TRANSIT

RAPID TRANSIT SYSTEM EXTENSIONS
COMPENDIUM OF DESIGN CRITERIA

VOLUME II
STATION DESIGN CRITERIA

CHAPTER 4
ELECTRICAL DESIGN CRITERIA

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MIAMI-DADE COUNTY
TRANSIT

VOLUME II - STATION

CHAPTER 4 – ELECTRICAL DESIGN CRITERIA

REVISION 1

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VOLUME II - STATION

CHAPTER 4 – ELECTRICAL DESIGN CRITERIA

REVISION 1

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4.01 GENERAL

4.01.1 PURPOSE

These criteria apply to the design of electric power, control, lighting and supervisory subsystems for the Stations within the Metrorail Line Extension.

Within this document, the term “Stations” refer to Metrorail facilities, to include; passenger stations, train control and communications rooms, traction power stations, gap tie stations, parking structures or parking lots, guard stations and other related structures unless otherwise noted. The Electrical criteria applicable to the guideway structure are covered in Volume III - Guideway, Chapter 4, Electrical Design Criteria, which should be used in close conjunction with this design criteria. Also supplementing these criteria are the Electrical Standard, Directive Drawings and other related design criteria

4.01.2 BASIC GOALS

4.01.2.1 The design shall:

A. Provide for safe, economical, reliable and continuous operation of the entire Metrorail system.

B. Promote uniformity and standardization in design and equipment.

C. Facilitate installation and maintenance of the equipment.

D. Provide reasonable spare capacity for future use, specifically spare electrical service capacity, panel spaces and spare conduits.

4.01.3 SCOPE

The following shall be included in the scope of the Station's electrical system design:

A. The electrical power requirements for the Metrorail stations and related facilities. The Station's electrical design shall provide the necessary electrical power, panels, raceways, conduits, conductors and cables to support all Metrorail systems related to the Station.

B. A raceway system is required to provide pathways for all cables and conductors between the station, facilities and equipment to include wayside equipment. Raceway systems and interfaces from the stations to the guideway structure are also covered in Volume III - Guideway, Chapter 4, Electrical Design Criteria.

C. Supervisory monitoring of the facilities and equipment.

D. Lighting requirements.

4.01.4 OTHER RELATED DESIGN CRITERIA

In addition to this Stations design criteria, other criteria, listed below, have requirements related to the Station's electrical design

4.01.4.1 The station's electrical design must accommodate the Station's Fire Alarm System, CCTV Security System, Public Address System, Variable Message Signs, and an Access Control System. Refer to:

Volume I – Systemwide

Chapter 7 – System Safety

Chapter 8 – System Security

Chapter 9 - Fire/Life Safety

4.01.4.2 Grounding and lightning protection is required for all aerial and at grade fixed facilities and equipment at the Stations to include rail, fences, and wayside equipment. To avoid duplication, these criteria are now covered in Volume III – Guideway, Chapter 4, Electrical Design Criteria

4.01.4.3 Corrosion control requirements exist for the Stations and related facilities for monitoring, controlling and minimizing stray currents. To avoid duplication, these criteria are now covered in Volume III – Guideway, Chapter 4, Electrical Design Criteria.

4.01.4.4 Supervisory monitoring of the facilities and equipment is required. The Station's equipment alarms and control signal lines are required to interface to the Metrorail Communications Network (MCN). Only the alarms and control signals related to the Station's electrical system are identified in this criteria. Other Metrorail Systems within the Stations and their interfaces are covered in separate criteria. Refer to:

Volume VII – Systemwide Equipment,

Chapter 1 – Traction Power Equipment
Chapter 3 – Traction Power Installation
Chapter 4 – Fare Collection
Chapter 6 – Train Control
Chapter 7 – Communications

4.01.5 INTERFACE DEFINITION AND CONTROL

The Station's electrical subsystem interfaces with a number of other subsystems and incorporates many interfaces between subsystems. In every case of subsystem to subsystem interface (for example, Traction Power

Substation / Passenger Station Interface) the interface will be defined by the Designer, and approved by MDT. Changes shall only be made upon approval by MDT. Section 4.06, Systems/Facilities Interface Raceway defines these interfaces to a great extent. Electrical subsystem interfaces are defined within these criteria and other related criteria and may change during the design process by MDT directive.

Commentary: Since the phase I electrical design was performed by more than one group, the design criteria attempted to define specific interface raceways between subsystems in detail. Since it is anticipated the new extension designs will be the responsibility of a single designer, and the interfaces and conduits may vary from phase I, the raceway requirements provided within this criteria should be used only as a guideline.

4.01.6 CODES, STANDARDS AND REGULATIONS

4.01.6.1 Unless otherwise indicated elsewhere, the Station's electrical system design shall conform to the latest edition of the following codes, standards and regulations:

- National Electrical Code (NEC)
- National Electric Safety Code (NESC)
- Miami-Dade County, City of Miami, Coral Gables, Hialeah and other Authorities Having Jurisdiction (AHD)
- American National Standards Institute (ANSI)
- National Electric Manufacturers Association (NEMA)
- Institute of Electrical and Electronic Engineers (IEEE)
- Insulated Power Cable Engineers Association (IPCEA)
- The Occupational Safety and Health Act (OSHA)

- Florida Building Code (FBC)
- Lightning Protection Code (NFPA No. 780)
- Local Protective Signaling Systems (NFPA No. 72A)
- Proprietary Signaling Systems (NFPA No. 72D)
- Automatic Fire Detectors (NFPA No. 72E)
- Life Safety Code (NFPA 101)
- American Society for Testing and Materials (ASTM)
- Certified Ballast Manufacturers Association (CBM)
- Underwriters' Laboratories, Inc. (UL)
- Illuminating Engineering Society (IES)
- Florida Fire Prevention Code
- American with Disabilities Act (ADA)

The current version of these documents, and applicable 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 documents, the more stringent requirement shall take precedence, unless otherwise directed by MDT.

Electrical design work shall be performed in accordance with the rules and regulations of the State of Florida, Department of Business Regulation, for Professional Engineers (PE).

4.01.6.2 Where the requirements of more than one code or standard are applicable or are in conflict, the Designer shall bring it to the attention of MDT in a timely manner with a recommendation for resolution by MDT.

4.01.7 PROCUREMENT AND INSTALLATION (RESERVED)

4.02 ELECTRICAL SYSTEMS

4.02.1 SCOPE

This section defines the general design requirements for the electrical power, control and communications of the facilities elements for the Metrorail Line Extension. These elements include:

- Plumbing and irrigation
- Heating, ventilation and air conditioning
- Escalators and Elevators
- Change dispensing and fare collection equipment power supply
- Backup and Emergency power
- Facilites Lighting
- Utility receptacles & Inspection lighting
- Clocks
- Illuminated fixed signing
- Variable Message Signs
- Parking lot control gates
- Train control equipment power supply
- Communication equipment power supply
- Traction Power Substation auxiliaries
- Gap Tie Station auxiliaries
- Blue Light Station with Emergency Trip Station (ETS)
- CCTV System
- Public Address (PA) System
- Fire Alarm System
- Access Control and Intrusion Alarms

4.02.2 POWER SUPPLY

4.02.2.1 Primary Power

A. Primary power at 13.2 kiloVolts (kV) shall be supplied to the Passenger Station Electrical Equipment Room by the electrical utility provider by means of two feeders. These feeder circuits will be terminated at the line side of each three-pole, two-position (open-close) load break air interrupter switch of each indoor type unit substation.

B. Each primary feeder shall be sized for a minimum of 150 percent of the self-cooled rating of the transformer and to withstand the maximum available short circuit current.

C. Each unit substation equipment shall consist of one metal enclosed 15 kV two-position load break air interrupter switch; one three-phase dry type ventilated transformer, 13.2 kV-480Y/277 Volts; one 480 Volt main power circuit breaker and necessary molded case feeder circuit breakers. One of the substations shall have one 480 Volt tie power circuit breaker. Each transformer shall be sized to handle the total demand load of the Passenger Station and other auxiliaries without the need of fan cooling. Transformers shall have provisions for fan cooling, if needed in the future. The main circuit breakers shall be provided with solid state long-and-short time trip devices and ground fault protection. All feeder breakers shall be provided with long time and instantaneous trips. Normally, both main breakers shall remain closed and the tie breaker shall remain open. Main circuit breakers and the tie circuit breaker shall be provided with an automatic throw over control which operates in the following manner:

In the event of loss of power on any of the incoming feeders, or loss of a transformer, an under voltage relay shall sense the loss of voltage and trip the respective main breaker after a time delay of five seconds. If the normal voltage is restored during the time delay period, the main breaker shall remain closed. Once a main breaker opens, the tie breaker shall close after a time delay of five seconds thus restoring power to the dead switchboard. Upon restoration of power to the failed feeder or after the transformer has been properly refurbished, the breakers shall be restored to their normal position manually. The above transfer operation shall take place only for tripping of the main breaker due to under voltage. For other tripping of the main breaker, such as short circuit or ground fault, the tie breaker shall remain open.

For the extension design, the Designer shall investigate the suitability of modern Intelligent Electronic Breakers with expanded control and monitoring capabilities over the existing implementation and provide a recommendation to MDT.

