STATE OF NEW JERSEY
DEPARTMENT OF TRANSPORTATION
TRENTON, NEW JERSEY 08625

METRIC SPECIFICATIONS FOR HAR SYSTEM
(A SYNCHRONIZED HIGHWAY ADVISORY RADIO TRAVELERS INFORMATION SYSTEM)

N. J. Specification No. EBM-HAR-2 Effective Date: July 1, 2001

New Jersey Department of Transportation Specifications for a synchronized Highway Advisory Radio Travelers Information system. The system includes field transmitters, fiber optic and cellular interface, and a central message station.

The purpose of these specifications is to describe minimum acceptable design and operating requirements for the corridor travelers information system.

GENERAL - I

1-1 Transmitter Site Components

The transmitter site components of the synchronized highway advisory radio, travelers information system, will consist of the following components: AM transmitter, Antenna tuning unit (ATU), antenna, ground system, power system, standby power system, carrier synchronization unit, on-site digital recorder/announcer, cellular telephone interface, cabinet - auxiliary equipment, RS232/Audio fiber optic interface, and system testing. The system Supplier shall also conduct all the necessary frequency research and engineering, signal strength contours, and FCC license preparation which is necessary to place the station on the air.

1-2 Central Message Center

The corridor HAR system shall include a Central Message Center. This message center shall be linked to each local transmitter over a fiber optic interface to be provided by others. This interface will provide an independent bi-directional RS232 data interface and a 4-wire Audio circuit to each transmitter. The purpose of the message center is to allow complete remote control of each transmitter from the central. In addition, via a digital recorder at the message center, the message center will provide the option of transmitting the same audio feed to one or more of the field transmitters, for simultaneous transmission. The requirements for the Central Message Center are fully defined in Section VIII.

1-3 Environment

All transmitter site components shall operate in the temperature range of -40 °C to +85 °C and a relative humidity of 0 to 95 percent non-condensing. The equipment must be designed to operate inside a NEMA 3R outdoor enclosure. The manufacturer must supply certification by an independent technical laboratory confirming that the equipment complies with these environmental specifications.

1-4 Standards

Materials not specifically covered in these specifications shall be in accordance with the accepted standards of the National Electrical Manufacturers Association, The Underwriters Inc., The National Electrical Code, and the American Society for Testing and Materials.

AM TRANSMITTER - II

2-1 FCC Part 90 Certification

The AM transmitter shall be FCC certified as accepted and eligible for licensing under Part 90.242 of the Federal Communications Commission Rules and Regulations.

2-2 Transmitter Circuitry

The AM transmitter shall utilize solid state Class AB circuitry with diffused emitter output transistors. Total solid state circuitry shall be employed in the transmitter unit. All components shall be identified by the industry standard nomenclature, except manufacturer's LSI Devices.

2-3 Transmitter Frequency

The AM transmitter shall be capable of transmitting at frequencies from 530 kilohertz up to 1 720 kilohertz. The frequency of the transmitter shall be revisable. Each unit shall be provided with the required components to achieve 530 or 1 610 kilohertz.

The AM transmitter shall be provided to operate at the frequency required by the contract or bid documents to which these specifications are part. However, if as the result of the licensing procedure, another frequency must be implemented, the supplier shall implement at no additional cost, the new frequency in lieu of the initial one specified in the bid documents.

2-4 Transmitter Power

The AM transmitter shall provide 30 watts of RF power to the antenna. The power shall be field adjustable from 0 to the 30-watt maximum. As part of the adjustment process, the power shall be adjusted to the highest legal level. A facility shall be provided which shall allow the transmitter power to be cut in half from a command issued from the remote cellular and fiber optic interface.

2-5 Transmitter Efficiency

The AM transmitter shall have a power efficiency of 80% or greater. The transmitter shall include an audio limiter and a visual peak limiter.

2-6 Transmitter Monitoring

The AM transmitter shall be provided with a headphone jack and headphones for on site monitoring of the output signal. This monitor shall be implemented via an independent

AM receiver permanently tuned to the frequency of the transmitter. In addition to on site headphone capability, the monitor signal shall be returned to the central site via the fiber optic audio interface. The monitor signal shall also be accessible via the cellular telephone. To reduce the number of telephone lines required to support the unit, a phone line switching unit shall be provided. The unit will allow the operator to place a call to a single number and select the local digital recorder or the monitor signal. The selection shall be by DTMF control codes.

