nanosecond
- Off-stage leakage current: <10 microamp

3.4.1.3.4 Capacitance: less than 220 pf

3.4.1.4 Communications Inputs

Each low voltage communications input shall be protected as it enters the cabinets with a solid state surge protection unit (EDCO PC642C-008D or approved equal) that meets or exceeds the following requirements:

3.4.1.4.1 The unit shall be a dual pair (four [4] wire) module with a printed circuit board connector, double sided and gold plated for reliability.

3.4.1.4.2 The unit shall mate with and be installed in a ten (10) circuit Buchanan connector PCB1B10A or equivalent.

3.4.1.4.3 The unit shall be utilized as two (2) independent signal pairs. The data

circuits shall pass through the protection in a serial fashion.

3.4.1.4.4 The unit shall meet the following minimum requirements:

- Peak surge current:
10 kA (8 X 20 microseconds wave shape)
500A (10 X 700 microseconds wave shape)
- Occurrences @ peak: 50 typical
- Response time: <1 nanoseconds
- Voltage clamp: 8 V line-to-line
- Series resistance: less than 24 ohms
- Primary protector: Three (3) element gas tube 5 kA, (8X20 microseconds wave shape), per side
- Secondary protector: Silicon avalanche, 1.5 kw minimum

3.4.1.5.5 The ground terminals shall be connected to power ground.

3.4.1.6 Low Voltage DC Inputs

Each low voltage DC input channel shall be protected by an external surge protection device, which meets the same requirements as the communication inputs with the following exception:

- Voltage clamp: 30 V line-to-line.

3.4.2 Field Wiring Surge Protection

3.4.2.1 Surge suppression for the field wiring shall be installed on the back of the output file. This shall include devices for a 9-position five (5) mm panel (Phoenix part #071024), and plug (Phoenix part #1778056). Each plug shall have six (6) 50 joule, 150V varistors encased in a sealed covered unit.

4.0 DOCUMENTATION/SUBMITTALS

The Contractor shall submit a sample manual, as specified below, and all documentation required by TEES, with the cabinet Model 336S and all associated documentation.

3.1 Submittal data shall be delivered to the following location:

**City of Houston – TranStar
Traffic Signal Engineering & Operations
6922 Old Katy Road
Houston, Texas 77024**

Telephone: 713-881-3172

4.2 All submittals shall be fully detailed and shall provide all information necessary to show that the Model 336S cabinet and components conform to the requirements of the specifications.

4.3 Manuals

All Model 336S cabinet and component equipment provided under this specification shall be provided with product/operational manuals, which document the operation and maintenance of the equipment.

4.3.1 One product/operational manual which include each item in Section 3,0 and Section 4.0 of this specification, shall be supplied for this contract.

4.3.2 The manual shall be printed in a font of 12 point Courier Bold on 8.5 by 11 inch paper. Schematics, layouts, parts lists and plan details may be on 11 by 17 inch sheets, but the sheets must be neatly folded to 8.5 by 11 inch size. The manuals shall be bound in durable covers, and shall not suffer degradation when subjected to normal cabinet temperature testing.

4.4 Manual Contents

Each manual shall include the following: General Description, General Characteristics, Installation, Adjustments, Theory of Operation, Systems Description (Including Block Diagram(s)), Detailed Description of Circuit Operations, and Maintenance. Maintenance shall cover Preventative Maintenance, Trouble Analysis, Trouble Shooting Sequence Chart, Wave Forms, Voltage Measurements, and Alignment Procedures. Software furnished shall include, detailed operating and user's manuals. In addition, manual contents shall include the following:

4.4.1 Technical Information

Technical information in the form of manufacturer's published data sheets for all medium and large scale integrated circuits.

4.4.2 Parts List

Parts lists (including circuit and board designation, part type and class, power rating and component manufacturer, and original manufacturer's part number.

4.4.3 Electrical Interconnection Drawing

An electrical interconnection drawing shall be furnished.

4.4.4 Schematic and Logic Diagram

Assembly drawings and a pictorial diagram showing physical locations and identification of each component.

4.4.5 Serial and Revision Numbers

The serial numbers and revision numbers of equipment covered by manuals shall be printed on the front cover of the manuals.

4.4.6 Wiring Diagram

A cabinet wiring diagram for the Model 336S cabinet shall be shown completely on

individual sheets.

