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Electrical

I. Electrical

A. Electrical Service Requirements

1. Calculations

- a. Provide detailed load calculations used to select all equipment for project. Load calculations shall provide (as a minimum) information for determining the following:
 - i. Primary vs. Secondary service.
 - ii. 1Ø vs. 3Ø service.
 - iii. Short circuit and Arc Flash Calculations.
 - iv. Include all AMEP and Amtrak Equipment loads.
- b. For existing systems, a load calculation shall be provided per the current NFPA NEC (See Article 220.87 Determining Existing Loads) to ensure the existing system can accommodate the additional load.
- c. Normal and Emergency (Life Safety) illumination calculations shall be provided to validate the lighting design. Include light loss factors and de-rated lumen output from emergency sources as required to ensure minimum life safety requirements are met.

2. Equipment selection

- a. Provide Amtrak with detailed written summary used to select all equipment for project. As a minimum, the summary will describe the following:
 - i. Outdoor vs. indoor locations
 - ii. Distribution Equipment (panels, transformers, etc.)
 - iii. Electric metering and utility coordination.
 - iv. Third party requirements

B. Power Distribution

1. Switchgear

- a. Allow capacity for anticipated future growth (generally 125%; consult and confirm with Amtrak PM).
- b. Bus to be copper.
- c. Neutral & Ground bus to be 100% rated.
- d. Mount on housekeeping pad if required.

2. Panelboards

- a. Outdoor locations.
 - i. Provide internal heater to maintain equipment above minimal allowable operating temperature and dew point as required. Provide control power transformer as needed.
 - ii. Equipment minimum requirement to be 3R unless environmental conditions require 4X stainless steel cabinet.

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- b. Indoor conditioned space: NEMA type 1 enclosure, unless a NEMA type 12 enclosure is required due to conditions.
- c. Indoor unconditioned space: See Outdoor locations.
- d. Indoor panels to use door-in-door construction.
- e. Bolt on breakers are required.
- f. Bus to be copper.
- g. Neutral & ground bus to be 100% rated.
- h. Allow capacity for future growth (generally 125%; consult and confirm with Amtrak PM).
- i. Switchable breakers with internal CPU control (consult with Amtrak PM).

3. Transformers

- a. Outdoor.
 - i. Medium Voltage – Oil Filled or Cast Coil. Oil-filled is the preference.
 - ii. Low voltage – Non-ventilated. Dry type with weather shield allowed on a case-by-case basis.
- b. Indoor – Dry type, ventilated unless environmental issues dictate otherwise.
- c. Copper windings.
- d. Evaluate loads for distribution transformers to determine “k” rating.
- e. Allow capacity for anticipated future growth (generally 125%; consult and confirm with Amtrak PM).

4. Motor Control Centers

- a. Copper bus & wire.
- b. Main Disconnect required.
- c. Allow capacity for anticipated future growth (consult with Amtrak Project Manager).

C. Wiring Requirements

1. Wire

- a. Insulation type
 - i. Indoor – THHN/THWN
 - ii. Exterior and underground – XHHW-2
- b. Conductor type
 - i. Copper

D. Cable Requirements

1. MC cables may be used, provided the following requirements are met:

- a. Indoor locations:
 - i. PVC coating is not allowed.
 - ii. Branch circuits (not allowed for feeder cables).

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iii. Located above a suspended ceiling, behind a drywall partition, or otherwise protected from damage.

b. Permitted for outdoor (including direct burial) use and inside tunnels where protected from fire and meets other applicable requirements.

E. Conduit & Raceway

1. RGS – where subject to damage and/or moisture, also elbows for PVC (minimum size ¾"). Not allowed for burial use along the right-of-way.
2. EMT – where not subject to moisture or physical abuse (minimum size ¾"). Couplings to be compression, set screws are not permitted.
3. PVC – underground or encased in concrete, use RGS elbows on long pulls (minimum size 1")
4. FMC – indoor connection to transformers, machinery and lighting whips (minimum size ¾")
5. Liquidtite – where flexible connection is required in an area subject to moisture (minimum size ¾").
6. Surface mounted (i.e. – Wiremold™) – retrofits in office area only. Construction to be metal only with the ability to accept paint.
7. Raceway and junction boxes/pullboxes/etc. shall be designed to match the rating of the equipment housing such as IP65 rated Luminaires.

