# DOCUMENT REVISION RECORD

<table>
<thead>
<tr>
<th>ISSUE NO.</th>
<th>DATE</th>
<th>REVISION DESCRIPTIONS</th>
</tr>
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<tr>
<td>0</td>
<td>5-3-07</td>
<td>Interim Release</td>
</tr>
<tr>
<td>1</td>
<td>10-30-08</td>
<td>Revisions to incorporate MIC-EH design specifications that have been adopted by MDT.</td>
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<th>SECTIONS CHANGED</th>
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<td>1</td>
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3.01 INTRODUCTION

3.01.1 SCOPE
The scope of the design criteria for the Traction Power Installation Hardware shall include the criteria for establishing the parameters and design methodology of the equipment required to properly install and operate the Traction Power Equipment and Contact Rail and protective Coverboard Equipment described in Chapters 1 and 2 of this Design Criteria Volume.

3.01.2 SYSTEM DESCRIPTION
The Traction Power Installation Hardware includes all the necessary electrical and mechanical devices required to properly install and operate the Traction Power Equipment and Contact Rail and Protective Coverboard Equipment. It consists of Power and Control Cables, Blue light stations with Emergency Trip Stations, dc Disconnect Switches, Negative Bus Boxes, as well as other Installation equipment such as raceways, pullboxes, manholes, etc.

If system equipment, such as a PLC, requires climate control, it shall be provided.

Any special storage and installation requirements for the TPSS batteries shall also be addressed.

Equipment placement and station interior lighting and access shall be closely coordinated.

3.01.3 CODES, STANDARDS AND REGULATIONS
The currently adopted versions of codes, standards and regulations shall apply, and unless otherwise directed, all addenda, interim supplements,
revisions, and ordinances by the respective code body shall also apply. Where conflicts exist between these requirements, the more stringent requirement shall take precedence, unless otherwise directed by MDT.

- National Fire Protection Association (NFPA)
- National Electrical Code (NEC)
- National Electrical Safety Code (NESC)
- American National Standards Institute (ANSI)
- National Electrical Manufacturer's Association (NEMA)
- Institute of Electrical and Electronics Engineers (IEEE)
- Insulated Cable Engineers Association (ICEA)
- Occupational Safety and Health Act (OSHA)
- American Society for Testing and Materials (ASTM)
- Underwriter's Laboratories, Inc. (UL)
- Florida Building Code
- Metropolitan Dade County Fire Prevention and Safety Code
3.02 POWER AND CONTROL CABLES

3.02.1 15 KVA C PRIMARY FEEDER CABLES

See Volume II - Station Criteria, Chapter 4 "Electrical Design Criteria" for details of the 15 kVac primary feeder cables.

If the TPSS requires back up power for systems operation, such as a PLC, a connection to the passenger station’s UPS is required. If connection to the passenger station UPS is not feasible, then a connector shall be provided external to the TPSS building for temporary connection to a portable external generator. A manual transfer switch with associated hardware and wiring shall be provided.

3.02.2 DC FEEDER CABLES

A. To mitigate cable damage caused by temperature cycling, all Traction Power Cabling installed from traction power substations to final termination points in cable trays, troughs and/or duct banks shall be suitable for direct burial or duct installations in all wet and dry locations. Insulations shall be heat, moisture and chemical resistant, mechanically rugged zero halogenated compound type. All traction power cable installations shall be within non metallic conduits, cabletrays, and duct banks, and to the maximum extent possible protected by concrete covering. Installation of the dc cables within the guideway cabletray is not permitted. Any exception must be approved by MDT.

B. When tested in accordance with ICEA and UL requirements, the low smoke, non halogenated, flame resistant thermoplastic polyolefin (TPPO) jacket shall meet or exceeds the guaranteed values of ICEA, ASTM and NEC requirements.
C. This cabling shall be assembled with a shock absorbing cushion where a polyethylene jacket will be applied overall for the purpose of protecting the cable against physical damage.

D. At the discretion of the Engineer, the cabling shall be constructed with shielding and shall have excellent electrical properties, high dielectric strength, low power factor and high insulation resistance.

E. All cabling installed in cable trays, troughs and/or duct banks shall conform in every way to the specification section(s) and technical appendices which address traction power cabling in this project.

F. The cable shall be rated 2,000 Volt minimum for use at a conductor temperature of 90 degrees C. Conductors shall be round, coated, electrolytic grade, soft drawn copper in accordance with ASTM Designation B189. Cable designs, dimensions, test requirements and other construction features shall conform to the ICEA, NEMA, UL and ASTM standard publications specified herein.