4.5 Manual

One Manual for Model 336S cabinets and components, in compliance with this specification, shall be furnished for this contract.

4.6 Cabinet Wiring Diagram

4.6.1 Each Model 336S cabinet shall have a wiring diagram, shown completely on one (1) sheet, delivered in the cabinet. This wiring diagram shall be in addition to the requirements of Section 4.3, 4.4 and 4.5, specified previously.

4.6.2 An electronic copy of the Model 336S cabinet wiring diagram shall be furnished on CD-ROM, in AutoCAD format.

4.7 Updated Documentation

Updated documentation shall be provided for any and all design changes or modifications to equipment, circuits, or components supplied to CITY OF HOUSTON. The Contractor shall notify CITY OF HOUSTON'S Project Manager or designee, in writing, of any impending changes.

4.8 Diagnostic Test Program

The diagnostic test program shall include all hardware, software, connectors, cables and test switches to thoroughly test all Model 336S cabinet components.

4.8.1 The Diagnostic Test Program and the appropriate Cabinet Verification Test Program shall be provided with each evaluation unit (4).

4.8.2 Each Diagnostic Test Program shall be provided with one (1) set of one (1) C1, and two (2) C2 wrap-around connectors, wired per this specification.

4.9 Certification

At delivery the contractor shall furnish certified documentation that the Model 336S cabinet, and applicable components, have been tested, environmentally and functionally, and comply with this specification and referenced documents.

4.10 Conflict Monitor Laptop Software

Contractor shall provide one (1) copy of Laptop Programming Software for the Conflict Monitor. The software must work with the upload/download units as defined in the specification.

5.0 TESTING

5.1 General

5.1.1 The Contractor shall comply with electrical, environmental and testing requirements defined in the TEES.

5.1.2 The Contractor shall comply with all testing, quality control and reporting procedures specified in the TEES.

6.0 WARRANTY

6.1 The Model 336S cabinet and components shall have a full warranty against manufacturer defects and workmanship, including parts and labor for a minimum of eighteen (18) months from the date of installation. Identification of manufacturer defects shall be as determined by CITY OF HOUSTON and the Contractor. The Contractor shall submit four (4) copies of all warranty certificates with the first delivery of each component.

6.2 CITY OF HOUSTON and the Contractor will determine the Contractor's responsibility for any Model 336S cabinet and components failure, should such failure occur within the warranty period. CITY OF HOUSTON will contact the Contractor with instructions for resolution of the warranty defects.

6.3 The Contractor shall bear all expenses for the return and repair of cabinets and components or field repair of installed equipment deemed necessary for adjustments during the warranty period.

6.4 Year 2000 Compliance

6.4.1 The Contractor warrants that the product(s) or service(s) provided or system(s) developed under this Contract shall be century compliant. "Century Compliant" means that the product, service or system:

6.4.1.1 Is able to process date data accurately - including date data century recognition, calculations that accommodate same century and multi-century formulas and date values (including leap year factors), and date data interface values that reflect the century - when used either in a stand-alone configuration or in combination with the other century compliant products used by CITY OF HOUSTON.

6.4.1.2 Shall not abnormally terminate its function or provide or cause invalid or incorrect results due to incompatibility with the calendar year.

6.4.2 In addition to any other warranties applicable to this Contract or any remedies otherwise available to CITY OF HOUSTON, the Contractor shall agree to promptly re-perform, repair or replace any product, service or system furnished under this Contract that is not century compliant, without cost, provided that CITY OF HOUSTON gives written notice within one (1) year following acceptance of the product, service or system or until December 31, 2000, whichever comes later. In addition, the Contractor shall remedy, at the Contractor's expense, any damage to CITY OF HOUSTON owned or controlled real or personal property or systems, when that damage is the result of:

6.4.2.1 The Contractor's failure to conform to the Contract requirements,

or

6.4.2.2 Any defect of services performed or products or systems furnished under the Contract.

6.4.3 If the Contractor fails to promptly remedy any failure, defect or damage and re-perform, repair or replace any nonconforming product, service or system as described above, CITY OF HOUSTON shall have the right to repair, replace or otherwise remedy the failure, defect or damage at the Contractor's expense.