2-7 Transmitter Synchronization Circuit

Each individual transmitter shall have the capability of being synchronized with an adjacent transmitter. Such adjacent transmitter may be located approximately 13 kilometers to 16 kilometers away, as indicated in the contract documents. In order to minimize interference in the transition zone between the two units, the transmitter carrier shall be synchronized to a standard reference. This reference shall be the strongest AM radio station which can be received throughout the corridor. The HAR transmitter shall be synchronized to the commercial AM station via a specially designed circuit.

Synchronization of the actual audio transmitted shall be accomplished via the central message station which may distribute the same audio signal to each transmitter via the fiber optic network. Reception of the audio signal at each point shall be within 1 millisecond at each local site.

2-8 Transmitter Case

The transmitter shall be housed in a metal case suitable for shelf mounting. The unit shall be completely equipped and wired to provide the required operation.

2-9 Extender Boards

If extender boards are necessary for testing or repair of the transmitter, two extender boards for each type of printed circuit board shall be provided with the first unit supplied under each contract or proposal to which this specification applies. One additional extender board for each type of printed circuit board shall be provided with every five units supplied thereafter under each contract.

ANTENNA ASSEMBLY - III

3-1 Antenna Components

The antenna assembly shall consist of an antenna, antenna support, foundation and antenna tuning unit.

3-2 Whip-Type

The antenna shall be a whip-type antenna. The antenna shall be vertically polarized, center loaded monopole tuned for operation at the frequency required by the contract documents to which these specifications apply. The antenna shall be constructed of

anodized aluminum with an adjustable stainless steel tuning tip. The antenna shall sustain winds of 129 kilometers per hour with 13 millimeter radial ice.

3-3 Antenna Support Structure

The antenna support shall be a free standing non-metallic fiber glass utility pole. The antenna shall be mounted to the support structure to provide a maximum height of 15 meters permitted by the FCC. If required, the installer will cut the support to adjust the height in the field to match legal requirements.

3-4 Antenna Foundation

The foundation for the antenna support shall conform to the requirement of the contract plans.

3-5 Antenna Mounting Hardware

All hardware used in the antenna assembly shall be stainless steel except for the anchor bolts which will comply with the contract plans.

3-6 Antenna Tuning Unit (ATU)

The antenna tuning unit shall accept transmitter power input of up to 30 watts continuous at 50 ohms unbalanced. The output impedance shall be variable from 0.5 to 65 ohms at 1:1 VSWR, as indicated on a self-contained VSWR bridge and meter. The meter shall read VSWR directly, and also directly read RF power delivered to the unit.

The ATU shall be supplied in a lockable fiberglass weatherproof enclosure to mount on the non-metallic utility pole supporting the antenna.

GROUND PLANE - IV

4-1 Radials

The ground plane shall consist of 20 each, 30 meter long, ground radials of 8 AWG bare tinned copper wire.

4-2 Installation Details

The ground plane shall be arranged in a circular pattern and should be buried at an approximate depth of 450 millimeters below existing surface. Care shall be taken to minimize disruption to the existing landscape and to avoid possible underground utilities or conduits.

4-3 Ground Rods

The end of each ground plane radial shall be equipped with a 1.2 meter ground rod mechanically and electrically attached to the wire. The ground rod shall be driven into the soil to ensure maximum grounding of the system.

4-4 Radial Connection

The ground plane radials shall be joined electrically together in a ring about the base of the antenna by the use of a mechanical compression joint. The radials shall then be soldered together. A minimum 8 AWG wire shall be mechanically joined and soldered to the ring. This wire will extend and be connected as recommended by the manufacturer.

4-5 Site Restoration

After installation of the ground plane, the landscape of the site shall be restored to the state that it was in prior to installation of the ground plane.

POWER SYSTEM - V

5-1 Power System Components

The power system shall consist of the power distribution equipment, surge protection and standby power system.

