PORT AUTHORITY NY NJ

Electrical Design

Guidelines

V.4
Last Updated:05/30/2025

ENGINEERING DEPARTMENT

CONTENTS

APPENDICES

1.0 ELECTRICAL DISCIPLINE

1.1 OVERVIEW

These guidelines are provided as an overview of the Port Authority's design standards. Design details and associated documents outlined in these documents will be provided, at the request of firms who are actively working on Port Authority projects, upon request.

The Guidelines shall not replace professional design analyses nor are the Guidelines intended to limit innovative design where equal performance in value, safety, and cost of maintenance can be demonstrated. The design team shall be responsible for producing designs that comply with the Guidelines in addition to all applicable codes, ordinances, statutes, rules, regulations, and laws. Any conflict between the Guidelines and an applicable code, ordinance, statute, rule, regulation, and/or law shall be addressed with the respective functional chief. The use and inclusion of the Guidelines, specifications, or example drawing details as part of the Contract Documents does not alleviate the design professional from their responsibilities/standard of care or legal liability for any Contract Documents they create. It is also recognized that the Guidelines are not universally applicable to every project. There may be instances where a guideline may not be appropriate. If the design professional believes that a deviation from the Guidelines is warranted, such a deviation shall be submitted in writing for approval to the respective functional chief.

The Electrical Discipline, and by extension consulting firms the Port Authority hires, prepares contract drawings, specifications, construction cost estimates, and construction staging plans for the installation and rehabilitation of power, lighting, fire alarm, communication, computer data, security, and various other electronic systems at the various Port Authority of New York & New Jersey facilities. During the design of these systems, the Electrical Discipline staff, performs condition surveys and prepares master plans, conceptual designs, contract drawings, specifications, construction staging, cost estimates, etc. The design guidelines contained herein are provided as an aid and reference for the engineering and design services outlined above.

Acronyms used throughout this guideline are defined in Appendix A.

Unless otherwise noted, all codes, standards and specifications shall be the latest approved by the authority having jurisdiction.

2.0 TECHNICAL AND CODE STANDARDS/REGULATIONS

2.1 THE CITY OF NEW YORK - APPLICABLE CODES

New York City Building Code

NYC Electrical Code

New York City Mechanical Code

New York City Fuel Gas Code

New York Plumbing Code

New York City Fire Code

New York City Fire Prevention Code and Directives

Rules of the City of New York currently in effect.

Title 1 – Department of Buildings

Title 2 – Board of Standards and Appeals (BS&A)

Title 3 – Fire Department

Title 24 – Department of Health

New York City Energy Conservation Construction Code

ADA – American with Disabilities Act – Federal Laws and 2010 ADA Standards for Accessible Design and 2004 ADAAG and Chapter 11 of 2014 NYC Building Code (NYCBC) & Appendices E, N and P

Applicable Latest Regulation of the New York City Environmental Protection agency.

New York State Labor Laws

2.2 NEW YORK STATE - APPLICABLE CODES

A. International Building Code of NYS, with amendments

International Existing Building Code of NYS, with amendments

Electrical Code of New York State

International Plumbing Code of NYS, with amendments

International Mechanical Code of NYS, with amendments

International Fuel Gas Code of NYS, with amendments

International Fire Code of NYS, with amendments

International Energy Conservation Code of NYS

International Residential Code of NYS, with amendments

New York State Multiple Dwelling Laws

ADA – American with Disabilities Act – Federal Laws and 2010 ADA Standards for Accessible Design and 2004 ADAAG

New York State Labor Laws

Safety Code for Elevator and Escalators – Chapter 30 of 2020 IBC and ASME A17.1 – 2016 and ASME 90.1-2015.