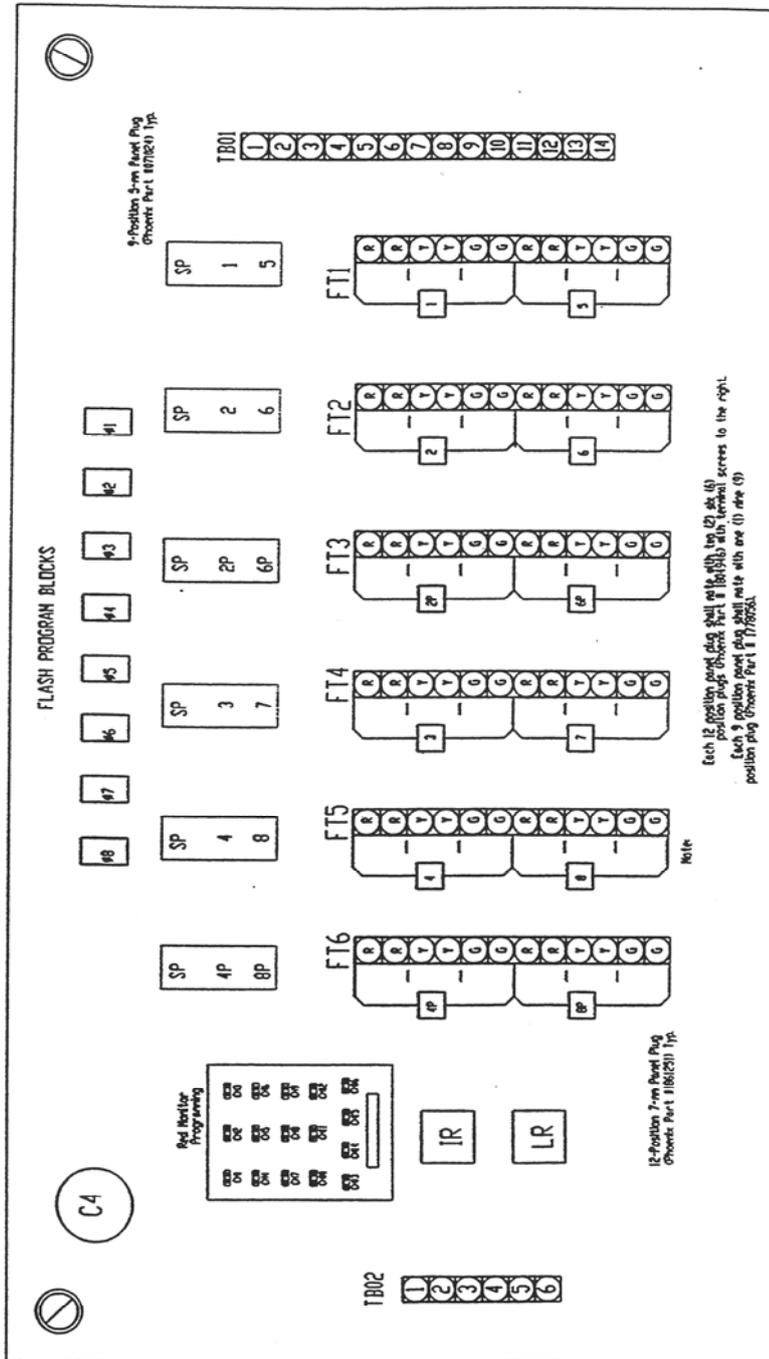
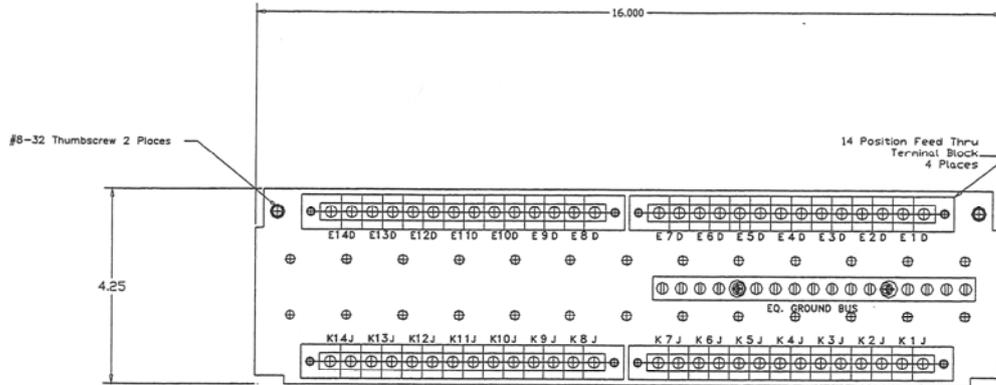


Figure 1: Model 336S Output File

Figure 2: Model 336S Surge Protection Panel



Input File Surge Panel Rear View

Notes:

1. Surge Panel is mounted directly behind the Input File.
2. Panel is hinged at the bottom and pivots down for access to SRA6LC surge devices mounted on the opposite side of the panel.
3. A 15 position Equipment Ground copper bus bar is mounted on the field terminal side (outside) for termination of loop lead-in shield grounds.