F. Boxes

1. Sheet steel – galvanized.
 - a. Device boxes.
 - b. Junction boxes not subject to precipitation.
2. Stainless steel – where subject to precipitation or corrosives.
 - a. Junction boxes.
 - b. Equipment (panelboards, contactors etc.).
 - c. Heaters to be installed where moisture infiltration must be prevented.
3. Cast - where subject to moisture or precipitation
 - a. Devices
 - b. Junction box
4. Non-metallic
 - a. Use with PVC conduit.
5. Devices
 - a. Switches – commercial or industrial grade.
 - b. Receptacles– commercial or industrial grade.
 - c. Covers – metallic in all areas except office areas.
6. Grounding
 - a. Ground conductor required for each circuit.

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- b. Do not use metallic conduit as a substitute for a ground or neutral conductor.
- c. Ground rods to be copper coated steel ground rod unless particular soil conditions mandate SS.

G. Lighting

1. Illumination values – As per chart below or IES minimums if not indicated in chart. The illumination values shall be designed at the task level.

Amtrak Illumination Values Chart		
Description	Foot-Candles (a)	Max/Min (a)
Station Platforms - covered (during train occupancy) (e) <i>see Amtrak Illumination Values Notes below</i>	17 (d)	20/15
Station Platforms - uncovered (during train occupancy) (f) <i>see Amtrak Illumination Values Notes below</i>	6 (d)	7/5
Station Platforms –uncovered (except during train occupancy)	Reduce occupancy light by 50%	
Toilet, Restroom, Break areas	20 (c)	.25/15
Storage	25 (c)	.30/20
Stairs and Ramps	15 (c)	.20/10
Office	45 (c)	50/40
Locker Rooms and Showers	30 (c)	25/35
Exterior Station Lighting	5 (d)	8/3
Exterior Monument/Sign Lighting	15 (d)	20/10
Exterior Train Inspection Areas	20	18/22
Vehicle Parking – uncovered (f) <i>see Amtrak Illumination Values Notes below</i>	2 (d)	4/1
Vehicle Parking – covered (e) <i>see Amtrak Illumination Values Notes below</i>	5 (d)	8/2
Uncovered parking lots	3	4/2
Loading docks	15	20/10
Train Maintenance facilities	50 (h)	100/35
Train pit lighting	50 (h)	60/30
Train Tunnels	2 (i)	0.25 (g)
Utility Tunnels	5	15/2

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Amtrak Illumination Values Chart

Description	Foot-Candles (a)	Max/Min (a)
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Amtrak Illumination Values Chart Notes:
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- a) All designated lighting levels are average and Max/Min Lighting levels are to be achieved at the brightest and the dimmest point.
- b) Additional task lighting may be required based on specific working details.
- c) Ceramic Metal Halide lamps with pulse start ballast with minimum of 85 CRI. Interior T-8 fluorescent lamp (TL835-3500k) with program start electronic ballast, CFL lamps to be utilized in lieu of incandescent lamps unless approved by Amtrak LED source to be comparable in color.
- d) Ceramic Metal Halide lamps with pulse start ballast with minimum of 85 CRI. T-5 fluorescent lamp (TL835-3500k) with program start electronic ballast. LED source to be comparable in color.
- e) "Covered" platform is defined as being an area with no appreciable ambient light available.
- f) "Uncovered" is defined as being an area with appreciable ambient light available.
- g) Minimum on walking area when train is present.
- h) On equipment.
- i) On walking surface

2. Exterior – except platform

- i. Housing shall be IP 54 location rated as a minimum.
- ii. LED, MH, or fluorescent lamp.
- iii. Style of fixture to compliment overall Architectural design of the station and platform.
- iv. Lighting fixture selection to be "dark sky" compliant.
- v. Light trespass onto adjacent properties to be minimal.

3. Platform

- a. Housing - IP65 minimum.
- b. LED with step dimming driver is the basis of design. Comparable MH or fluorescent light sources/systems may be utilized.
- c. Style of fixture to compliment overall Architectural design of the station and platform.
- d. The location of the fixtures must be studied and coordinated with signage and signal location.
- e. Lighting shall not interfere with train crew operations or train signals.
- f. Lighting fixture selection to be "dark sky" compliant.
- g. Light trespass onto adjacent properties to be minimal.
- h. Raceway and junction boxes/pullboxes/etc. shall be designed to match the rating of the luminaire housing.
- i. A minimum of two circuits shall be utilized for branch circuit wiring along the platform. The circuits shall alternate fixture sequence along the platform. The tripping of a single platform lighting branch circuit breaker shall not cause complete loss of illumination on the platform.

j. Tunnels

- i. Housing shall be IP66 as a minimum.