2.3 NEW JERSEY STATE - APPLICABLE CODES

A. New Jersey Administrative Code (N.J.A.C)

Title 5, Chapter 23, New Jersey Uniform Construction Code (NJUCC – 5:23):

Building Subcode 5:23–3.14:

Plumbing Subcode 5:23-3.15:

Electrical Subcode 5:23-3.16:

Energy Subcode 5:23-3/18: ASHRAE 90.1-2016

Mechanical Subcode 5:23-3.20:

Fire Protection Subcode 5:23-3.17:

Accessibility Subcode –

a. ADA – American with Disabilities Act – Federal Laws and 2010 ADA Design Standards and 2004 ADAAG
b. Barrier Free Subcode 5:23-7, ICC / ANSI A-117.1-2009 as amended by NJUCC -

Fuel Gas Code 5:23-3.22:

Safety Code for Elevator and Escalators 5:23-12 – Chapter 30 of 2018 IBC NJ Edition, ASME A17.1-2016, ASME A18.1-2014, ASME 90.1-2015, and NJUCC Subchapter 12 - Effective September 3, 2019

Asbestos Hazard Abatement Sub Code – NJUCC – Sub Chapter 8

Industrialized/Modular Buildings and Bldg Components – NJUCC – Sub Chapter 4A

Rehabilitation Sub Code : NJUCC ; 5:23-6, Sub Chapter 6, update yearly

Title 7 – Environmental Protection Laws

Rules, N. J. Bureau of Air Pollution Control and Federal Clean Air Act.

3.0 Design Criteria & Special Requirements

3.1 Specialty Requirements

3.1.1 PATH

The PATH Electrical System consists of:

- ❒ The Traction Power System, (27 KV AC to 650 VDC)
- ❒ The Emergency Ventilation, (Smoke Purge), Passenger Station Emergency Evacuation System and Tunnel Flooding Prevention (15 KV to 480 VAC)
- ❒ The Low Voltage Auxiliary Power System, (Passenger Station Lighting and Auxiliary Equipment and Tunnel low voltage power and Lighting system (480 Volts to 208/120 volts)
- ❒ The PATH SCADA System

3.1.1.1 The Traction Power System Includes The Following Conversion and DC Distribution Equipment:

- ❒ 26.4 KV Utility (PSE&G) incoming Switchgear, PATH 26.4 KV distribution switchgear, AC to DC Conversion equipment, (Traction Power Transformers and Rectifiers) and DC distribution equipment (DC substation feeder breakers, feeder cables, track switches and tunnel breakers), this equipment is designed in accordance with Contract requirements including Drawings and Standard and Custom PANY & NJ Specifications, ANSI and IEC Standards, NEC and PATH Requirements.
- ❒ 26.4 KV feeder cables from the 34.5 KV PATH Switchgear in Substations 2 (Washington Street) and PATH Substation 15(Caisson) provide incoming 27 KV power to the Traction Power equipment (34.5 KV switches) in Substations 1,3 and 4 located in the PATH tunnel system, these feeder cables are routed in different PATH tunnels for redundancy.
- ❒ PATH Substations 15, 5, 7, 8, 9 and 15 are fed from 26.4 KV PSE & G loop feeders, Substation 2 is fed from 3- 26.4 KV PSE & G feeders.

3.1.1.2 The Emergency Ventilation System, (Smoke Purge), Passenger Station Emergency Evacuation System *(15* KV to 480 VAC) and Tunnel Flooding Prevention (480 VAC) includes the following equipment: this system is designed per NFPA 130, NEC, Standard and Custom PA Specifications, Contract Drawings and PATH Requirement.

The 15 KV Emergency System is derived from the 26.4 KV PATH Distribution System Via 1-26.4 KV / 13.8 KV 10, MVA low Impedance transformer in Substation 15 and 2-5 MVA 26.4 KV / 13.8 KV low impedance Transformers in Substation 2A and 15 KV distribution switchgear. 15 KV emergency feeders are routed in separate PATH tunnels in accordance with NFPA 130, from the originating 15 KV switchgear in PATH Substations 2A and 15 to the Emergency Ventilation 15 KV switches,13.8 KV/ 480 Volt Transformers, 480 Volt Switchgear and Emergency Smoke Purge Fans and other Emergency Loads.

3.1.1.3 The Low Voltage Auxiliary Power System 480 Volt

This system is fed from Local Con Edison, PSE&G and PATH System low voltage power and is designed in accordance with PA Contract Documents, including Standard PA Specifications, and Drawings, PATH

requirements, New York City Electrical Code, NEC and all codes and standards as listed in the Standard PA Specifications.