Table 1: C1 Harness #1 Wiring List for 336S Cabinet

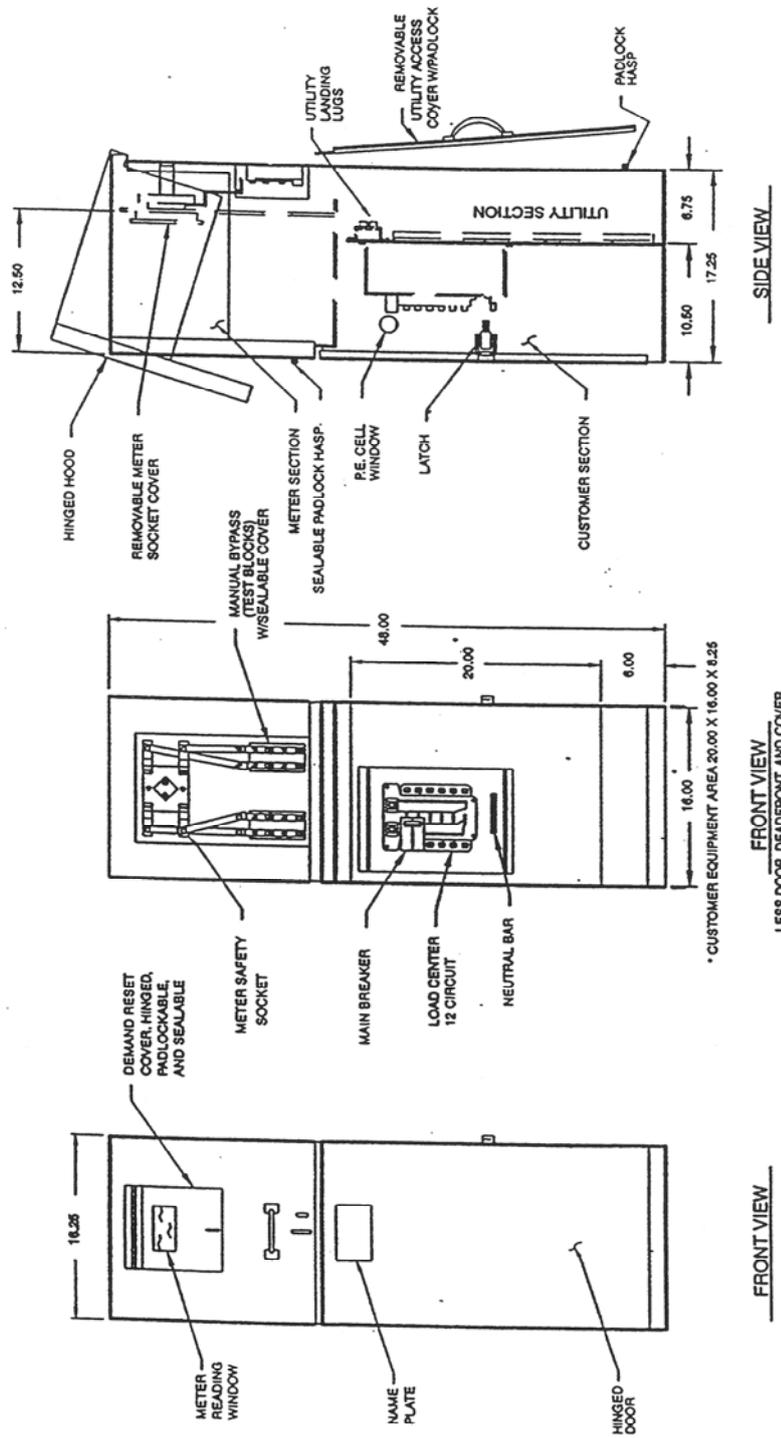
| PIN | SOURCE | DESTINATION | FUNCTION | PIN | SOURCE | DESTINATION | FUNCTION | PIN | SOURCE | DESTINATION | FUNCTION | PIN | SOURCE | DESTINATION | FUNCTION |
|-----|------------|-------------|---------------|-----|--------|-------------|---------------|-----|--------|-------------|-------------|-----|--------|-------------|----------------|
| 1 | DC.GND.BUS | DC.GND.BUS | SWPK 4P - RED | 27 | 04-1 | C4-25 | SWPK 6P - RED | 53 | 12-7 | IFI-11W | SPARE#1 | 79 | 16-5 | IFI-7W | 8 CE |
| 2 | 01-1 | C4-1 | SWPK 4P - GRN | 28 | 04-2 | C4-26 | SWPK 6P - GRN | 54 | 12-8 | IFI-11F | SPARE#2 | 80 | 16-6 | IFI-11F | ADVANCE |
| 3 | 01-2 | C4-2 | SWPK 4 - RED | 29 | 04-3 | C4-27 | SWPK 6 - RED | 55 | 13-1 | IFI-1F&W | 5 CE | 81 | 16-7 | IFI-14F | FLASH SENSE |
| 4 | 01-3 | C4-3 | SWPK 4 - YEL | 30 | 04-4 | C4-28 | SWPK 6 - YEL | 56 | 13-2 | IFI-1F&W | 1 CE | 82 | 16-8 | IFI-14W | STOP TIME |
| 5 | 01-4 | C4-4 | SWPK 4 - GRN | 31 | 04-5 | C4-29 | SWPK 6 - GRN | 57 | 13-3 | IFI-5F&W | 7 CE | 83 | 06-1 | C5-1 | SWPK 14 - RED |
| 6 | 01-5 | C4-5 | SWPK 3 - RED | 32 | 04-6 | C4-30 | SWPK 5 - RED | 58 | 13-4 | IFI-5F&W | 3 CE | 84 | 06-2 | C5-2 | SWPK 14 - GRN |