4.02.2.2 Concrete Encased Service Duct Banks

A. The Passenger Station incoming primary feeder duct bank shall consist of a minimum of four each 4” diameter PVC conduits (two spares) and two each 2” diameter PVC conduits (one 2” diameter conduit for 480V feeder to Traction Power Substation and one 2” diameter spare conduit) and shall extend from the passenger station Electrical Equipment Room to the Traction Power Substation at a minimum of two feet below ground level and identified. Duct bank concrete envelope and reinforcing shall be as indicated on Electrical Standard Drawings.

B. The Parking Structure service duct bank shall extend from the passenger station Electrical Equipment Room to the Parking Structure Main Electrical Closet. Duct bank configuration, number and size of PVC conduits shall be determined taking into consideration both initial and future level lighting loads; elevators and fire pump (if any), CCTV and other systems. Refer to the other related design criteria for complete parking structure electrical requirements.

4.02.3 INCOMING TELEPHONE SERVICE AND PUBLIC TELEPHONES

4.02.3.1 One 2" diameter PVC empty conduit shall be extended from the telephone backboard in the passenger station Electrical Room to the station property line and capped for telephone incoming service. Coordinate exact location of stub out, hand holes and other requirements with the telephone service provider selected by MDT; BellSouth or other.

Two 1" diameter PVC empty conduits shall be provided, one from each end of the Fare Collection area, to the Telephone Backboard in the passenger station Electrical Room for public telephones. Conduits in the Fare Collection area shall be terminated in a flush outlet box four feet above finished floor in the Public Telephone Booths.

ADA requirements shall be taken into consideration for public telephone locations and access.

4.02.4 GENERAL ELECTRICAL CHARACTERISTICS

Facilities distribution voltage shall be nominal 480Y/277 Volts, three phase, four wire, 60 hertz. Voltage other than the distribution voltage shall be obtained with dry type transformers. Utilization voltages for electrical devices

and equipment requiring ac power shall conform to the following characteristics:

• Fluorescent lighting	277 Volts, single phase
• Incandescent lighting	120 Volts, single phase
• High intensity discharge lighting	277 Volts, single phase
• Convenience receptacles	120 Volts, single phase
• Inspection lighting receptacles (in box structures)	120 Volts, single phase
• Motors 1/2 HP and above (Motor rating 460 v, three phase)	480 Volts, three phase
• Motors under 1/2 HP	120 Volts, single phase or 208 Volts, single phase
• Starter control power	As required
• Hot water tank heaters & space heaters	120 Volts, single phase up to 1,000 watts 208 or 480 Volts, single phase above 1,000 watts or three phase
• Train Control and Communications equipment	120 Volts, single phase and 208Y/120 Volts, three Phase (Derived system through Isolation transformer)
• Change Dispensing and Fare Collection equipment	120 Volts, single phase
• Feeder to Traction Power Substations	480Y/277 Volts, three phase, four wire
• Feeder to Gap Tie Stations	277 Volts, single phase, two wire
• Emergency power	As Required per NFPA and other applicable codes
• Special receptacles	As Required
• Electric clocks	As required

• Dry type transformers	480 Volts delta to 208Y/120 Volts, three phase, four wire
• Incremental air conditioners	120 or 208 Volts, single phase

4.02.5 DEMAND FACTORS

The following demand factors shall be used for sizing unit substation transformers:

Service	Demand Factor
• Lighting and signs	per N.E.C.
• Emergency lighting	per N.E.C.
• Fare collection equipment	per N.E.C.
• Elevators	per N.E.C.
• Escalators	per N.E.C.
• Ventilation equipment	per N.E.C.
• Air conditioning equipment	per N.E.C.
• Drainage pumps and ejectors	per N.E.C.
• Traction Power Substation auxiliaries	per N.E.C.
• Gap Tie Station auxiliaries	per N.E.C.
• Train control equipment	per N.E.C.
• Communications equipment	per N.E.C.
• Convenience receptacle	per N.E.C.

One hundred percent demand factor shall be used for sizing feeder circuit breakers and their respective feeders.

4.02.6 PANELBOARDS

4.02.6.1 General

A. Panel boards shall be located in Electrical Equipment Rooms, Electrical Rooms, Electrical Closets or suitable ancillary rooms located near the loads to be served. All branch circuit homeruns shall be shown and identified on the floor plans with the panel board designation and circuit number for the individual circuit. Conduit and Feeder Schedules shall be used to list all empty conduits and all feeders. Panel boards shall be Equipped with a minimum of 20 percent spare breakers.

B. Ampacity and protection of panel board feeders shall be adequate for the size of the panel boards based on the demand load, plus estimated future load.

4.02.6.2 Panel Board Designations

Panel boards shall be designated depending on their function and service Voltage as follows:

480Y/277 Volts	Designation
Lighting panel	L1, L2, L3, etc.
Distribution panel	DI,D2,D3, etc.
Power panel	P1,P2,P3, etc.
Motor control center	MCCI,MCC2,MCC3, etc.
Motor starter panel	MSPI,MSP2,MSP3, etc.
Emergency lighting panel	EL1,EL2,EL3, etc.
Emergency power panel	EP1, EP2, EP3, etc.
Emergency distribution panel	ED1, ED2, ED3, etc.

Standby lighting panel	SL1,SL2,SL3, etc.
Standby power panel	SP1, SP2, SP3, etc
Standby distribution panel	SD1, SD2, SD3, etc.

208Y/120 Volts	Designation
Lighting, receptacles and miscellaneous power	LL1, LL2, LL3, etc.
Distribution panel	DD1, DD2, DD3, etc.
Emergency lighting panel	ELL1, ELL2, ELL3, etc.
Emergency power panel	EPP1, EPP2, EPP3, etc.
Standby lighting panel	SLL1,SLL2,SLL3, etc.
Standby power panel	SPP1, SPP2, SPP3, etc

4.02.7 MOTORS

Integral horsepower motors for driven equipment shall be totally enclosed fan cooled squirrel cage induction motors. They shall be High Efficient NEMA Design B unless the application requires other torque-speed characteristics. Fractional horsepower motors shall be totally enclosed fan cooled or non-ventilated except where applications or environmental conditions dictate otherwise.

TABLE 1 – MOTOR WIRING AND LOAD DATA - RESERVED

4.02.8 MOTOR CONTROLS

4.02.8.1 General

A. Circuit breaker combination starters in motor control center type construction shall be used for the 480 Volt motors. Motor control centers shall be equipped with a main circuit breaker as part of the equipment. Main busses shall be adequately braced for the available short circuit. Motor control centers shall be NEMA Class II, Type B wiring. However, individually mounted circuit breaker combination starters may be used where practicable.

B. All starters shall be magnetic, full voltage start, single speed, non-reversing type or reversing type except when the driven equipment characteristics require other types. Each three phase starter shall be equipped with 120 Volt control power transformer and three thermal overload relays, and auxiliary contacts for remote monitoring. Each single phase starter shall be equipped with 120 Volt coil and two thermal overload relays.

C. Control stations having lockout type stop button and a start button or hand-off-auto switch may be provided near each motor.

D. Enclosures for motor control centers, motor starters and control devices shall be NEMA type 12 except where environmental conditions dictate otherwise. Wiring for motors, size of starter and circuit breaker ratings shall be per N.E.C.

4.02.9 EMERGENCY AND STANDBY SYSTEMS

4.02.9.1 Automatic Transfer Switches (ATS)

The primary power feeders, one from each unit substation, shall be connected to the line side of the necessary Automatic Transfer Switches (ATS) installed at the station. The ATSs shall be a 4 wire units which also switches the neutral.

4.02.9.2 Uninterruptible Power Supply and Generator

Backup power is required in the event of interruption of primary power- the electrical power supplied by the utility. Backup power shall be supplied at the station by a combination of a battery powered uninterruptible Power Supply (UPS) and a LPG fueled generator.

The back power is intended to supply;

A. Emergency loads, and
B. Standby loads essential to station operations.

It is important to define these loads separately, since their specific power requirements, durations, certifications and inspections vary.

4.02.9.3 Emergency Power

Emergency Power is defined as power needed to supply the equipment in order to comply with life/safety requirements as determined by applicable codes, the AHJ and MDT.

Emergency power shall be provided for operation of the following equipment:

A. Emergency lighting
B. Exit signs
C. Emergency audio-visual announcements (Horns, PA and VMS signs)

D. Fire & Life Safety related loads

The Designer shall investigate other equipment which may require emergency power in order to properly operate in an emergency situation, such as;

A. Access Control equipment -gates and door locks
B. Fare collection equipment for emergency egress

4.02.9.4 Standby Power

Standby backup power shall be provided for operation of the following:

A. Select Non- Emergency station lighting
B. Access Control equipment
C. Train control equipment
D. Fare collection equipment
E. Communications equipment circuits (Refer to Vol VII, Chapter 7- Communications Design Criteria).

4.02.9.5 Uninterruptible Power Supplies (UPS)

Uninterruptible Power Supplies (UPS) shall consist of pre-engineered "packaged" stackable “smart” units. These units shall contain all components necessary for the operation of the loads, to include; Batteries, transfer system, charger, inverter, test switch, load centers, indicator lights and meters. The UPS shall be “online” at all times, thereby filtering the power to the loads and preventing an interruption of power upon a primary power failure.

4.02.9.6 UPS Management

The UPS shall be provided with SNMP compatible management program with an Ethernet interface for control and monitoring. UPS management interface

will connect to the MDT communications network as defined in Volume 7, Chapter 7 - Communications System Criteria.