3.1.1.4 THE PATH SCADA SYSTEM

The PATH SCADA System Includes Normal and Back-Up control locations. Normal Control is from C Yard Control Center and Back-Up is from HOBAN Control Center (Journal Square), Indication and control is provided for The PATH Traction Power System and the 15 KV Emergency System.

The Path SCADA System is designed in accordance with Contract Documents, including Standard PA Specifications, and Drawings, PATH requirements, New York City Electrical Code, NEC and all codes and standards as listed in the Standard PA Specifications. Components of SCADA system shall be coordinated with all involved parties during design phase.

3.1.2 TUNNELS, BRIDGES, AND TERMINALS

3.1.2.1 TUNNELS

In order to maintain and expedite vehicular traffic through the tubes of Port Authority of New York & New Jersey tunnels, a reliable and interrupted source of electrical power shall be available at all times. Two utility companies are employed for supplying the power required for the tunnels' operation: The Consolidated Edison Co. (Con Ed), which supplies power to the tunnels on the New York side of the Hudson River and the Public Service Electric and Gas Co. (PSE&G), which supplies power to the tunnels on the New Jersey side of the river. Con Ed provides three 15kV feeders at each tunnel while PSE&G provides two 15kV feeders at the Lincoln Tunnel and three 15kV feeders at the Holland Tunnel. This configuration allows for design and construction work to consider shutting down one or even more feeders at a time. It should be noted that under extreme emergency condition, tunnel emergency and essential equipment may be operated from only one 15kV feeder from either utility company. However, this type of emergency operation is not allowed to be considered as a design criterion when preparing any design documents. A minimum of three operational 15kV feeders shall be available at any time to avoid operating the tunnel at reduced capacity.

Tunnel power distribution systems, as well as miscellaneous electrical equipment, shall be remotely controlled at any time by a centralized system called Supervisory Control and Data Acquisition (SCADA). Tunnel Cable and conduit requirements.

No polyvinyl chloride (PVC)-coated conduits are allowed to be installed in tunnels.

Cables and wires (further called "cables") to be installed in the tunnels should comply with the following requirements:

- ❒ No PVC-insulated cables are allowed to be installed in tunnels except for communication systems, remote control, and signaling and power-limited circuits.
- ❒ Cables shall have a thermoset, low smoke, zero halogen, cross-linked polyolefin insulation.
- ❒ Cables shall pass the flame propagatory test VW-1, be Underwriters Laboratories, Inc. (UL) listed as XHHW-2 rated 90 degrees for both wet and dry applications. Full requirements for these cables are indicated on PA Standard Specification 260519.

3.1.2.2 BRIDGES

Electrical design shall consider the following:

- ❒ All conduits to be supported in an applicable manner in orientation and loads according to manufacturer specifications and recommendations.
- ❒ All conduits vertically mounted using UnistrutÒ, KindorfÒ, or similar supports shall be installed in such a way to prevent any conduit slippage due to excessive vibrations, either utilizing a cantilever bracket, a two-hole strap, or stop-nuts.
- ❒ Beam clamps shall not be used to support conduit mounted in a vertical fashion.
- ❒ All conduit support shop drawings shall be approved by the engineer prior to construction.
- ❒ Expansion/deflection fittings have to be installed not only on long conduit runs but also wherever conduits pass through structural joints.

3.1.2.3 TERMINALS

3.1.2.3.1 ***There are no special requirements for the Port Authority Bus Terminal and the George Washington Bridge Bus Station at this time.***

3.1.3 PORTS

<<Under Development>>

3.1.4 AVIATION

3.1.4.1 AVIATION VISUAL AIDS

A. Runway Lights: For operations under Category I configuration, runway centerline, elevated edge lights, and runway end identification lights shall be provided. Touchdown zone lights shall be additionally installed for all Category II and III configurations. The items listed below should be confirmed with the facility at the start of every project.