5-2 Power Distribution System

The power distribution system shall include the main circuit breaker and distribution breakers with their respective enclosures. The transmitter and local voice recorder shall each be protected with a circuit breaker of proper rating as per the manufactures recommendations. The breakers shall be compatible to an E frame circuit breaker.

5-3 Surge Protector

A 120 volt AC single phase surge protector shall be installed as a precautionary measure against possible damage resulting from voltage surges on all incoming power lines. The 120 volt AC single phase surge protector shall incorporate a series choke at a maximum clamp voltage of 340 volts at 20 kiloamps with 5 nanoseconds response. In addition, the surge protector shall have the capability of removing high energy surges and block high speed transients. The surge protector shall comply with the following specifications:

A. Peak Current: 20 000 amps (8x20 µs waveshape)
B. Occurrences: 20 times at peak current

C. Minimum Series Inductance: 200 microhenries

D. Continuous Series Current: 10 amps

E. Temperature Range: to -40 °C to +85 °C

5-4 Standby Power System

The standby power system shall be capable of providing normal full power operation of the highway advisory radio system for a minimum of 72 hours without normal 115 volt power. The current draw of each component of the system, including the transmitter, local digital recorder/announcer, cellular telephone, and any other electrical loads present during operation will be measured and provided to the engineer for verification of proper sizing of the battery system.

A. Batteries

The batteries for the standby power system shall be maintenance free, deep cycle, gel-cell industrial batteries capable of total discharge and recharge without damage to the batteries. The proposed number and type of batteries shall be approved by the Engineer. One set of spare rechargeable batteries shall be furnished for each local transmitter included in the project.

B. Charging System

A battery charging system shall trickle charge the batteries from the normal 115 volt power. The system shall not over charge the batteries and will include a load controller and a charge regulator in addition to automatic battery temperature compensation. Voltmeters and ammeters shall be provided to indicate the current state and rate of charge of the batteries.

ON-SITE DIGITAL RECORDER/ANNOUNCER - VI

6-1 Message Memory

The digital recorder/announcer shall be completely solid state with no moving parts. The device shall have one audio output channel and be able to retain a minimum of twenty-four minutes of voice messages. The message time shall be segmentable into up to 250 distinct messages which may be recorded or deleted independently. Sequences of up to 100 messages shall be possible.

6-2 Message Retention

The digital recorder/announcer shall be capable of playing the current message sequence while new messages are being programmed into the system for subsequent play. The messages shall be retained during a power failure of at least seven days, in addition to that capacity provided by the standby power system, by a rechargeable battery.

6-3 Internal Clock

The digital recorder/announcer shall have an internal clock which can be utilized to schedule the message sequences on a 24 hour and 7 day per week basis. The clock shall be capable of being updated remotely via the cellular or fiber optic interface.

6-4 Weather Receiver

The digital recorder/announcer will include a separate receiver for the National Weather Service that will be played at specific times or between recorded message sequences as programmed by the internal clock.

6-5 Message Downloading

The audio messages shall be loaded via the cellular or fiber-optic interface.

A. Cellular Interface

Using DTMF control tones, the operator shall be able to control the data recorder.

B. Fiber Optic Interface

The fiber optic interface shall include a 4-wire audio and RS232 control port. Via the RS232 control port, the data recorder shall be fully controllable. In addition, the capability shall exist to download a digitized voice file directly into the recorder memory. Alternatively, RS232 command shall be issuable which will result in the capture of any message being received via the fiber optic audio interface from central, into the recorder's memory.

6-6 Message Center Compatibility

The on-site data recorder shall be fully compatible with the Central Message Station specified in Section VIII.

6-7 Local Microphone

The digital recorder/announcer shall include a microphone for field recording of messages. The dynamic type microphone shall have a minimum frequency response of 80 to 10 kilohertz. The microphone will include an on/off switch and all cables.

6-8 Incidental Equipment

The on-site digital recorder/announcer will include all the necessary cables, connectors and wiring to provide a fully operational highway advisory radio system.