G. Stranding of single conductor dc cables shall be in accordance with ASTM Designation Class B. Unless otherwise approved by MDT, the dc feeder cables from the TPSS to the guideway shall be 750 kcmil with 61 strands and extra flexible 777 MCM cables with 1927 conductor stranding shall be provided for jumpers from potheads to rail and expansion joints. Extra flexible cables shall have ASTM Class G stranding.
H. The traction power cables connecting the dc feeder breakers to the contact rail and from the running rails to the negative bus box shall be sized to accept maximum overload currents with a temperature rise not to exceed safe insulation design limits of the cables based on a desired life cycle of 40 years.

I. The cables shall have sufficient conductivity to maintain traction power voltage levels within the limits defined, confining the major voltage drops to the contact and running rails rather than permitting excessive voltage drop in the connecting cables.

J. Negative cable conductivity equivalent to positive cable conductivity shall be provided between the substation negative bus box and the connection to each pair of the running rails.

K. Conductor sizes shall be standardized except as otherwise noted in these criteria. Feeders shall be a multiple number of standardized conductors for different capacities. Standard conductor size shall be selected to optimize installation and lifetime maintenance cost.

L. From the interior face of the substation wall, extending toward the contact and running rails, the positive and negative traction power cables shall be adequately protected by non-metallic conduits, such as schedule 80 PVC or Fiberglass Reinforced Epoxy (FRE), concrete encased both underground and along the piers to a height of 8 feet for physical protection. All conduit stub-ups shall be protected against damage during construction operation.
M. All ends of exposed conduits shall be capped and sealed to prevent intrusion of water, rodents and insects.

N. The ends of all exposed conduits shall be identified by non-removable embossed tags.

3.02.3 CABLE TERMINATIONS

Since the contact rail constitutes a vibrating mass, provision shall be made in the design of all cable terminations to the rail to assure no cable termination failures. The design shall utilize standard stranding feeder cables terminating in a non-metallic, ozone resistant, junction box adjacent to the contact rail, with extra flexible stranded cables being provided for the final connection to the rail.

3.02.4 CABLE SUPPORTS

Traction power positive cables from the dc feeder breakers and negative cables from the negative bus connections shall be laid or run in appropriate raceways such as non-metallic cable trays, cable trenches or on racks through the substation and gap tie station.

Such raceways shall provide adequate cross sectional area to permit a neat alignment of the cables and avoid crossing or twisting.

On racks, porcelain insulators designed for such purpose shall be used on the supporting arms. Such supporting arms or racks shall be spaced to avoid excessive weight or pressure against the cable insulation. The cables shall be arranged in not more than two layers. Positive and negative cables shall be run in separate non-metallic raceways.
Only non-metallic raceways of Fiberglass Reinforced Epoxy (FRE) or schedule 80 PVC shall be used. PVC is acceptable for use in open outdoor areas where permitted by codes and standards.

3.02.5 CABLE ADAPTERS
Cable adapters will be used as transition points for soft drawn stranded power feeder cable and extra flexible cable which will be terminated at the contact rail. They shall be one piece tin plated copper and act as a transition for the soft drawn copper power feeder cables to extra-flexible stranded cables for termination to the contact rail.

3.02.6 CONTROL CABLES
See Volume II-Station Criteria, Chapter 4 “Electrical Design Criteria” and Volume VII, Chapter 7, “Communications Design Criteria” for details of the control cables.
3.03 EMERGENCY TRIP STATIONS

3.03.1 GENERAL

Blue Light Stations as identified by NFPA standards shall be provided within the Metrorail System. The Blue Light station shall provide an Emergency Trip Button, an emergency telephone with a direct line connection to central control, and a distinctive blue light to identify the location.

Within the Metrorail system, the Blue Light Station is sometimes simply referred to as the Emergency Trip Station (ETS).

The traction power Emergency Trip Station (ETS) provides the capability to remove power from all contact rails in a power zone. The power zone shall be defined so that trains cannot enter the emergency zone where the ETS was tripped.

The ETS zone will be from the station platform of one station to the two adjacent traction power substations that feed toward that station from either direction, one station North and one station South for this example. In a simple two track system, an ETS trip will require 4 dc feeder breakers to be opened at the station where the ETS was tripped, and 2 breakers for the adjacent station to the North and 2 breakers for the adjacent station to the South for a total of 8 dc feeder breakers opening. The intent is to remove all power from the zone and prevent the unintended energizing of the emergency zone by a train crossing a bridgeable gap from an energized zone.