1. Runway Centerline Lights shall be L-850A 8” LED type flush fixtures with 12” FAA support ring without arctic kit, unless otherwise indicated by the facility. Verify manufacturer and catalog number with the facility. Fixtures shall be 2-plug fixtures at all airports except for LGA. Lateral spacing of light fixtures from the runway centerline varies and shall be confirmed prior to the start of work.
2. Elevated runway edge, end, and threshold lights shall be L-862 high intensity Incandescent or LED with arctic kit, confirm type with the facility, on 2” EMT with a frangible EMT coupling. Verify manufacturer and catalog number with the facility. Edge light height, lateral and longitudinal spacing, and circuiting varies by airport and shall be confirmed prior to the start of work.
3. In-pavement runway edge lights shall be L-850C high intensity 12” Incandescent or LED without arctic kit, confirm type with the facility. Verify manufacturer and catalog number with the facility. Elevated runway edge lights shall only be replaced by in-pavement lights where required due to direct aircraft rollover or interference with maintenance equipment such as snow plows or brushing machines. Edge light lateral and longitudinal spacing, and circuiting varies by airport and shall be confirmed prior to the start of work.
4. Touchdown zone (TDZ) lights shall be L-850B 8” LED type flush fixtures with 12” FAA support ring without arctic kit, unless otherwise indicated by the facility. Verify manufacturer and catalog number with the facility. TDZ lights are installed on CAT II and III runways or as directed by the Aviation Planning Group.

5. The installation of other runway lighting systems such as LAHSO lights, REIL lighting, runway status lighting, runway threshold lighting, approach lighting (e.g., MALSR and ALSF), etc., shall be coordinated with the facility, the Aviation Planning Group, and Aviation Technical Services on a case-by-case basis.

Taxiway Lights:

1. Taxiway centerline lights shall be L-852C/D/K 8” LED type flush fixtures with 12” FAA support ring without arctic kit, unless otherwise indicated by the facility. Verify manufacturer and catalog number with the facility. Taxiway centerline lights shall be designed to Below 1200 RVR requirements, unless otherwise directed by Aviation Technical Services and Facility Operations. The lateral spacing of the centerline lights varies and shall be confirmed prior to the start of work. Color-coding of lights and use of narrow-beam vs wide-beam fixtures shall follow FAA AC 150/5340-30 guidelines. At LGA and JFK clearance bars are supplemented with yellow/yellow fixtures at 90-degree taxiway intersections (in Lieu of yellow omni-directional fixtures). At all other airports, standard green/green fixtures are installed.
2. Clearance bar lights shall be L-852C/D/K 8” LED type flush fixtures with 12” FAA support ring without arctic kit, unless otherwise indicated by the facility. Verify manufacturer and catalog number with the facility. Clearance bar lights shall be uni-directional yellow lights, unless otherwise required by taxiway geometry. Bi-directional clearance bar fixtures shall be avoided wherever possible. If a centerline light interferes with the middle light of a clearance bar, the centerline light may be shifted per the tolerances in AC 150/5340-30 to avoid the conflict. Clearance bar lights shall be installed per the “Taxiway Centerline to Fixed or Moveable Object” distances in Table 4-1 of FAA AC 150/5300-13A and Figure A-44 in FAA AC 150/5340-30J. The Airplane Design Group (ADG) shall be confirmed with the facility and Aviation Technical Services for each airport at the start of a project.
3. Taxiway edge lights and retro-reflective markers:
    a. Elevated taxiway edge lights shall be L-861T LED type without arctic kit except for at SWF where they are installed with the arctic kit. Light manufacturer and frangible coupling size shall be discussed with the facility at the start of each project. Taxiway edge lights are installed on all taxiways at SWF and TEB airports. At LGA, taxiway edge lights are installed on all taxiways leading off runways until one light past the guard bar. At JFK, taxiway edge lights are installed on all high-speed taxiways leading off runways until one light past the guard bar. Taxiway edge lights are not installed at EWR. The lateral spacing and heights of the taxiway edge lights varies and shall be confirmed with the facility and aviation technical services. Taxiway edge lights are installed 10 feet off the taxiway edge on L-867 base cans, except at JFK where they are installed 15’ feet off the taxiway edge (per Modification of Standard) and on L-868 base cans.
    b. In-pavement taxiway edge lights shall be L-852T LED type omni-directional fixtures. Light manufacturer shall be discussed with the facility at the start of each project. In-pavement taxiway edge lights are installed only when required due to operational issues and at the request of the Facility. At LGA, in-pavement taxiway edge lights are installed at the last fixtures on each taxiway before the runway edge.
    c. Retro-reflective edge markers shall be 24" High with 14" of Retro-reflective blue tape. Base shall be Type B surface mounted with locking pins. Taxiway retro-reflective markers are installed at all airports except for SWF, and TEB, where retro-reflective markers are only installed in a few locations. The locations, lateral