| 7 | 01-6 | C4-6 | SWPK 3 - YEL | 33 | 04-7 | C4-31 | SWPK 5 - YEL | 59 | 13-5 | IFI-9F | 5 CE | 85 | 06-3 | C5-3 | SWPK 13 - RED |
| 8 | 01-7 | C4-7 | SWPK 3 - GRN | 34 | 04-8 | C4-32 | SWPK 5 - GRN | 60 | 13-6 | IFI-9F | 1 CE | 86 | 06-4 | C5-4 | SWPK 13 - YEL |
| 9 | 01-8 | C4-8 | SWPK 2P - RED | 35 | 05-1 | C4-33 | SWPK 2P - YEL | 61 | 13-7 | IFI-9W | 7 CE | 87 | 06-5 | C5-5 | SWPK 13 - GRN |
| 10 | 02-1 | C4-9 | SWPK 2P - GRN | 36 | 05-2 | C4-34 | SWPK 6P - YEL | 62 | 13-8 | IFI-9W | 3 CE | 88 | 06-6 | C5-6 | SWPK 12 - RED |
| 11 | 02-2 | C4-10 | SWPK 2 - RED | 37 | 05-3 | C4-35 | SWPK 4P - YEL | 63 | 14-5 | IFI-3F | 2 CE | 89 | 06-7 | C5-7 | SWPK 12 - YEL |
| 12 | 02-3 | C4-11 | SWPK 2 - YEL | 38 | 05-4 | C4-36 | SWPK 8P - YEL | 64 | 14-6 | IFI-3F | 6 CE | 90 | 06-8 | C5-8 | SWPK 12 - GRN |
| 13 | 02-4 | C4-12 | SWPK 2 - GRN | 39 | 11-1 | IFI-2F | 2 CE | 65 | 14-7 | IFI-7F | 4 CE | 91 | 07-1 | C5-9 | SWPK 11 - RED |
| 14 | DC.GND.BUS | IFI-15-4 | INPUT DC GND | 40 | 11-2 | IFI-2F | 6 CE | 66 | 14-8 | IFI-7F | 8 CE | 92 | DC.GND | DC.GND.BUS | - |
| 15 | 02-5 | C4-13 | SWPK 2 - GRN | 41 | 11-3 | IFI-6F | 4 CE | 67 | 15-1 | IFI-12F | 2 PED | 93 | 07-2 | C5-10 | SWPK 11 - GRN |
| 16 | 02-6 | C4-14 | SWPK 1 - RED | 42 | 11-4 | IFI-6F | 8 CE | 68 | 14-2 | IFI-13F | 6 PED | 94 | 07-3 | C5-11 | SWPK 10 - RED |