The trip switch shall be self locking and can only be reset by key. Activation of the mechanical lockout capability at a station or mainline ETS shall preclude restoration of power on either track of the power zone controlled by the ETS.
until the mechanical lockout is released. When not in the lock out condition (that is, after the switch is reset by the key operation of the particular trip station), power control then will be maintained only by the Central Control Operator. It shall be possible to restore power on the opposite track from the emergency, if such power restoration does not impact safety in the emergency zone. This will permit controlled operation of trains at a reduced performance level on the opposite track if desired. Upon the installation, and as per Contractor’s request, MDT’s Safety and Security group will provide the key pattern for compatibility of the new ETS equipment with the existing ETS equipment.

3.03.2 BLUE LIGHT STATION EQUIPMENT
Traction power Blue Light Stations with Emergency Trip Stations (ETS) shall consist of a NEMA 4X stainless steel electrical enclosure, with a mechanical device to trip contact rail feeder circuit breakers to an open condition, using either relay technology or a communication based system, with appropriate lockout capability and thereby remove power from all sections of contact rails within a power zone; a bypass switch shall be provided for each ETS ring circuit, a dedicated direct line emergency telephone communicating only to Central Control and a UL Listed wet location lighting fixture, with a shatter resistant blue globe, for identification purposes, which, within the access area, is visible during inclement weather and at night. The lamp illumination shall be visible within 800 feet in either direction, and shall have expected bulb life of 10,000 hours. The tripping feature shall be designed to be fail safe. The entire ETS system shall be designed to have an availability of 99.99 percent or better.
Mounting hardware shall utilize stainless steel channel supports, mounting plates, nuts, bolts and any other hardware as required.

3.03.3 BLUE LIGHT STATION LOCATION

Traction power Blue Light Stations with Emergency Trip Stations (ETS) shall be located at strategic locations throughout the system. They shall be located as follows:

A. At each end of each platform in a position outside the station platform public area which is easily accessed by persons on the station platforms and/or on the adjacent guideways at each at-grade area designated for hi-rail vehicle insertion, and at other locations where entry or access to the rails is possible.

B. Within each station attendant's booth and within each line supervisor's booth.

C. On the maintenance yard and shops and the test track facilities. Emergency Trip Stations shall be provided on the yard site, maintenance areas and test track as directed by MDT.

D. At the entrance to the Traction Power Substation, mounted externally to the building for use by emergency response personnel. The ETS button shall be within an enclosure accessible only by MDT and emergency response personnel.

E. At locations where an extraordinary hazard may exist.
The Designer shall submit the proposed Blue Light Station/ETS locations to MDT Safety group for approval. MDT may add or delete locations at their discretion.
3.04 DC DISCONNECT SWITCHES

3.04.1 GENERAL

The dc disconnect switches will be used in the yard area of the Maintenance Facilities and in special locations throughout the mainline system to isolate power from a section of the contact rail during maintenance, repairs, and emergency conditions.

3.04.2 DISCONNECT SWITCH ASSEMBLY

The dc disconnect switches are covered in Volume VII, Chapter 1, Traction Power Equipment Design Criteria. Remote control from Central Control and indications to Central Control will be provided for the motor operated switches by way of the input/output modules of the PLC based SCADA system.

The dc disconnect switches shall be housed in a weatherproof, fiberglass enclosure.

The designer shall consider current industry practices and MDT’s operating practices and procedures to determine if interlocks should be provided to prevent the switches being operated when the circuits are energized.
3.05 NEGATIVE BUS BOXES

3.05.1 GENERAL

The negative bus boxes will be used as a common termination of negative return cables from the tracks, and from the negative terminal of the rectifiers.

3.05.2 NEGATIVE BUS BOX ASSEMBLY

Bus box enclosures will be free standing, metal enclosed, indoor type, with all corners continuously welded. The enclosure will be gasketed.

Bus bars will be tin-plated copper. Traction power negative returns will be terminated at this box. It will have provisions for connecting a negative drainage panel to provide for utility drainage cable connections.

Locations of negative return connections to the running rails must be coordinated with the design of the train control system.

Sufficient cross bonds shall be provided to assure utilization of the four running rails in parallel. Cross bonding of the rails shall be coordinated with train control requirements but shall be spaced no greater than 1,500 feet.
3.06 OTHER INSTALLATION HARDWARE

All wires and cables entering the TPSS shall be properly protected from surges and lightning.

For details of other installation hardware (for example Raceways, Pullboxes, Manholes, etc.) see Volume II-Station Criteria, Chapter 4 "Electrical Design Criteria" and Volume II- Guideway Criteria, Chapter 4, “Electrical Design Criteria”.