4.02.9.7 The battery systems shall have sufficient capacity to:

A. Supply the emergency load continuously for 90 minutes, unless otherwise dictated by other codes, the AHJ or as directed by the MDT

B. Supply the standby loads for 90 minutes, unless otherwise directed by MDT

In the event of the station's generator failure to start, the 90 minute battery capacity will assure code compliance and an orderly shutdown of station operations.

4.02.9.8 Generator size

The Generator when in operation shall be properly sized to provide power to;

A. The emergency loads,

B. The standby loads, and

C. To restore and maintain the charge on the UPS batteries.

4.02.9.9 Generator Startup

The generator shall be programmed to start within five minutes of a primary power failure. The generator ATS shall switch the generator online, replacing the utility as the primary source of power to the loads listed in 4.02.9.7.

4.02.9.10 Generator Operation Time

The generator's fuel tank shall be sized to provide up to 72 hours of operation while supplying power to the loads listed in 4.02.9.7.

4.02.9.11 Restoration of Primary Power

Upon restoration of primary power from the utility, the load shall be automatically transferred from the generator to the primary source. The UPS will remain online, thereby providing uninterrupted filtered power to the loads.

4.02.10 WIRING METHODS

Wiring within facility areas shall be in rigid metallic or non-metallic conduits as described in Section 4.02.11. Cable trays may be used in specific areas when approved by MDT. Expansion fittings shall be provided where conduits pass through expansion joints.

Conduits shall be concealed within the station passenger areas where possible.

Pull and junction boxes shall be accessible or preferably readily accessible as defined by NEC.

4.02.11 MATERIAL

4.02.11.1 Materials used shall be listed by UL or other NRTL and conform to the following:

A. Conduit

1) Minimum size of conduit shall be 3/4 inch for exposed work and one inch conduits embedded within a column and for all embedded applications in floor slabs. 1/2 inch conduits are acceptable for small diameter low voltage communications and CCTV cables. Conduit fill ratios shall not exceed NEC standards.

2) Galvanized rigid steel conduit shall be used for exposed and embedded work and concealed work in ceiling spaces or behind walls.

3) Rigid non-metallic conduit shall be used for underground or under floor applications, either direct burial or concrete encasement. An example of the application is for enclosing primary feeder conductors which run from the Traction Power Substations to Passenger Station Electrical Equipment Rooms. Rigid non-metallic conduit shall not be used for the support of lighting fixtures. A continuous green bonding wire shall be provided in all non-metallic conduit runs.

4) Flexible metal conduit (minimum 18 inch length) shall be used for:
   a) Recessed lighting fixtures
   b) Transformers
   c) Vibrating electrical equipment in dry locations
   d) Other electrical equipment in dry locations for maintenance convenience.

5) Liquid-tight flexible metal conduit (minimum 18 inch length) shall be used for:
   a) All motors
   b) Vibrating electrical equipment in wet locations
   c) Other electrical equipment in wet locations for maintenance convenience.

6) Conduit fittings shall be of materials similar to the adjoining conduit.

B. Cable Trays (within Passenger Stations) shall be non-metallic ladder type. Power cables and control cables shall be in separate channels.

C. Under floor Ducts: Separate, non-metallic under floor ducts shall be used to facilitate the separate routing of power and control cables from the Change Dispensing and Fare Collection equipment to the Change Dispensing and Fare Collection equipment panel board in the Electrical Room and the Station Attendant's Booth, respectively.

D. Conductors:

1) All conductor material shall be copper. Use of aluminum conductors must be specifically approved by MDT for each application.

2) Conductors shall be properly sized for ampacity and voltage drop per NEC. In general, minimum conductor size shall be No. 16 AWG for fixture wire, No. 14 AWG for control and No. 12 AWG for lighting or power branch circuits.

3) Conductors for 15 kV application shall have cross-linked polyethylene insulation, shielded, with overall neoprene jacket.

4) Conductor insulation for system voltages up to 480 Volts shall be 600 Volt class, THHN or XHHW. (90°C insulation)

5) Fixture wire shall be type SF-2 or AF (for 300 Volt indoor use only).

6) For cable tray application, multi-conductor cables with flexible galvanized steel armor (or other shielding when so required) and neoprene jacket shall be utilized. Proper grounding fittings shall be applied at the ends of all flexible armored cables at terminations, boxes or cabinets to assure continuity of grounding conductor. All metal surfaces shall be bonded together. Where necessary, additional bonds or ground connections shall be provided.

7) All feeders shall be sized for future growth of the system. Short wiring interconnections between switches or panels shall be in conduit. Cable splices shall be avoided; however, where more than one length is required, splices shall be made in properly sized accessible junction boxes.

E. Wiring Devices

1) Receptacles: Convenience duplex receptacles shall not be on lighting circuits. All receptacles in public areas shall be installed in a weatherproof, lockable type box and shall be protected by a ground fault (GFI) type circuit receptacle. Convenience receptacles shall be sized for 20 Ampere service. Not more than six receptacles shall be placed on each circuit.

Convenience duplex receptacles shall be located as follows:

a) Public areas of station structure: These shall be spaced so that not more than 50 feet of cord will be required to reach any point from the receptacles. These receptacles shall be located flush in the walls or in the floors as required. Special attention

shall be given to floor mounted receptacles such that no tripping hazard is presented.

b) Ancillary Spaces: There shall be a minimum of one surface mounted duplex receptacle for each wall or 30 feet of wall inside the ancillary spaces. More shall be provided where indicated by operational requirements.

c) Maintenance Outlets in Passenger Station: One convenience duplex receptacle shall be provided at every hose bib location within the passenger station public areas. A safe separation shall be provided between hose bib and receptacle.

d) Receptacles for guideway box structure inspections; receptacles shall be installed within each guideway structure at each inspection entrance to provide electrical power for portable lighting for inspection purposes. The electrical power shall be supplied by the nearest MDT facility.
See Vol. III Guideway, Chapter 4 Electrical.

2) Switches: Surface mounted wall switches shall be installed inside each room of the ancillary spaces to control the lighting. Switches shall be rated 20 amps, 120-277 Volt ac.

F. Disconnect Switches

Where required by the National Electrical Code, motor circuits shall have integral disconnect switches, plug-in devices or separately mounted non-fusible disconnect switches within sight of the motor. These devices and switches shall be heavy duty safety types having a NEMA 12 enclosure

for indoor dry locations and NEMA 4 for wet locations both indoor and outdoor. All branch circuit disconnect switches shall be heavy duty type, fused or un-fused, as the application requires.

G. Transformers

Transformers shall be dry type with standard full capacity taps on high voltage winding. Transformers shall be three phase, having a 480 Volt high voltage winding and a 208Y/120 Volt low voltage winding. They shall be wall mounted for ratings up to 30 KVA.

4.02.12 VOLTAGE DROP

Voltage drop calculations shall be prepared for all Branch circuits and feeders. Calculations for motor circuits shall be based on the N.E.C. The total voltage drop from the 480 Volt switchboard to the point of utilization shall not exceed the following:

- Fluorescent lighting 5 percent
- Incandescent lighting (Indoor) 5 percent
- High intensity discharge lighting (indoor) 5 percent
- High intensity discharge lighting (Outdoor & Parking lots) 5 percent
- Receptacles 5 percent
- Motors 5 percent
- Incandescent lighting (Outdoor) 5 percent

4.02.13 HEATING, VENTILATION AND AIR CONDITIONING AND CONTROLS

Electrical power feeders and branch circuits shall be provided at each passenger station for heating, ventilation and air conditioning and control equipment described in Volume II, Chapter 5, Mechanical, of this compendium.

4.02.14 ELEVATORS

The power supply to each elevator shall be sized per the equipment's requirement. A separate 120 Volt, 20 ampere circuit and 120 Volt, 20 ampere emergency power circuit shall be provided for the hoistway and pit lighting and receptacles and to return the elevator cab to the ground level and open the doors respectively in the event of a power failure. The circuits shall be terminated in separate fusible disconnect switches in the Elevator Machine Room.

4.02.15 ESCALATORS

The power supply for each escalator shall be sized per the equipment's requirement. The feeder shall be sized as per N.E.C. A separate 120 Volt, 20 ampere circuit shall be provided for each escalator for maintenance lights and receptacles and terminated in a fusible disconnect switch in the Escalator Pit.

4.02.16 PUMP AND COMPRESSOR STATIONS

A 480Y/277 Volt, three phase, four wire feeders shall be run from the unit substation or from a power panel board to the pump or compressor station.

4.02.17 TRAIN CONTROL AND COMMUNICATIONS ROOM

4.02.17.1 Train Control

One 208Y/120 Volt, three phase, four wire feeders shall be provided for a demand load of 15 KVA at non-interlocking stations and 30 KVA at interlocking stations. The designer shall obtain equipment loads and perform calculations to confirm feeder sizes are adequate.

The Train Control equipment contains two redundant dc power supplies, each with independent 120/208 Volt input feeds. To avoid a possible single point

of failure, the two power supplies should be fed from separate power sources. The Train Control primary dc power supply should be fed from the backup power source. The input power to the second power supply should come from a separate fused disconnect connected to the load side of the "A" feeder in the Train Control & Communications room. The intent of this second direct feed is to bypass the ATS, UPS and other associated circuits if those circuits are powered down for maintenance.

4.02.17.2 Communications

A. One 208Y/120 Volt, three phase, four wire feeders shall be provided for a demand load of 25 KVA at non-interlocking stations and 30 KVA at interlocking stations.