| 17 | 02-7 | C4-15 | SWPK 1 - YEL | 43 | 11-5 | IFI-2W | 2 CE | 69 | 14-3 | IFI-12W | 4 PED | 95 | 07-4 | C5-12 | SWPK 10 - YEL |
| 18 | 02-8 | C4-16 | SWPK 1 - GRN | 44 | 11-6 | IFI-2W | 6 CE | 70 | 14-4 | IFI-13W | 8 PED | 96 | 07-5 | C5-13 | SWPK 10 - GRN |
| 19 | 03-1 | C4-17 | SWPK 8P - RED | 45 | 11-7 | IFI-6W | 4 CE | 71 | 15-5 | IFI-12F | EVA PREEMPT | 97 | 07-6 | C5-14 | SWPK 9 - RED |
| 20 | 03-2 | C4-18 | SWPK 8P - GRN | 46 | 11-8 | IFI-6W | 8 CE | 72 | 15-6 | IFI-13F | EVB PREEMPT | 98 | 07-7 | C5-15 | SWPK 9 - YEL |
| 21 | 03-3 | C4-19 | SWPK 8 - RED | 47 | 12-1 | IFI-4F&W | 2 CALL | 73 | 15-7 | IFI-12W | EVC PREEMPT | 99 | 07-8 | C5-16 | SWPK 9 - GRN |
| 22 | 03-4 | C4-20 | SWPK 8 - YEL | 48 | 12-2 | IFI-4F&W | 6 CALL | 74 | 15-8 | IFI-13W | EVD PREEMPT | 100 | 05-5 | C5-17 | SWPK 14 - YEL |
| 23 | 03-5 | C4-21 | SWPK 8 - GRN | 49 | 12-3 | IFI-8F&W | 4 CALL | 75 | 16-1 | IFI-11W | SPARE#3 | 101 | 05-6 | C5-18 | SWPK 11 - YEL |
| 24 | 03-6 | C4-22 | SWPK 7 - RED | 50 | 12-4 | IFI-8F&W | 8 CALL | 76 | 16-2 | IFI-3W | 2 CE | 102 | 05-7 | IFI&J-15-3 | DETECTOR RESET |
| 25 | 03-7 | C4-23 | SWPK 7 - YEL | 51 | 12-5 | IFI-14F | RR1 PREEMPT | 77 | 16-3 | IFI-3W | 6 CE | 103 | 05-8 | C4-37 | WDT - MU |
| 26 | 03-8 | C4-24 | SWPK 7 - GRN | 52 | 12-6 | IFI-14W | RR2 PREEMPT | 78 | 16-4 | IFI-7W | 4 CE | 104 | DC.GND | IFI-15-4 | INPUT.DC.GND |