CELLULAR TELEPHONE - VII

7-1 General

A full featured cellular telephone shall be provided with each transmitter. The telephone shall be FCC registered and type accepted. The telephone shall be rated at 3 watts output power. All equipment required to interface the telephone and the digital recorder/announcer shall be provided and installed.

7-2 Activation Cost

The cost of activation of the telephone will be included as part of the system on a carrier specified by the Engineer.

CENTRAL MESSAGE CENTER - VIII

8-1 General

The corridor HAR system shall include a Central Message Center. This message center shall be linked to each local transmitter over a fiber optic interface to be provided by others. This interface will provide an independent bi-directional RS232 data port and a 4-wire audio circuit to each transmitter. The purpose of the message center is to allow complete remote control of each transmitter from the central. In addition, via a digital recorder at the message center, the message center will provide the option of transmitting the same audio feed to one or more of the field transmitters, for simultaneous transmission.

8-2 Sizing

The central message center shall be sized to support the number of transmitters specified in the contract documents plus two additional units.

8-3 Digital Recorder

The Central Message center shall include a Digital Recorder meeting the Section VI requirements.

8-4 Audio Selection Panel

The audio selection panel shall allow the output of the central digital recorder to be transmitted to one or more local transmitters via the fiber optic outbound audio channel. Via a button assigned to each local transmitter, the operator shall be able to connect the output from the central digital recorder to each individual transmitter. When the local data recorder and/or transmitter receive audio via the fiber optic interface, the on-site digital recorder shall be disconnected from the transmitter. The audio signal being obtained from the central shall be gated to the transmitter, overriding the local data recorder. Upon loss of audio from the central, the local data recorder will be reconnected to the on-site recorder. In this regard, the system can be utilized to transmit the same message or individual messages to each transmitter.

The selection button shall be locking and include LED indicators which clearly indicate if the channel is patched into the central.

8-5 Monitor Selection Panel

The inbound audio channel from each local transmitter shall be wired to the message center. Via buttons similar to those described in Section VIII-4, the monitor signal obtained from any of the local transmitters shall be gated to an on-board speaker. Volume control for the speaker shall be provided. In addition, a jack shall be provided to connect a headset, which will disconnect the speaker. By pressing the appropriate button, the operator shall be able to monitor the transmitter output from each local.

8-6 RS232 Port

The message center shall be equipped with one master RS232 port. Via this port, a standard PC shall be able to communicate with either the center or any of the local data recorders. The message center shall include a built in "port switch device" which will allow the host to select which data recorder will be addressed.

8-7 Cassette Deck

A professional quality cassette deck shall be provided. Tapes played on the cassette deck shall be directly transferred into the central's data recorder memory.

8-8 Software Protocol

The RS232 protocol to support the operation of the central and local data recorders shall be documented and provided to the engineer.

8-9 Diagnostic MSDOS Software

A software program shall be provided which can be run on a standard PC operating MSDOS. This program shall allow any of the data recorders to be fully controlled. In addition, a facility shall be provided to digitize messages for downloading via the RS232 ports of the data recorders. If an external voice card is required to accomplish this, two boards shall be provided. One board should work under ISA bus and the other should operate under IBM Micro-channel.

TRANSMITTER CABINET-AUXILIARY EQUIPMENT - IX

9-1 NEMA Enclosure

All Section II, V, VI, and VII equipment and a fiber optic modem to be supplied by others, shall be housed in an aluminum cabinet (Grade 50-52-H32) fabricated in accordance with sketch attached to and forming a part of this specification, identified as Drawing No. P-21 Dimensions of the cabinet furnished must meet or exceed all minimum dimensions shown. Cabinets not conforming will not be approved. The cabinets shall be of adequate size to house all of the on-site equipment.

9-2 Cabinet Construction

All surfaces of the cabinet shall be clean, free of holes or blemishes, smooth without burrs and with exterior corners rounded. The cabinet shall not be painted.

9-3 Ventilation Fan

A thermostatically controlled ventilation fan shall be provided to supply a minimum of 2.83 cubic meters per minute airflow. The ventilation fan shall be screened against the entrance of dust and foreign matter, and shall be mounted in the top of the cabinet. The unit shall be completely wired and interconnected.