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- ii. LED preferred, induction or MH may be used if justified.
- iii. Luminaire selection and coordination with clearances shall be provided as part of the design documents. A section depicting the largest of the 3 basis of design luminaires shall be included with the design.

k. Emergency

- i. Quartz re-strike shall not to be used with HID
- ii. See “Emergency Power”

l. Exit signs

- i. LED
- ii. Provide Internal battery if UPS or generator is not available

m. Lighting Controls

- i. Wall mounted light switch.
- ii. Occupancy Sensors where practical and employee safety is not compromised. “Night lighting” where appropriate.
- iii. Electronic switchable breakers – controlled by internal panel controller (CPU) and external input devices.

n. Platforms:

- i. Photo cell shall activate the CPU to provide illumination on the platform to a uniform 50% foot candle level from dusk to dawn.
- ii. The integral time clock shall activate the CPU integral time clock to provide balance of illumination from 50% to 100%-foot candle level on the platform based on train schedule. Full illumination (100%) shall be provided from 1 hour prior to 1 hour after train schedule arrival/departure.
- iii. Override controls (push button vs occupancy sensors) shall be evaluated on a station-by-station basis.

4. Non switchable breakers - Contactor – Photocell & Time Clock control.

a. Platforms:

- i. Photocell shall activate a control contactor to provide illumination on the platform to a uniform 50% foot candle level from dusk to dawn.
- ii. Time clock shall activate a control contactor to provide balance of illumination from 50% to 100%-foot candle level on the platform based on train schedule. Full illumination (100%) shall be provided from 1 hour prior to 1 hour after train schedule arrival/departure.
- iii. Override controls (push button vs occupancy sensors) shall be evaluated on a station-by-station basis.

b. Lighting Controls are to be reviewed at BOD for all areas.

5. The use of CPU based switchable breakers, non-switchable breakers, photocell, time clock, contactor, control cabinet, etc. to be identified and described in the BOD submission and updated with each subsequent submission. The controls, and misc. circuit breakers and devices shall be housed in a control panel/enclosure. The control panel/enclosure shall be suitable for the local climate, mounting location, and accessibility.

6. Lighting Controls shall meet the local energy codes and Amtrak’s goal of energy efficiency but not compromising passenger/ employee safety.

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- a. Lighting controls shall not be unique/single source equipment.
- b. Control systems shall not be Wi-Fi based.

H. Power Redundancy

1. Requirements Evaluation

- a. In accordance with the requirements below and applicable codes, the Design Consultant shall, within the Project Definition Report specified within Section 1.00, provide recommendations on the level of power redundancy for each asset family within the scope of the project. Assets should be assigned a recommendation among the categories of:
 - i. Normal (unavailable during utility outages)
 - ii. Emergency Power
 - iii. Standby Power
 - iv. Legally Required Standby Power
 - v. Optional Standby Power

2. Backup Power

- i. UPS
 - (i) UPS shall be rated for the environment where it is to be installed. Provide appropriate environmental equipment to maintain operating conditions for the lighting inverter or ups.
 - (ii) UPS shall provide remote alarm annunciation.
 - (iii) Coordinate battery capacity with Amtrak Project Manager.
 - (iv) Coordinate maintenance bypass and other optional equipment with Amtrak Project Manager.
 - (v) Covered platforms will require a dedicated UL 924 Listed UPS/ Lighting Inverter to provide continuous lighting. The UPS will be powered from the generator when available.

3. Backup Generator

- a. The following will be required to be fed from the Generator if provided:
 - i. Life Safety Lighting via the Emergency Lighting Inverter (UL 924 Listed). Emergency lighting shall not be permitted to be backed up directly with a generator.
 - ii. ADA Elevators
 - iii. Amtrak Police/ Cop-in-box
 - iv. Fire Pumps (review design with Amtrak PM, design shall comply with local codes and NEC Article 695)
 - v. Fire Alarm System (provide integral batteries in addition to being fed from Generator)
 - vi. Security Systems
 - vii. Other loads; coordinated with the Amtrak PM
 - viii. Crew Bases/ Offices
 - ix. IT Related Loads / UPS Systems and associated Cooling Systems

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- x. Vehicular traffic-control systems
- xi. Sump Pumps/ Ejector Pumps
- xii. Other loads; coordinate with the Amtrak PM

b. Facilities

i. All facilities

- (i) For lighting only –provide a lighting inverter. For small, readily accessible installations, self-contained battery packs may be used.
- (ii) For lighting and computer loads – UPS.
- (iii) Where operation of facility is required, other than for emergency egress, provide an emergency generator (If HID lighting, provide UPS or lighting inverter in addition to generator).

ii. Facilities with diesel locomotives

- (i) Where emergency power is required to operate the facility and not for life safety, a wayside power cabinet with backfeed capability shall be considered. Note that the 480V power does not have a neutral and a transformer is required where a neutral is required.

c. UPS

- i. UPS shall be rated for the environment where it is to be installed. Provide appropriate environmental equipment to maintain operating conditions for the lighting inverter or ups.
- ii. UPS shall provide remote alarm annunciation.

d. Generator system designs shall include at minimum provisions for a temporary load bank connection. Discuss with local stakeholders as to whether a permanent load bank is appropriate. Depending on the specific application and/or as required by code, connection for a portable generator during periods of permanent generator downtime shall be included in the design.

e. Diesel backup generators are preferred over natural gas.