spacing and heights of the taxiway retro-reflective edge markers varies and shall be confirmed with the facility and aviation technical services. Taxiway retro-reflective markers are installed 10 feet off the taxiway edge, except at JFK where they are installed 15' feet off the taxiway edge (per Modification of Standard).

4. In-pavement and Elevated guar bar lights shall be L-852G and L-804 LED type respectively, unless otherwise directed by the facility. Verify manufacturer and catalog number with the facility. Both in-pavement and elevated guard lights are installed at every taxiway entering a runway. The locations of the lights shall be coordinated with the painted hold position marking. In-pavement and elevated guard lights should be installed on different circuits if possible.

Guidance signs and distance remaining signs

1. Guidance signs shall be L-858 Size 3, Style 3 at all airports except for TEB where they shall be Size 2, Style 3. Guidance signs shall be LED fiberglass type except at SWF and TEB where they shall be LED Aluminum type. Verify manufacturer and catalog number with the facility. Coordinate sign foundation detail with Structural Engineering. Signs shall be installed per the "Taxiway Centerline to Fixed or Moveable Object" distances in Table 4-1 of FAA AC 150/5300-13A. The Airplane Design Group (ADG) shall be confirmed with the facility and Aviation Technical Services for each airport at the start of a project. Signs shall be grounded per the sign manufacturers recommendations.
2. Distance remaining signs shall be L-858 Size 4, Style 3 at all airports except for TEB where they shall be Size 5, Style 3. Guidance signs shall be LED fiberglass type except at SWF and TEB where they shall be LED Aluminum type. Verify manufacturer and catalog number with the facility. Coordinate sign foundation detail with Structural Engineering. Signs shall be grounded per the sign manufacturers recommendations.

3.1.4.2 Fixture Support Base and Extension Cans

Coordinate with the PA Electrical Engineering Design Group at the start of a project to obtain the most up-to-date base can installation details.

A. L-868 Load Bearing Base Cans:

1. Stainless-steel L-868 base cans shall be installed for all in-pavement light fixtures installed within concrete pavement. In addition, at EWR, all base cans for in-pavement fixtures installed within the limits of a runway, regardless of whether it is asphalt or concrete pavement, shall be stainless steel type. Refer to Specification 265010 "Taxiway/Runway Light Fixtures" for additional base can details.
2. Hot-dip galvanized L-868 base cans shall be installed for all other in-pavement fixtures. At JFK, base cans for elevated fixtures shall also be hot-dip galvanized L-868 type. Refer to Specification 265010 "Taxiway/Runway Light Fixtures" for additional base can details.
3. L-868 extension collar material shall match the bottom section base can material, unless otherwise directed. The typical height for L-868 extensions shall be approximately 4". Refer to Specification 265010 "Taxiway/Runway Light Fixtures" for additional extension collar details.
4. The typical L-868 base can installation for in-pavement fixtures shall include a ¾" flange ring with pavement dam and two ¼" spacer rings, unless otherwise directed.
5. All extensions and fixtures shall be installed with 3/8"-16 410 Black Oxide bolts with 316L Nord-Lock washers torqued to 28 ft-lbs.

6. Safety ground rods shall be installed inside every base can. Ground cable shall be exothermically welded to the ground rod.