9-4 Cabinet Filter

A replaceable 305 by 406 by 25 millimeter filter for incoming air shall be provided.

9-5 Schematic

A permanent wiring diagram of the inputs and outputs shall be provided and mounted to the inside of the door.

9-6 Construction

All cabinet doors shall incorporate hinges and hinge pins utilizing stainless steel. Fastening of hinges to doors and cabinets shall be made using stainless steel pop-rivets or stainless steel nuts and bolts. Welding of hinges to cabinets and doors shall not be permitted. When the door is closed and latched, the door shall be locked. The locks shall be CCL 2-NJIVHS type, or equal. One key shall be supplied with each lock. The keys shall be removable in the locked position only.

9-7 Lighting

A fluorescent fixture supplied with a lens or shield and a 20 watt Type T-12 430 milliamp lamp with rapid start, high power factor ballast shall be supplied and installed to the top front portion of the cabinet. A switch shall be installed on the inside of the cabinet door so that the lamp can be extinguished manually.

SYSTEM TESTING - X

10-1 An HAR factory authorized and trained technician shall adjust each transmitter and test the system to insure compliance with FCC Part 90.242. The technician shall be responsible for testing all functions of the system to verify their proper operation. A test procedure shall be supplied for approval by the Engineer.

10-2 After the transmitter is fine tuned, a minimum of 20 sites within the coverage area will be selected by the Engineer for testing. The test program shall demonstrate to the Engineer that an acceptable signal is being obtained throughout the coverage area for both day and night conditions. If the technician determines that the maximum field strength is not being obtained with the 10-watt input power setting, the Supplier will prepare the necessary FCC applications to request a waiver which will allow the transmitter power to be adjusted upwards to achieve the maximum field strength allowable under FCC Part 90.242.

10-3 The factory technician shall test the remote loading of messages to verify the quality of the data recording process. The technician will also load 24 minutes of messages and demonstrate different sequences of playback. The test program shall include message loading at the transmitter cabinet, via the cellular interface, via the local RS232 data recorder interface, and remotely from the Central Message Center facility. The technician shall demonstrate the system's ability to switch to the on-site data recorder upon loss of audio from the central site. In addition, the switch back to the audio obtained from the central shall be verified.

10-4 Synchronization Testing

Via the Central Message Center, all field transmitters will be connected to the central data recorder. The entire corridor shall be driven and the signal monitored. Throughout the corridor, an audible signal shall be obtainable which is relatively free of interference caused by synchronization faults.

TRAINING - XI

11-1 Prior to the acceptance of the highway advisory radio system, training shall be provided for the Department's engineering, maintenance and operations staff, at a facility provided by the Department. The training shall include all material and manuals required for each participant. The training shall be as follows:

11-2 Maintenance Training

The training shall be provided for a minimum of 40 hours for a minimum of five (5) maintenance personnel. The training shall include operation instructions, theory of operation, circuit description, preventive maintenance procedures, troubleshooting and repair of all equipment including: transmitter, data recorder and all other equipment specified herein.

11-3 Engineering Training

The training shall be provided for a minimum of 24 hours for at least 20 engineering personnel. The training shall include a complete demonstration of the system, procedures, operation, troubleshooting procedures and equipment operation. This course shall stress the day-to-day operation of the completed system and its capabilities.

11-4 Operation Training

The training shall be provided for a minimum of 16 hours for a minimum of five (5) operation personnel. The training shall include the operation of the system and basic troubleshooting procedures geared to identifying bad sub-assemblies.

INSTRUCTIONS AND GUARANTEES - XII

12-1 Two sets of complete schematics and operation & maintenance manuals of all equipment shall be supplied with the system. The manuals as a minimum shall contain the following:

A. Operation Instructions

B. Theory of Operation, Circuit Description

C. Preventative Maintenance Procedures

D. Trouble Shooting Flow Chart or Guide

E. Wiring Diagrams

F. Parts List (which will identify each part by the industry standard nomenclature and include at least one manufacturer's name and address)

12-2 One reproducible blackline Diazo mylar (0.10 millimeter thick) A1 size (594 by 841 millimeters) and two prints of the schematic wiring diagram for the cabinet and auxiliary equipment shall be supplied with each highway advisory radio system. The schematic wiring diagram shall contain the information in at least 6 millimeter lettering.