B. One 120 Volt, single phase, two wire feeder shall be provided at all stations for a demand load of 7.5 KVA.

Train Control and Communications feeders shall be supplied from the backup power supply and terminated in an individually mounted circuit breaker located in the Train Control and Communications Room. The designer shall obtain equipment loads and perform calculations to confirm feeder sizes are adequate.

4.02.18 CHANGE DISPENSING AND FARE COLLECTION EQUIPMENT

120 Volt, 60 Hz power shall be supplied to change dispensing and fare collection equipment in accordance with the Electrical Directive Drawing from a 208Y/120 Volt, three phases, four wire panel located in the Electrical Room. Panel rating and number of poles shall be determined based on equipment load requirements.

The equipment circuits shall be supplied from the back-up power supply.

4.02.19 TRACTION POWER SUBSTATION

The auxiliary lighting and power requirements of each Traction Power Substation shall be supplied from the adjacent passenger station with one 480Y/277 Volt, three phases, four wire feeder fed from the load side of the automatic transfer switch located in the passenger station Electrical Equipment Room and one spare conduit.

Distribution equipment including distribution and lighting panels, transformer, 120 Volt convenience receptacles, and self-contained battery operated emergency lights shall be provided inside the Traction Power Substation. In addition to the above lighting and power requirements, the following loads shall apply to the Traction Power Substation equipment:

208Y/120 Volt System

Type of Load	Breaker Type	Quantity	Load (Watts)
Heaters for ac Switchgear	1P-15A	11	5500
Heaters for dc Switchgear	1P-15A	9	4500
Outdoor Lighting for ac equipment	1P-20A	1	500
Spares	1P-20A	6	5400

4.02.20 GAP TIE STATION

Each Gap Tie Station shall be supplied with one 277 Volt, single phase, two wire auxiliary power feeder from one of the unit substations in the nearest passenger station for power and lighting requirements as indicated on the Electrical Directive and Standard Drawings. Distribution equipment including distribution and lighting panels, transformer, 120 Volt convenience receptacles and self-contained battery operated emergency lights shall be

provided. In addition to lighting and power requirements, the following loads shall apply to the Gap Tie Station equipment:

208Y/120 Volt System

Type of Load	Breaker Type	Quantity	Load (Watts)
Heaters for dc switchgear	1P-15A	5	2500
Battery charger	1P-50	1	4320
Spares	1P-20A	4	3600
Communications (120V.1 phase)	1P-30A	1	2400

4.02.21 BLUE LIGHT EMERGENCY TRIP STATIONS

Blue Light Stations with Traction Power Emergency Trip Stations (ETS) shall be installed as specified in Volume VII, Chapter 1 Traction Power Equipment and Chapter 3 Traction Power Installation Hardware.

Pull boxes which are accessible for maintenance without entering the guideway shall be provided for the Blue Light ETS Stations conductors.

4.02.22 FIRE PUMPS

Service to electrically operated fire pumps shall be per the requirements of the NFPA 20.

4.02.23 PARKING STRUCTURES

Separate feeders shall be provided for the lighting load, elevators and fire pump. Electrical closets shall be provided to house the panel boards and shall be located such that the largest conductor size used for lighting branch wiring does not exceed #10. Electrical closets shall be located on the ground level. Lighting panel boards shall be sized taking into consideration the future levels. Emergency lighting shall be provided by means of pre-engineered

"package" units fed from the Emergency Distribution panel located in the Electrical Equipment Room.

Parking structures also contain Metrorail subsystems. Refer to the other related design criteria listed in Section 4.01.4 for electrical requirements of the equipment and facilities at the parking structure and lot.

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4.03 FACILITIES SUPERVISORY CONTROL~ STATUS AND ALARM REQUIREMENTS

4.03.1 SCOPE

The station's PLC based SCADA system provides the ability to send status and alarms of the station's equipment over the Metrorail Communications Network (MCN) to the Central Control Facility (CCF) for monitoring and logging purposes, and to receive commands from the CCF to control the equipment.

This section defines the Supervisory Control, Status and Alarm requirements for various Facility Electrical Subsystem equipment items, Facility Mechanical Subsystem equipment items.

To insure a common understanding of the terms Supervisory Control, Status and Alarm, indicated below is a brief description of each one of them:

1. Supervisory Control: The status monitoring and controlling of a specific function of a component or subsystem of a system from either a local or remote location, or both.

2. Status: The monitoring of a specific function of a component or subsystem of a system from a local or remote location or both, which does not require or include controlling the function. This is a unidirectional method of indication.

3. Alarm: The monitoring of a specific component or subsystem function from a local or remote location or both, which in addition to indicating status, provides audible personnel alerting until acknowledged when the

component or subsystem function is creating or is in an abnormal condition. This is a unidirectional method of indication combined with a personnel alerting capability.

Supervisory Control, Status and Alarm Functions can be either analog (amplitude) or discrete (on/off) in content.

The Station's equipment elements and subsystem's Facilities supervisory control, status and alarm wiring shall be interfaced to the SCADA system by connecting to the Input/Output modules of the Station's PLC.

The design of the SCADA system, the Metrorail Communications Network, and the subsystem equipment is not within the scope of this section. These are covered in other related design criteria, as listed in Section 4.01.4.

The Facilities Supervisory Control, Status and Alarm Requirements are enumerated in an example table in the Communications criteria – Vol VII, Chap 7. The Extension Designer shall use this table to prepare the Facilities Contract documents. In order to standardize on the size and locations of the equipment cabinets and the terminal assignments, the Designers are directed to follow the existing stations drawings, and modify them only with prior approval from MDT. For maintenance purposes, to the maximum extent possible MDT requires a uniform and consistent design with the existing facilities.

The Phase I Fire and Intrusion Alarm system and Intrusion system were designed as one system. For the extensions, they are required to be separate systems, compatible with the updated systems presently installed.

The Fire System shall operate independently of other Metrorail systems. Electrical power with associated raceways, conduits and other related items shall be provided within the electrical design for the Fire System. The Station Electrical design shall provide all necessary conduits and conductors for the Fire System including detectors, alarms, strobes, panels as specified within the Fire System design criteria, to include connections to the Metrorail Communications Network (MCN).

Dedicated fibers shall be used for the Fire System communication. Specific Fibers to be used and connection to the existing Fire System communications ring shall be coordinated with MDT.

The Access Control System with intrusion alarms shall operate independently of other systems. Electrical power with associated raceways, conduits and other related items shall be provided for the Access Control and intrusion System. Electrical design shall provide all necessary conduits and conductors for the Access Control System to include connections to the MDT Communications Network.

For other station equipment, the Designers are directed to follow the PLC terminal assignments indicated on the existing installations and modify them only with prior approval from MDT.

For Supervisory Control, Status and Alarm signals from subsystems so equipped, the discrete signals will be transmitted to the PLC's input modules either by means of a momentary pulse of 0.25 Sec. minimum appearing on a set of auxiliary dry contacts rated for a maximum of 125Vdc or 120Vac, 0.25 amp., or by an analog signal.

Use of “Smart” subsystems which contain a network interface and management system is encouraged.

Coordination with the Communications system designer is required.

NOTE: The following Table 2 – FACILITIES SUPERVISORY CONTROL, STATUS, AND ALARM REQUIREMENTS are based on the phase I implementation. The new equipment design may vary from the phase I design, but the basic requirements of this section remain the same.

TABLE 4-2 – FACILITIES SUPERVISORY CONTROL, STATUS AND ALARM REQUIREMENTS (EXAMPLE)

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DEFINITIONS:

Supervisory Control:	Status Monitoring and Controlling
Status:	Status Monitoring Only
Alarm:	Status Monitoring and Audible

LEGEND:

FACP:	Fire Alarm Control Panel
FMP:	Fire Management Panel
*	Part of Fire Management Panel
**	Separate Alarm
F_1 :	Separate summary fire alarm
A_1 :	Separate operational alarm
S_1 :	Separate operational status
I_1 :	Separate summary intrusion alarm

TABLE 4-2 - (EXAMPLE)
FACILITIES SUPERVISORY CONTROL, STATUS AND ALARM REQUIREMENTS

		At the Equipment			Sta. Attendant's Booth			Central Control			
Location	Function or Device	Supv. Control/ Local	Status	Alarm	Supv. Control/ Hard-Wired	Status	Alarm	Supv. Control	Status	Alarm	Remarks
					FACILITIES ELECTRICAL AND MECHANICAL STATION FACILITIES						
Electrical Equipment Room	Transformer Second Stage Overtempera-ture		X						S_1		
Electrical Equipment Room	Transfomer Third Stage Overtempera-ture			X						A_1	

TABLE 4-2 - (EXAMPLE)
FACILITIES SUPERVISORY CONTROL, STATUS AND ALARM REQUIREMENTS

		At the Equipment			Sta. Attendant's Booth			Central Control			
Location	Function or Device	Supv. Control/ Local	Status	Alarm	Supv. Control/ Hard-Wired	Status	Alarm	Supv. Control	Status	Alarm	Remarks
					FACILITIES ELECTRICAL AND MECHANICAL STATION FACILITIES						
Electrical Equipment Room	Main Breaker Tripped			X						A_1	
Electrical Equipment Room	Tie Breaker Closed			X						A_3	
Electrical Equipment Room	High Temperature		X							A_4	
Electrical Room	Emergency Power System Battery Charger Mal-function		X							A_5	
Electrical Room	Emergency Power System Transfer Switch Mal-		X							A_6	