4. Emergency Generator

a. Emergency generators shall be designed for a fuel supply for a 24-hour run time unless altered in coordination with Amtrak PM and DM based on a site fuel availability, exercising frequency, etc.

I. Wayside power for trains

1. All internal wiring is to conform to National Electrical Code and NEMA specifications.

a. Wayside power cabinets shall adhere to Standard Practice Drawings SP6001 and SP6002.

b. The maximum available short circuit current at the wayside power cabinet receptacles shall be coordinated with the planned rolling stock. If this is impractical or impracticable to provide, a designed solution shall be developed to create a safe condition both at the cabinet and within the trains/trainsets.

c. 480V distribution panels shall include power metering equipment. If desired, feeder circuit metering shall be provided. Meters shall conform to at a minimum the following requirements:

- i. Store a minimum of 1 year’s worth of data (kWh, kVA, kW, kVAR, PF, Hz, V, A)
- ii. Data shall be downloadable via USB or other approved means

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iii. Meters shall support Modbus or other approved open/non-proprietary protocol.

2. 60 Hz substations may supply both 480V HEP/wayside power and other loads as long as 1) short-circuit requirements can be met and 2) all 480V HEP/wayside power loads are fed from a panel that does not include any other loads. Requirement 2) may be waived if automatic load shedding and restoration provisions are included in the panel supplying both types of loads.

II. Design Guidelines and Processes for “Front-Line” Facilities

A. Scope

1. This document applies to the “facilities” side of Amtrak’s front-line facilities, such as air plants for track switches, power for signaling systems, power for comms, etc. Especially those facilities that are typically unattended. The asset owners of these wayside assets may opt to design their own power distribution system for their wayside assets. Should Facilities be asked to provide guidance, this section shall apply. Before issuing a scope to a consultant, a risk-analysis conversation shall be held with stakeholders in Transportation, B&B, and any other groups who may be impacted by a failure of this infrastructure. The key things to identify are the key risks and associated potential impacts to Amtrak’s operations and thereby our bottom line.
2. The conversation shall address stakeholder needs regarding contingency plans in the event of a utility power outage, such as an ATS and generator or other backup power source.
3. A determination by Amtrak shall be made as to whether or not NEC Section 708 (and other critical system code) shall be enforced on the project.

B. General Design Guidelines

1. Where third parties wish to draw power from electrical infrastructure that supplies front-line infrastructure, the third party’s designer shall include in their design a breaker coordination scheme or other means to mitigate the impact of a fault on their equipment to Amtrak infrastructure. This design, including the mitigation scheme shall be approved by Amtrak.
2. National Electrical Code shall apply at a minimum to electrical distribution systems powering wayside infrastructure, up to the point of connection with the main panel(s) inside of the huts. Downstream of this point, code application is as dictated by the rail system SME’s (e.g. Communications and Signals, Moveable Bridges, etc.).
3. The bottom of electrical equipment (panels, generators, ATS units, etc.) shall be situated not lower than 1 foot above the 100-year floodplain.
4. Buried feeders shall be protected with detectable warning tape placed a minimum of one foot above the top of the conduit or direct-buried wiring.
5. Grounding design shall be designed to avoid conflicts with comms, signals, and ET grounding practices.
6. Voltage drop shall be limited by the more strict criteria of code maximums or 3% unless permitted in writing by Amtrak.

C. Equipment Requirements

1. Electrical enclosures: NEMA 4X is the minimum standard for outdoor equipment.
2. For dry-type transformers, only non-ventilated types are permissible.
3. Surge/lightning suppression to be installed at a minimum at the most upstream disconnect/OCPD.
4. Transformer primary overcurrent protection shall in no case be less than 125% of the rated primary current.

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5. ATS units installed shall, via integrated means or provided accessories, be compatible with Amtrak infrastructure for status reporting. The DM shall provide direction to the Design Contractor regarding integration with Amtrak’s signals and/or comms infrastructure. At a minimum, the ATS shall support email notifications and SNMP traps. Additionally, the DM may also provide an RTU specification that the ATS shall be compliant with for integration with Signals/AMTEC infrastructure.
6. Automatic transfer switches shall, where provided, be specified to include isolation bypass.