Table 2: C4 Harness #1 & #3 Wiring List for Output File

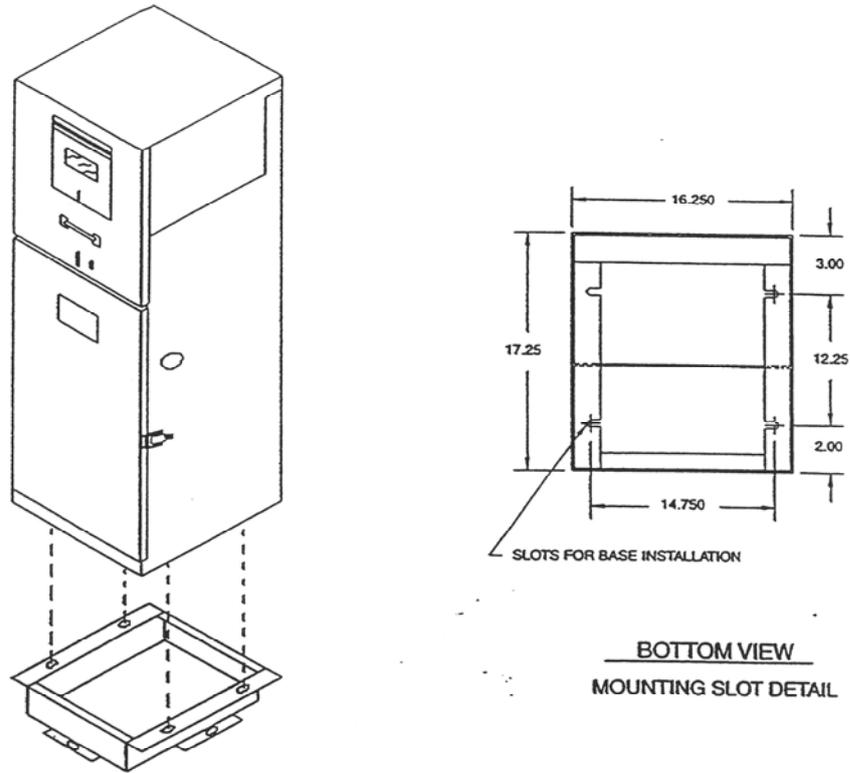
| PIN | SOURCE | DESTINATION |
|-----|---------|---------------|
| 1 | C1- 2 | SWPK 4P - RED |
| 2 | C1- 3 | SWPK 4P - GRN |
| 3 | C1- 4 | SWPK 4 - RED |
| 4 | C1- 5 | SWPK 4 - YEL |
| 5 | C1- 6 | SWPK 4 - GRN |
| 6 | C1- 7 | SWPK 3 - RED |
| 7 | C1- 8 | SWPK 3 - YEL |
| 8 | C1- 9 | SWPK 3 - GRN |
| 9 | C1- 10 | SWPK 2P - RED |
| 10 | C1- 11 | SWPK 2P - GRN |
| 11 | C1- 12 | SWPK 2 - RED |
| 12 | C1- 13 | SWPK 2 - YEL |
| 13 | C1- 15 | SWPK 2 - GRN |
| 14 | C1- 16 | SWPK 1 - RED |
| 15 | C1- 17 | SWPK 1 - YEL |
| 16 | C1- 18 | SWPK 1 - GRN |
| 17 | C1- 19 | SWPK 8P - RED |
| 18 | C1- 20 | SWPK 8P - GRN |
| 19 | C1- 21 | SWPK 8 - RED |
| 20 | C1- 22 | SWPK 8 - YEL |
| 21 | C1- 23 | SWPK 8 - GRN |
| 22 | C1- 24 | SWPK 7 - RED |
| 23 | C1- 25 | SWPK 7 - YEL |
| 24 | C1- 26 | SWPK 7 - GRN |
| 25 | C1- 27 | SWPK 6P - GRN |
| 26 | C1- 28 | SWPK 6P - RED |
| 27 | C1- 29 | SWPK 6 - RED |
| 28 | C1- 30 | SWPK 6 - YEL |
| 29 | C1- 31 | SWPK 6 - GRN |
| 30 | C1- 32 | SWPK 5 - RED |
| 31 | C1- 33 | SWPK 5 - YEL |
| 32 | C1- 34 | SWPK 5 - GRN |
| 33 | C1- 35 | SWPK 2P - YEL |
| 34 | C1- 36 | SWPK 6P - YEL |
| 35 | C1- 37 | SWPK 4P - YEL |
| 36 | C1- 38 | SWPK 8P - YEL |
| 37 | C1- 103 | WDT-MU |

Table 3: Input File Layout

| | | | | | | | | | | | | |
|----------|-----------|-----------|---------|---------|----------|----------|---------|--------|---------|---------|----|----|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| 56 | 39 | 63 | 47 | 58 | 41 | 65 | 49 | 60 | 10* | 80 | 67 | 68 |
| 1 EX, CT | 2, EX, CT | 2, EX, CT | 2 CALL | 3 EX CT | 4 EX, CT | 4 EX, CT | 4 CALL | 1 F/F | SPARE 5 | SPARE 7 | 2P | 6P |
| SPARE 1 | 2, EX, CT | 2 EX | SPARE 2 | SPARE 3 | 4 EX, CT | 4 EX | SPARE 4 | 3 (R1) | SPARE 6 | SPARE 8 | 4P | 8P |
| 15* | 43 | 76 | 16* | 17* | 45 | 78 | 18* | 62 | 11* | 53 | 69 | 70 |



Meter Cabinet
Figure 3



Meter Cabinet
Figure 4