TABLE 4-2 - (EXAMPLE)
FACILITIES SUPERVISORY CONTROL, STATUS AND ALARM REQUIREMENTS

		At the Equipment			Sta. Attendant's Booth			Central Control			
Location	Function or Device	Supv. Control/ Local	Status	Alarm	Supv. Control/ Hard-Wired	Status	Alarm	Supv. Control	Status	Alarm	Remarks
					FACILITIES ELECTRICAL AND MECHANICAL STATION FACILITIES						
	Function										
Elevator Cab	Emergency Alarm Button			X			X				
Elevator Cab	Elevator Occupied					X					
Elevator Cab	Elevator Location				X						
Elevator Cab	Elevator Travel Direction					X					
Elevator Cab	Elevator Door Opening/ Closing				X						
Elevator Cab	Elevator Malfunction					X					
Elevator Cab	Elevator					X					

TABLE 4-2 - (EXAMPLE)
FACILITIES SUPERVISORY CONTROL, STATUS AND ALARM REQUIREMENTS

		At the Equipment			Sta. Attendant's Booth			Central Control			
Location	Function or Device	Supv. Control/ Local	Status	Alarm	Supv. Control/ Hard-Wired	Status	Alarm	Supv. Control	Status	Alarm	Remarks
					FACILITIES ELECTRICAL AND MECHANICAL STATION FACILITIES						
	Stopped										
Escalator	Emergency Stop Button			X	X		X				
Escalator	On/Off/Up/ Down					X					
Escalator	Escalator Malfunction					X					
Train Control and Communi-cations Battery Room	Battery Room Fan Malfunc-tion			X						A_7	

TABLE 4-2 - (EXAMPLE)
FACILITIES SUPERVISORY CONTROL, STATUS AND ALARM REQUIREMENTS

		At the Equipment			Sta. Attendant's Booth			Central Control			
Location	Function or Device	Supv. Control/ Local	Status	Alarm	Supv. Control/ Hard-Wired	Status	Alarm	Supv. Control	Status	Alarm	Remarks
FACILITIES ELECTRICAL AND MECHANICAL STATION FACILITIES											
Train Control and Communi-cations Battery Room	High Temperature			X						A_8	
Station Toilet Room	Electronic Lock				X						
Traction Power Substation	High Temperature		X							A_9	
Gap Tie Station	High Temperature		X							A_{10}	

TABLE 4-2 (EXAMPLE)
FACILITIES SUPERVISORY CONTROL, STATUS AND ALARM REQUIREMENTS

		FACP			Sta. Attendant's Booth			Central Control			
Location	Function or Device	Supv. Control/ Local	Status	Alarm	Supv. Control/ Hard-Wired	Status	Alarm	DTS/Supv. Control	Status	Alarm	Remarks
					FIRE ALARM SYSTEM AND ACCESS CONTROL/INTRUSION SYSTEM STATION FACILITIES						
Train Control and Communi-cations Room	Cross-Zoned Smoke (Ionization) Detector			X			X*			F_1	
Electrical Room	Smoke (Ionization) Detector			X			X*			F_3	
Escalator Trusses, Pits and Machine Spaces	Smoke (Ionization) Detector			X			X*			F_2	
Toilet Room	Smoke (Ionization) Detector			X			X*			F_3	

TABLE 4-2 (EXAMPLE)
FACILITIES SUPERVISORY CONTROL, STATUS AND ALARM REQUIREMENTS

		FACP			Sta. Attendant's Booth			Central Control			
Location	Function or Device	Supv. Control/ Local	Status	Alarm	Supv. Control/ Hard-Wired	Status	Alarm	DTS/Supv. Control	Status	Alarm	Remarks
					FIRE ALARM SYSTEM AND ACCESS CONTROL/INTRUSION SYSTEM STATION FACILITIES						
Supply Ducts of Air Condi-tioning System	Smoke (Ionization) Detector			X			X*			F_3	
Return Air Ducts and After Filters in Air Condi-tioning System	Smoke (Ionization) Detector			X			X*			F_3	
Elevator Machine Rooms	Smoke (Ionization) Detector			X			X*			F_2	
Revenue Rooms	Smoke (Ionization) Detector			X			X*			F_3	

TABLE 4-2 (EXAMPLE)
FACILITIES SUPERVISORY CONTROL, STATUS AND ALARM REQUIREMENTS

		FACP			Sta. Attendant's Booth			Central Control			
Location	Function or Device	Supv. Control/ Local	Status	Alarm	Supv. Control/ Hard-Wired	Status	Alarm	DTS/Supv. Control	Status	Alarm	Remarks
					FIRE ALARM SYSTEM AND ACCESS CONTROL/INTRUSION SYSTEM STATION FACILITIES						
Battery Rooms	Smoke (Ionization) Detector			X			X*			F_3	
Traction Power Substation	Rate of Rise/ Fixed Tem-perature Heat Detector			X			X*			F_4	
Gap Tie Station	Rate of Rise/Fixed Temperature Heat Detector			X			X*			F_5	
Electrical Equipment Room	Ionization and Rate of Rise/ Fixed Temper-ature Heat Detector			X			X*			F_3	

TABLE 4-2 (EXAMPLE)
FACILITIES SUPERVISORY CONTROL, STATUS AND ALARM REQUIREMENTS

		FACP			Sta. Attendant's Booth			Central Control			
Location	Function or Device	Supv. Control/ Local	Status	Alarm	Supv. Control/ Hard-Wired	Status	Alarm	DTS/Supv. Control	Status	Alarm	Remarks
					FIRE ALARM SYSTEM AND ACCESS CONTROL/INTRUSION SYSTEM STATION FACILITIES						
Station Attendant's Booth	Smoke Detector			X			X*			F_3	
Station Area	Waterflow in Sprinkler System			X			X*			F_6	
Parking Area	Waterflow in Wet Standpipe System			X			X*			F_6	
Station Area	Valve Position Indicator			X			X*			F_7	
Train Control and Comm-unications Room	Trouble – FACP			X						F_8	

TABLE 4-2 (EXAMPLE)
FACILITIES SUPERVISORY CONTROL, STATUS AND ALARM REQUIREMENTS

		FACP			Sta. Attendant's Booth			Central Control			
Location	Function or Device	Supv. Control/ Local	Status	Alarm	Supv. Control/ Hard-Wired	Status	Alarm	DTS/Supv. Control	Status	Alarm	Remarks
					FIRE ALARM SYSTEM AND ACCESS CONTROL/INTRUSION SYSTEM STATION FACILITIES						
Train Control and Comm-unications Room	Trouble – PA System			X						F_9	
Station Area	Manual Pull Station			X			X*			F_{10}	
Mechanical Equipment Room	Smoke (Ionization) Detector			X			X*			F_3	
Station Area	Fire Extinguisher Cabinet Door			X			X*				
Station Entrance Emergency Exit Door #s 118, 119				X			X*			I_1	

TABLE 4-2 (EXAMPLE)
FACILITIES SUPERVISORY CONTROL, STATUS AND ALARM REQUIREMENTS

		FACP			Sta. Attendant's Booth			Central Control			
Location	Function or Device	Supv. Control/ Local	Status	Alarm	Supv. Control/ Hard-Wired	Status	Alarm	DTS/Supv. Control	Status	Alarm	Remarks
FIRE ALARM SYSTEM AND ACCESS CONTROL/INTRUSION SYSTEM STATION FACILITIES											
Station Entrance Security Gate	Intrusion Detector			X			X*			I_1	
Electrical Equipment Room Door #s 114, 115	Intrusion Detector			X			X*			I_2	
Train Control and Comm-unications Room Door #110	Intrusion Detector			X			X*				Dead Bolt Lock
Change Machine	Intrusion Detector			X			X*			I_4	

TABLE 4-2 (EXAMPLE)
FACILITIES SUPERVISORY CONTROL, STATUS AND ALARM REQUIREMENTS

Location	Function or Device	FACP: Supv. Control/ Local	FACP: Status	FACP: Alarm	Sta. Attendant's Booth: Supv. Control/ Hard-Wired	Sta. Attendant's Booth: Status	Sta. Attendant's Booth: Alarm	Central Control: DTS/Supv. Control	Central Control: Status	Central Control: Alarm	Remarks
FIRE ALARM SYSTEM AND ACCESS CONTROL/INTRUSION SYSTEM STATION FACILITIES											
Revenue Room Door #106	Intrusion Detector			X			X*			I_4	
Mechanical Equipment Room	Intrusion Detector			X			X*			I_2	
Traction Power Substation	Intrusion Detector			X						I_5	
Gap Tie Station	Intrusion Detector			X						I_6	

TABLE 4-2 (EXAMPLE)
FACILITIES SUPERVISORY CONTROL, STATUS AND ALARM REQUIREMENTS

		At the Equipment			Adm. Bldg. Mgr's Console			Central Control			
Location	Function or Device	Supv. Control/ Local	Status	Alarm	Supv. Control/ Hard-Wired	Status	Alarm	DTS/Supv. Control	Status	Alarm	Remarks
					FACILITIES ELECTRICAL AND MECHANICAL ADMINISTRATION FACILITIES						
Electrical Equipment Room	Transformer Second Stage Overtempera-ture		X			X			X		
Electrical Equipment Room	Transformer Third Stage Overtempera-ture			X			X			X	
Electrical Equipment Room	Main Breaker Tripped			X			X			X	
Electrical Equipment Room	Tie Breaker Closed			X			X			X	
Electrical Equipment	High Temperature		X				X			X	