A. Contract and bid dated.

B. Model and number of all equipment.

C. Local Transmitter Location

12-3 No changes or substitutions in these requirements will be acceptable unless authorized in writing. Inquiries regarding this specification shall be addressed to the Manager, Office of ITS Engineering, New Jersey Department of Transportation, P.O. Box 613, 1035 Parkway Avenue, Trenton, New Jersey 08625.

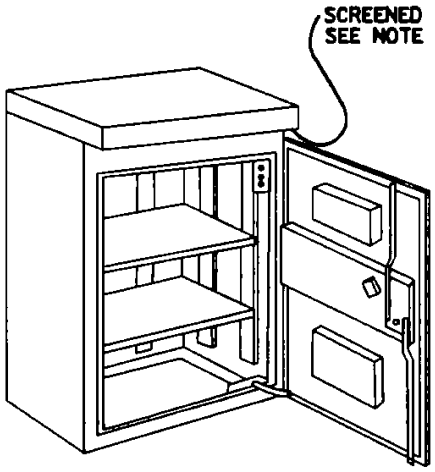
12-4 The complete highway advisory radio system equipment shall carry a two-year guarantee from the date of final acceptance against any imperfections in workmanship or materials. Any tests or repairs made by a manufacturer or representative shall be documented on the New Jersey Department of Transportation "Equipment Failure Analysis and Report Form" and returned with units when warranty repaired. The Department will attach a copy of this form to all returned equipment. This documentation shall include an explanation of the exact repairs made and identification of parts replaced by part number and circuit number. All warranty repairs must be made within thirty days upon receiving equipment.

12-5 The company agrees upon the request of the Manager, Office of ITS Engineering to deliver to the Office, a sample of the equipment to be supplied in compliance with these specifications for inspection and test before acceptance. After completion of the test, the sample shall be returned.

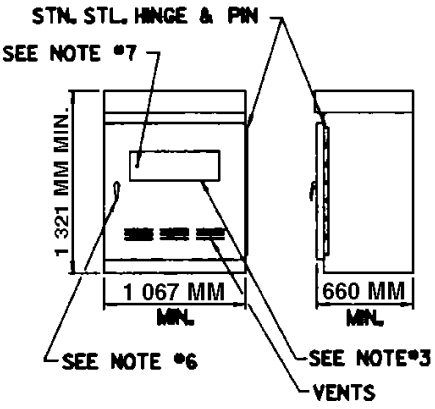
12-6 The company shall furnish any and all equipment which they deem necessary for safe and reliable field operation of the highway advisory radio system equipment.

12-7 All equipment furnished under this specification must be current production equipment and of recent manufacturer, identical models of which are field operational. The HAR supplier shall have installed at least twenty (20) field transmitters similar to that required by this document. Untried or prototype units shall not be considered for acceptance.

12-8 All major components shall be identified with a metal plate containing the serial number with a bar code identification.



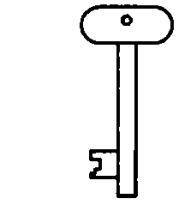
MINIMUM DIMENSIONS OF CABINET



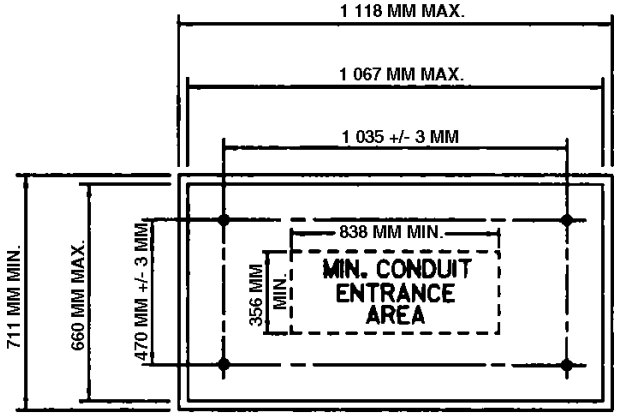
NOTES:

1. CABINET SHALL BE FABRICATED OF 3 MM THK. ALUM. THE CABINET TO BE MOUNTED WITH THE ANCHOR BOLT CONFIGURATIONS SHOWN. IF BASE ADAPTER PLATES ARE USED THEY SHALL BE 6 MM THK. ALUM. AND SHALL BE CONSTRUCTED TO MEET THE MINIMUM CONDUIT ENTRANCE AREA.
2. EACH DOOR SHALL BE FITTED WITH A GASKET TO INSURE DUST TIGHT & WEATHERPROOF PROTECTION UNDER ALL WEATHER CONDITIONS.
3. MANUAL CONTROL WEATHERPROOF MOMENTARY CONTACT SWITCH CONNECTED TO 1.8 M REINFORCED CORD STORED IN RECESS BEHIND SMALL DOOR IN LARGE DOOR.
4. INSTALL TWO ADJUSTABLE SHELVES.
5. SMALL DOOR SHALL BE SECURED WITH A SUB-TREASURY LOCK #0357S AND KEYED ALIKE FOR #10 AS MANUFACTURED BY THE AMERICAN HARDWARE CO. NEW BRITIAN, CONN. THE SHANK LENGTH OF KEY SHALL BE AS SHOWN. PROVIDE (2) KEYS.
6. LARGE DOOR SHALL BE SECURED WITH A CCL LOCK #15481RS WITH A MATCH #2 KEY TO BE SUPPLIED TO NEW JERSEY DEPARTMENT OF TRANSPORTATION. FOR DOOR AND LOCK DETAILS, SEE SHEET 2 OF 2.
7. WITH THE EXCEPTION OF LARGE DOOR LOCK DETAILS, ALL CABINET DIMENSIONS ARE APPROXIMATE.
8. THE LARGE DOOR MUST BE SECURED AT THE TOP AND BOTTOM OF THE CABINET BY A LOCKING BAR.
9. ALUMINUM VENT WITH SCREEN SHALL BE INSTALLED UNDER FRONT LIP ABOVE DOOR.
10. THERMOSTAT TO BE INSTALLED IN TOP OF CABINET.
11. THE MAIN DOOR HANDLE SHALL ROTATE INWARD.

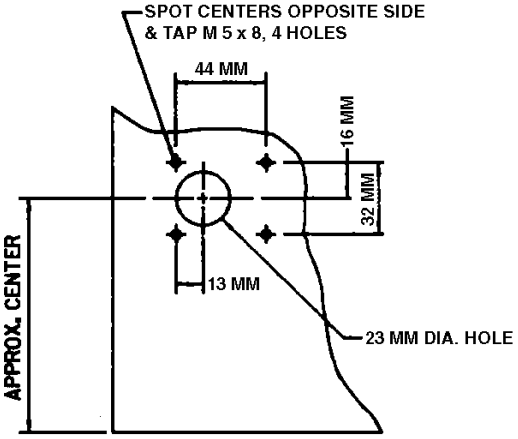
NEW JERSEY DEPARTMENT OF TRANSPORTATION	
TITLE: CONTROLLER CABINET TYPE "P" FOR FOUR AND EIGHT PHASE CONTROLLER	
SHEET 1 OF 2	DRAWING No. P-21



TYPICAL KEY
(BRASS)

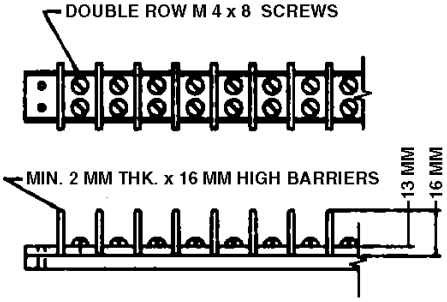


ANCHOR BOLT SLOT LOCATIONS



DOOR LOCK DETAIL

FIELD TERMINAL BLOCK
50 AMP., HIGH TYPE BARRIERS



NEW JERSEY DEPARTMENT OF TRANSPORTATION	
TITLE: CONTROLLER CABINET TYPE "P" FOR FOUR AND EIGHT PHASE CONTROLLER	
SHEET 2 OF 2	DRAWING No. P-21