TABLE 4-2 (EXAMPLE)
FACILITIES SUPERVISORY CONTROL, STATUS AND ALARM REQUIREMENTS

		At the Equipment			Adm. Bldg. Mgr's Console			Central Control			
Location	Function or Device	Supv. Control/ Local	Status	Alarm	Supv. Control/ Hard-Wired	Status	Alarm	DTS/Supv. Control	Status	Alarm	Remarks
					FACILITIES ELECTRICAL AND MECHANICAL ADMINISTRATION FACILITIES						
Room											
Electrical Room	Emergency Power System Battery Charger Malfunction		X				X			X	
Electrical Room	Emergency Power System Transfer Switch Malfunciton		X				X			X	
Train Control and Comm-unications Battery Room	Battery Room Fan Malfunction			X			X			X	

TABLE 4-2 (EXAMPLE)
FACILITIES SUPERVISORY CONTROL, STATUS AND ALARM REQUIREMENTS

		At the Equipment			Adm. Bldg. Mgr's Console			Central Control			
Location	Function or Device	Supv. Control/ Local	Status	Alarm	Supv. Control/ Hard-Wired	Status	Alarm	DTS/Supv. Control	Status	Alarm	Remarks
					FACILITIES ELECTRICAL AND MECHANICAL ADMINISTRATION FACILITIES						
Train Control and Comm-unications Room	High Temperature			X			X			X	

TABLE 4-2 (EXAMPLE)
FACILITIES SUPERVISORY CONTROL, STATUS AND ALARM REQUIREMENTS

		FACP			FMP			Central Control			
Location	Function or Device	Supv. Control/ Local	Status	Alarm	Supv. Control/ Hard-Wired	Status	Alarm	DTS/Supv. Control	Status	Alarm	Remarks
	FIRE ALARM SYSTEM AND ACCESS CONTROL/INTRUSION SYSTEM ADMINISTRATION FACILITIES										
Admin. Facility	Fire Alarm by Zones			X			X			X**	
Admin. Facility	Valve Supervision by Zones			X			X			X**	
Admin. Facility	Waterflow in any Sprinkler System			X			X			X**	
Document Storage	Intrusion Detector			X			X			X**	
Security Office	Intrusion Detector			X			X			X**	
Operations Center	Intrusion Detector			X			X			X**	

TABLE 4-2 (EXAMPLE)
FACILITIES SUPERVISORY CONTROL, STATUS AND ALARM REQUIREMENTS

		FACP			FMP			Central Control			
Location	Function or Device	Supv. Control/ Local	Status	Alarm	Supv. Control/ Hard-Wired	Status	Alarm	DTS/Supv. Control	Status	Alarm	Remarks
FIRE ALARM SYSTEM AND ACCESS CONTROL/INTRUSION SYSTEM ADMINISTRATION FACILITIES											
Operations Data/Record Equipment/ Storage	Intrusion Detector			X			X			X**	
Fare Collection Revenue Depot	Intrusion Detector			X			X	X++		X**	++Elec-tronic Door Lock Control
Electrical Equipment Room	Intrusion Detector			X			X			X**	
Mechanical Equipment Room	Intrusion Detector			X			X			X**	

TABLE 4-2 (EXAMPLE)
FACILITIES SUPERVISORY CONTROL, STATUS AND ALARM REQUIREMENTS

		At the Equipment			Yard Control Tower			
Location	Function or Device	Supv. Control/ Local	Status	Alarm	DTS/Supv. Control	Status	Alarm	Remarks
			FACILITIES ELECTRICAL AND MECHANICAL MAINTENANCE FACILITIES					
Electrical Room	Transformer Second Stage Overtempera-ture		X			X		
Electrical Room	Transfer Third Stage Overtempera-ture			X			X	
Electrical Room	Main Breaker Tripped			X			X	
Electrical Room	Tie Breaker Closed			X			X	
Electrical Room	High Temperature		X				X	

TABLE 4-2 (EXAMPLE)
FACILITIES SUPERVISORY CONTROL, STATUS AND ALARM REQUIREMENTS

		At the Equipment			Yard Control Tower			
Location	Function or Device	Supv. Control/ Local	Status	Alarm	DTS/Supv. Control	Status	Alarm	Remarks
FACILITIES ELECTRICAL AND MECHANICAL MAINTENANCE FACILITIES								
Electrical Room	Emergency Power System Transfer Switch Mal-function		X				X	
Train Control and Comm-unications Room	High Temperature						X	
Train Control and Comm-ications Battery Room	Battery Room Fan Malfunction			X			X	
Yard Traction Power Substation	High Temperature		X				X	

TABLE 4-2 (EXAMPLE)
FACILITIES SUPERVISORY CONTROL, STATUS AND ALARM REQUIREMENTS

		At the Equipment			Yard Control Tower			
Location	Function or Device	Supv. Control/ Local	Status	Alarm	DTS/Supv. Control	Status	Alarm	Remarks
FACILITIES ELECTRICAL AND MECHANICAL MAINTENANCE FACILITIES								
Test Track Traction Power Substation	High Temperature		X				X	

TABLE 4-2 (EXAMPLE)
FACILITIES SUPERVISORY CONTROL, STATUS AND ALARM REQUIREMENTS

		FACP			FMP			Yard Control Tower			
Location	Function or Device	Supv. Control/ Local	Status	Alarm	Supv. Control/ Hard-Wired	Status	Alarm	DTS/Supv. Control	Status	Alarm	Remarks
	FIRE ALARM SYSTEM AND ACCESS CONTROL/INTRUSION SYSTEM MAINTENANCE FACILITIES										
Maintenance Facilities	Fire Alarm by Zones			X			X			X*	
Maintenance Facilities	Valve Supervision by Zones			X			X			X*	
Maintenance Facilities	Waterflow in Sprinkler System by Zones			X			X			X*	
Maintenance Facilities	Waterflow in Standpipe System by Zones			X			X			X*	
Electronic Repair Room	Intrusion Detector			X			X			X*	Shunt Switch

TABLE 4-2 (EXAMPLE)
FACILITIES SUPERVISORY CONTROL, STATUS AND ALARM REQUIREMENTS

		FACP			FMP			Yard Control Tower			
Location	Function or Device	Supv. Control/ Local	Status	Alarm	Supv. Control/ Hard-Wired	Status	Alarm	DTS/Supv. Control	Status	Alarm	Remarks
FIRE ALARM SYSTEM AND ACCESS CONTROL/INTRUSION SYSTEM MAINTENANCE FACILITIES											
Train Control Rooms (5)	Intrusion Detector			X			X			X*	Controlled
Yard Traction Power Substation	Intursion Detector			X			X			X*	
Test Track Traction Power Substation	Intrusion Detector			X			X			X*	
Store Room – Tool Room	Intrusion Alarm			X			X			X*	Shunt Switch Con-trolled

TABLE 4-2 (EXAMPLE)
FACILITIES SUPERVISORY CONTROL, STATUS AND ALARM REQUIREMENTS

		FACP			FMP			Yard Control Tower			
Location	Function or Device	Supv. Control/ Local	Status	Alarm	Supv. Control/ Hard-Wired	Status	Alarm	DTS/Supv. Control	Status	Alarm	Remarks
FIRE ALARM SYSTEM AND ACCESS CONTROL/INTRUSION SYSTEM MAINTENANCE FACILITIES											
Electrical Equipment Room	Intrusion Detector			X			X			X*	

TABLE 4-2 (EXAMPLE)
FACILITIES SUPERVISORY CONTROL, STATUS AND ALARM REQUIREMENTS

		At the Equipment			Sta. Attendant's Booth			
Location	Function or Device	Supv. Control/ Local	Status	Alarm	Supv. Control/ Hard-Wired	Status	Alarm	Remarks
				FARE COLLECTION SYSTEM STATION FACILITIES				
Station Fare Collection Area	Entry Turn-stile Close/ Release				X			
Station Fare Collection Area	Reduced Fare Entry Turnstile Close/Release				X			
Station Fare Collection Area	Entry Turnstile Override/ Restore Time Control				X			
Station Fare Collection Area	Reduced Fare Entry Turnstile Override/ Restore Time Control				X			

TABLE 4-2 (EXAMPLE)
FACILITIES SUPERVISORY CONTROL, STATUS AND ALARM REQUIREMENTS

		At the Equipment			Sta. Attendant's Booth			
Location	Function or Device	Supv. Control/ Local	Status	Alarm	Supv. Control/ Hard-Wired	Status	Alarm	Remarks
				FARE COLLECTION SYSTEM STATION FACILITIES				
Station Fare Collection Area	Entry Turnstile Reduced Fare Indicator					X		
Station Fare Collection Area	Reduced Fare Entry Turn-stile On/Off and Set for Reduced Fare Switch	X						
Station Fare Collection Area	Handicapped Gate Releasase/ Close				X			
Station Fare Collection Area	Handicapped Gate Open						X	After a predeter-mined time

TABLE 4-2 (EXAMPLE)
FACILITIES SUPERVISORY CONTROL, STATUS AND ALARM REQUIREMENTS

		At the Equipment			Sta. Attendant's Booth			
Location	Function or Device	Supv. Control/ Local	Status	Alarm	Supv. Control/ Hard-Wired	Status	Alarm	Remarks
				FARE COLLECTION SYSTEM STATION FACILITIES				
Station Fare Collection Area	Handicapped Gate Crash Bar Alarm						X	
Station Fare Collection Area	Service Door Release/Close				X			
Station Fare Collection Area	Reduced Fare Entry Turnstile Reduced Fare Indicator					X		
Station Fare Collection Area	Entry Turn-stile Fault Indicator					X		
Station Fare Collection Area	Reduced Fare Entry Turnstile Fault Indicator					X		

TABLE 4-2 (EXAMPLE)
FACILITIES SUPERVISORY CONTROL, STATUS AND ALARM REQUIREMENTS

		At the Equipment			Sta. Attendant's Booth			
Location	Function or Device	Supv. Control/ Local	Status	Alarm	Supv. Control/ Hard-Wired	Status	Alarm	Remarks
			FARE COLLECTION SYSTEM STATION FACILITIES					
Station Fare Collection Area	Entry Turn-stile On/Off and Set for Reduced Fare Switch	X						
Station Fare Collection Area	Service Door Open						X	After a prede-termined time
Station Fare Collection Area	Change Machine Open						X	
Station Fare Collection Area	Change Machine Fault Indicator					X		

TABLE 4-2 (EXAMPLE)
FACILITIES SUPERVISORY CONTROL, STATUS AND ALARM REQUIREMENTS

		At the Equipment			Sta. Attendant's Booth			
Location	Function or Device	Supv. Control/ Local	Status	Alarm	Supv. Control/ Hard-Wired	Status	Alarm	Remarks
			FARE COLLECTION SYSTEM STATION FACILITIES					
Station Fare Collection Area	Change Machine On/Off Switch	X						
Station Fare Collection Area	Transfer Dispenser Fault Indicator		X					
Station Fare Collection Area	Transfer Dispenser On/Off Switch	X						
Station Fare Collection Area	Transfer Dispenser Malfunction		X				X	

4.04 GROUNDING AND LIGHTNING PROTECTION (Reserved)

4.04.1 SCOPE (Reserved)

Refer to: Volume III – Guideway Design, Chapter 4 – Guideway Electrical, for the grounding and lightning protection systems design criteria applicable to the Metrorail Line Extension.

4.04.2 OBJECTIVE (Reserved)

Refer to: Volume III – Guideway Design, Chapter 4 – Guideway Electrical

4.04.3 ABNORMAL CONDITIONS (Reserved)

Refer to: Volume III – Guideway Design, Chapter 4 – Guideway Electrical

4.04.4 GROUNDING ELECTRODE SYSTEM (Reserved)

Refer to: Volume III – Guideway Design, Chapter 4 – Guideway Electrical

4.04.5 TRACTION POWER GROUNDING (Reserved)

Refer to: Volume III – Guideway Design, Chapter 4 – Guideway Electrical

4.04.6 SECONDARY POWER DISTRIBUTION SYSTEM GROUNDING (Reserved)

Refer to: Volume III – Guideway Design, Chapter 4 – Guideway Electrical

4.04.7 GROUNDING NETWORKS (Reserved)

Refer to: Volume III – Guideway Design, Chapter 4 – Guideway Electrical

4.04.8 LIGHTNING PROTECTION (Reserved)

Refer to: Volume III – Guideway Design, Chapter 4 – Guideway Electrical

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4.05 CORROSION CONTROL (Reserved)

4.05.1 SCOPE (Reserved)

Refer to: Volume III – Guideway Design, Chapter 4 – Guideway Electrical, for the corrosion control design criteria applicable to the Metrorail Line Extension.

4.05.2 CONTROL OF ATMOSPHERIC CORROSION (Reserved)

Refer to: Volume III – Guideway Design, Chapter 4 – Guideway Electrical

4.05.3 STRAY CURRENT CORROSION CONTROL (Reserved)

Refer to: Volume III – Guideway Design, Chapter 4 – Guideway Electrical

4.05.4 CATHODIC PROTECTION (Reserved)

Refer to: Volume III – Guideway Design, Chapter 4 – Guideway Electrical

4.05.5 TEST STATIONS (Reserved)

Refer to: Volume III – Guideway Design, Chapter 4 – Guideway Electrical

4.05.6 CORROSION CONTROL OF MECHANICAL EQUIPMENT (Reserved)

Refer to: Volume III – Guideway Design, Chapter 4 – Guideway Electrical

Refer also to: This Volume, Chapter 5, Mechanical Design Criteria

4.05.7 MISCELLANEOUS ITEMS (Reserved)

Refer to: Volume III – Guideway Design, Chapter 4 – Guideway Electrical

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4.06 SYSTEMS-FACILITIES INTERFACE RACEWAY (Reserved)

Refer to: Volume III – Guideway Design, Chapter 4 – Guideway Electrical, for the Systems-Facilities Interface Raceway design criteria.

4.06.1 SCOPE (Reserved)

Refer to: Volume III – Guideway Design, Chapter 4 – Guideway Electrical

4.06.2 PHYSICAL RELATIONSHIP (Reserved)

Refer to: Volume III – Guideway Design, Chapter 4 – Guideway Electrical

4.06.3 PHYSICAL INSTALLATION (Reserved)

Refer to: Volume III – Guideway Design, Chapter 4 – Guideway Electrical

4.06.4 MATERIALS OF CONSTRUCTION (Reserved)

Refer to: Volume III – Guideway Design, Chapter 4 – Guideway Electrical

4.06.5 RACEWAY IDENTIFICATION METHODS (Reserved)

Refer to: Volume III – Guideway Design, Chapter 4 – Guideway Electrical

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4.07 LIGHTING DESIGN CRITERIA

4.07.1 INTRODUCTION

The Primary criterion for lighting is as follows:

"Lighting levels shall be established (by accepted standards and applicable codes) to provide for comfort, safety and amenity of the system user. Lighting shall be designed to be maintenance friendly, in a glare-free, orderly manner, using long life, low power consumption, high lumen lamps whenever possible. Emergency lighting shall also be provided to allow persons to safely exit the system and facilities under prolonged primary outage conditions. Lighting shall comply with the energy efficiency requirements of the Florida Building Code. "

The lighting criteria contained herein is consistent with the above requirements and is intended to provide the Section Designer with the functional and aesthetic guidance necessary to design the lighting for site areas, passenger stations, parking areas, walkways, traction power substations, gap tie stations, and ancillary spaces.

See also Volume I, Systemwide Criteria - Chapter 7, System Safety Criteria; Chapter 8, System Security Design Criteria; and Chapter 9, Fire/Life Safety Criteria.

These documents supply specific solutions to repetitive problems of illumination. The intent is to standardize components and mounting configurations throughout the system. Adherence to these documents by all lighting designers will insure consistent ambience for the system facilities, and

provide the required maintainability, convenience, safety, and efficiency of the transit system.

4.07.2 DESIGN OBJECTIVES

The Extension Designer shall achieve the indicated illumination levels and visual and functional clarity by using the selected standard design elements provided by MDT, i.e., General Plans, Standard and Directive Drawings, and applicable codes.

These standards unify the appearance and maintenance of the system, but are not meant to preclude individual interpretation of interesting or stimulating lighting treatments that may accent or reinforce particular architectural features. The Designer shall be responsible for the applications of luminaries, chosen from Luminary Palette, and their relationship to associated environments, ceilings and supporting structures. Variation from standard design elements is subject to review and specific prior approval by MDT.

The following guidelines are applicable to lighting design throughout the transit system (specific area requirements are contained in subsequent sections herein).

The lighting subsystem design and selection of lighting equipment shall be made to minimize initial, maintenance and energy costs.

A High Intensity Discharge (H.I.D.) source shall be utilized for general site and high-bay lighting. In general, fluorescent and H.I.D. sources shall provide the required illumination for passenger stations, parking structures, and interior spaces. Incandescent lamps shall be used to supplement pedestrian

way illumination levels and for design accent but only with prior approval by MDT.

The color rendering properties of the family of lamps chosen shall be used to provide maximum color discrimination.

The illumination levels indicated shall define and differentiate between task areas, decision and transition points, and areas of potential hazard. In addition to quantity of light, it is essential that illumination for the system be designed to minimize glare and provide uniform distribution. Luminaries shall be so selected, located and/or aimed that, while accomplishing their primary purpose, they shall produce a minimum of objectionable glare and/or interference with task accuracy, vehicular traffic and neighboring areas.

Luminance in the visual field shall be as uniform as practicable with brightness and contrast ratios minimized and veiling reflections eliminated or effectively reduced. The following values shall apply as practical standardization but are not applicable for small areas of lighting provided for accent, design, interest or message purposes.

	Brightness ratio
Wall to Floor	3:1
Wall to Ceiling	1:3
Luminaries to adjacent surfaces	20:1
Stairs and escalators to general platform or concourse area	2:1

(in open area structures brightness ratios are undefined).

The system shall provide a minimum Visual Comfort Probability (VCP) rating of 75. VCP can be maximized through coordination with MDT on the selection of ceiling, wall and floor finishes and colors. Generally, high reflectance factors are desirable.

Ceilings	60 - 80%
Walls	40 - 60%
Floors	10 - 30%

4.07.3 CALCULATIONS

The normal method of calculating illumination levels shall be as outlined in the Illumination Engineering Society (IES) Lighting Handbook. The "lumen" method shall be used in routine interior calculations. The IES "roadway" method shall be used to calculate lighting levels for access lanes, open parking areas and vehicle storage areas. The "point-by-point" method shall be used for special locations as required.

Illumination levels for general interior spaces shall be in accordance with the specified average maintained foot candle values on a horizontal plane 30 inches above the finished floor except emergency and parking structure lighting, whose values shall be on a horizontal plane at the floor level. Illumination uniformity will be acceptable if it is within 1/3 from the specified average. Minimum site area illumination levels shall be calculated from the "iso-foot candle" curves of the appropriate luminary. Uniformity for major site lighting shall utilize the "average level-to-minimum point" method, and shall not exceed a ratio of three to one. Coefficients of utilization shall be used to determine the average level of illumination.

Lighting used in small areas as a “Design Feature” shall be considered supplementary to the required general illumination level for any particular area. Such lighting design shall include backlit graphics, graphic and/or advertising display units, and lighting intended to provide accent or sparkle against the necessary background. Lighting used as a “Design Feature” shall be subject to approval by MDT.

4.07.4 SITE AREAS

4.07.4.1 General

A. Site lighting provides for identification, unification, safety and security of each facility. The lighting shall define the site organization by the hierarchy of visual response through illumination levels, patterns, and colors. For example, major traffic areas shall be strengthened by higher intensity lighting, while subordinate elements such as walkways shall be emphasized by visually subdued patterns of lighting and/or color, thereby attracting and guiding both driver and pedestrian to the facility entrance.

B. The standard site lighting elements shall distribute the output of concealed sources efficiently over broad areas, creating a quickly, recognizable "site identity" and "personality" of the site environment.

1. Station site lighting is concerned with internal site circulation and access to station. The placement of luminaries shall not obstruct the movement and parking of vehicles. Luminary placement shall be coordinated with the landscape and parking plan to protect light standards which may occur directly adjacent to parking stalls and to ensure that plantings will not obscure the lighting distribution pattern.

2. Vehicular access lighting shall provide a natural lead in to the bus loading/unloading, kiss-and-ride, and park-and-ride areas. The illumination on all access and egress roads shall be graduated up or down to the illumination level of the "feeder" street or highway.

3. Pedestrian access lighting shall define pedestrian walkways, crosswalks, ramps, stairs and bridges.

4. Landscape lighting is an element which shall reinforce the variety, color and texture of the landscape design, and is subject to approval by MDT.

5. Park-and-Ride lighting shall be an extension of the access-way lighting environment, but shall be made brighter by additional lighting elements placed between the ranks of automobiles and in pedestrian access-ways. Parking occupies the largest single area of the transit station site and its lighting shall be used to define the parking area perimeter, not only as the principal location of light sources at night, but as a visible architectural element bounded by regularly spaced standards during daylight hours.

For illumination levels, see Table 4-3.

4.07.5 PASSENGER STATIONS

A. General

Station lighting shall be integrated with the structure to form a systematic design within the total architectural concept. The station shall be

provided with the highest illumination level in the transit site area creating a destination focus. The lighting design shall preclude visual clutter that may distract from the directional signing or cause disruption of the normal traffic flow and shall anticipate the use of, and compatibility with, CCTV surveillance, particularly at station elevator entrances and on platforms.

1. Concourse area lighting shall define two distinct, related areas: Paid and unpaid. The "unpaid area" lighting shall guide the patron to informational messages, fare collection equipment, and the fare gates. The "Paid Area" lighting shall direct the patron through the concourse to the vertical elements that lead to the platform loading area.

2. The Station Attendant's booth (or console) shall be provided with illumination for reading control data and light report writing. The attendant must have an unobstructed view of the concourse area, free from specular reflections from the glass enclosure and control equipment, and free from veiling reflections.

3. Platform area lighting shall be of higher intensity than the concourse level and shall delimit the waiting and loading areas. The multi-media elements shall extend the length of the platform and shall integrate a general illumination source with speaker systems, CCTV and graphic signage. These elements shall accent the center platform and landings associated with escalators and stairs. The platform edge where transition between station and

transit vehicle occurs shall be emphasized by a change in luminance.

4. Vertical circulation lighting shall be provided for efficient and safe movement of patrons between levels.

5. Ancillary lighting is covered in Subsection 4.07.7.

For illumination levels, see Table 4-4.

4.07.6 TRACTION POWER SUBSTATIONS AND GAP TIE STATIONS

Traction Power Substation and Gap Tie Station lighting shall be functional and, when exposed to public view, as inconspicuous as possible. The lighting design shall provide good vertical illumination on all equipment. Placement of luminaries shall be coordinated with the electrification design to avoid physical conflicts with traction power equipment, cable trays, bus ducts, etc. Outside security lighting shall be provided for the transformer yard area of the Traction Power Substation.

For illumination levels, see Table 4-5.

4.07.7 ANCILLARY SPACES

Electrical and mechanical equipment room lighting shall provide illumination for general inspection, meter and gauge reading.

Supplemental lighting is recommended to provide vertical illumination on control panels, relay equipment, switchgear, and motor control centers. Emergency lighting shall be provided as indicated.

For illumination levels, see Table 4-6.

4.07.8 EMERGENCY LIGHTING

Emergency lighting in transit facilities shall be supplied by a percentage of normally burning luminaries to provide adequate lighting for the orderly egress of patrons and employees under power failure. These luminaries, including all exit, egress and essential directional signage, shall be powered by an emergency power unit as described in Section 4.02.9, and shall provide indicated illumination levels for a period of 90 minutes. During non-operating hours, the emergency lighting luminaries shall serve as night lighting.

Illumination emphasis shall be required at all transition points and vertical elements of circulation.

For illumination levels, see Table 4-7.

4.07.9 CONTROL OF LIGHTING SYSTEM

Lighting control shall be designed to use energy efficiently automatic and manual control arrangements shall insure efficient utilization of energy and maintenance procedures. All exterior site areas shall be illuminated from dusk until 30 minutes after revenue service stops. Provision shall be made for manual and time clock (astronomic dial with skip-a-day feature) photocell override.

Ancillary spaces shall be individually switched.

All interior incandescent lighting shall be controlled by dimmers. All exterior incandescent lighting shall be served at a reduced nominal voltage (allow six to eight percent voltage drop).

Illumination provided by the emergency power source for the concourse and platform areas shall be switched from the power source.

In general, all contactors, relays, time clocks, etc., shall be mounted in a separate control cabinet adjacent to the lighting panel; however, control equipment may be mounted within the lighting panel where space allows.

The emergency stair lighting at the end of the platform over the ancillary facility roof shall be controlled from the Station Attendant's Booth.

TABLE 4-3 – SITE AREA ILLUMINATION LEVELS

The following minimum levels of illumination shall be provided unless superseded by more stringent Code requirements:

AREA		MINIMUM MAINTAINED ILLUMINATION LEVELS IN FOOTCANDLES
Vehicular Access Roadways		1.0 FC
Bus Loading/Unloading		2 FC
Open Parking	1 FC	
Parking Structures		
	Entrance	20 FC (average)
	Vehicular/Pedestrian Intersections	20 FC (average)
	General Parking	5 FC (average)
Pedestrian Ways		
	Walkways, Ramps and Bridges	2 FC
	Tunnels and Passageways	5 FC
Landscape		
	General	1 FC
	Highlight	5 FC
	Focal Point	10-15 FC
Graphics		
	Internal Illumination/Surface Brightness	30 Foot Lamberts
	External Illuminated Signs	50-100 FC

TABLE 4-4 – PASSENGER STATION ILLUMINATION LEVELS

AREA	AVERAGE MAINTAINED ILLUMINATION LEVELS IN FOOTCANDLES
Concourse area	15 FC
Platform area, covered	25 FC
Platform area, open	5 FC
Stairs, escalators, elevators	20 FC
Station Attendants Booth	15 FC
Elevator Pits	5 FC (at floor)
Elevator Machine Rooms	10 FC (at floor)

TABLE 4-5 - TRACTION POWER SUBSTATION & GAP TIE STATION ILLUMINATION LEVELS

AREA	AVERAGE MAINTAINED ILLUMINATION LEVELS IN FOOTCANDLES
Vertical illumination on equipment	30 FC
Battery Rooms	15 FC
Outside Security lighting (Traction Power Substation only)	0.2 FC

TABLE 4-6 – ANCILLARY SPACES ILLUMINATION LEVELS

AREA	AVERAGE MAINTAINED ILLUMINATION LEVELS IN FOOTCANDLES
Toilets 20 FC	
Storage (active)	10 FC
(inactive)	5 FC
Train Control and Communications Rooms	30 FC
Electrical and Mechanical Equipment Rooms	30 FC
Battery Rooms	15 FC
Stairs, Ramps, Corridors, Passageways	20 FC
Revenue Rooms	20 FC
Dispatcher's Rooms	30 FC
Trainmen's Rooms	20 FC
Custodial and Trash Rooms	10 FC

TABLE 4-7 - EMERGENCY LIGHTING ILLUMINATION LEVELS

AREA	AVERAGE MAINTAINED ILLUMINATION LEVELS IN FOOTCANDLES
Station entrances and entrance to escalators/elevators	2 FC
Station Attendant's Booth	2 FC
Fare vending and collection areas	3 FC
Interior stairs and escalators	2 FC
Interior of elevators	2 FC
Platform and concourse	2 FC
Ancillary spaces (except battery room)	3 FC
Battery rooms (separate enclosure)	1 FC
Toilets	1 FC

APPENDIX A (Reserved)

SYSTEMS-FACILITIES INTERFACE
RACEWAY CRITERIA

GUIDE FOR DESIGNING WAYSIDE DUCT BANKS AND CONDUITS

Refer to: Volume III – Guideway Design, Chapter 4 – Guideway Electrical for Systems-Facilities Interface Raceway Criteria