B. L-867 Non-Load Bearing Base Cans:

1. Hot-dip galvanized L-867 base cans shall be installed for all elevated light fixtures except at JFK. Refer to Specification 265010 “Taxiway/Runway Light Fixtures” for additional base can details.
2. L-867 extension collar material shall match the bottom section base can material, unless otherwise directed. The typical height for L-867 extensions shall be approximately 4”. Refer to Specification 265010 “Taxiway/Runway Light Fixtures” for additional extension collar details.
3. All extensions and fixtures shall be installed with 3/8”-16 410 Black Oxide bolts with 316L Nord-Lock washers torqued to 18 ft-lbs.
4. Safety ground rods shall be installed inside every base can. Ground cable shall be exothermically welded to the ground rod.

3.1.4.3 Constant Current Regulators

Constant current regulators shall be ferro-resonance type, rated 30KW or below, dry type, indoor model, either suitable for stacking or cubicle housing. All regulators shall be provided with five steps and suitable digital cards to communicate with the airport lighting control computer located in the control tower.

3.1.4.4 Series Lighting Cables and Connectors

A. Series lighting high-voltage 5 KV non-shielded cables shall be single conductor with semi-conducting tape over the conductor, ethylene-propylene rubber (EPR) insulated with overall black chlorinated polyethylene (CPE) jacket. All series lighting cables shall be FAA L-824 Type-B and shall be suitable for use in conduits laid in kerf cuts or ductbank.

B. Single-pole series lighting cable connectors shall be plug and receptacle with insulated compression type connectors suitable for the cable size, FAA L-823 certified, and water resistant quick disconnect with rubber sleeve over the finished joint.

C. Refer to Specification 261015 “Taxiway Runway Wires and Cables” for additional cable and connector details.

3.1.4.5 Underground Ductbank and Kerf Cuts

A. Underground concrete encased ductbank with PVC schedule 40 conduits shall be utilized for all series cable lighting circuits. The top of conduit inside the ductbank shall be at least 30 inches below the grade. All ductbank along with handholes and manholes shall be located beyond runway/taxiway safety area for ease of maintenance.

B. The top of conduit shall be at least 18 inches below grade for all PVC schedule 40 conduits for series lighting circuits installed in concrete encased kerf. Usually one or two conduits shall be laid inside kerf cuts in airside of airports. Kerf cuts are preferred in place of ductbanks to avoid any major soil disturbance in safety area of taxiways/runways. Conduit directly buried in earth is not acceptable within the AOA.

C. Counterpoise cable for conduits and ductbanks shall be installed as per the requirements of FAA AC 150/5340-30.

3.1.4.6 Computerized Airport-wide Light Control

A. All taxiways and runways including jet run-up pad areas are provided with aviation light luminaires as per FAA operational and safety requirements. Monitoring and control of all these lights are done by the operators located inside the control tower with the help of command touch screens giving graphical display of all light luminaires and digital computers working in conjunction with the constant current regulators housed inside different lighting vaults.

B. For the sake of monitoring functioning of all lights, similar industrial-grade computers with flat panel touch screen graphical displays of all taxiways and runways lights shall be provided inside standard cabinets inside all lighting vaults for ease of maintenance purpose.

3.1.4.7 Emergency Diesel Generators

A. Non-FAA emergency diesel generator sets shall be three-phase, low-voltage type located near the lighting vaults for back-up power to all regulators and shall be rated for supplying all series circuit lights supplied from the particular lighting vault in the airport. For smooth airport operations, black start of the emergency set shall be as per FAA guidance.

B. The emergency generator set along with load bank and all accessories shall be housed inside a prefabricated weatherproof steel building painted in checkerboard fashion with FAA-approved aviation orange and white paints and shall be complete with all light and ventilation requirements.

3.1.4.8 FAA Light Luminaires and FAA Substations

A. All FAA light luminaires required for navigation/al aid (NAVAID) and visual aid (VISAID) under Category I, II, or III mode of airport operations shall be properly coordinated with Port Authority of New York & New Jersey lights located on runways and shall be supplied through a separate set of FAA cables and ductbank and kerf cut conduit network.

B. One FAA substation per each runway end shall be suitably located beyond the safety area inside a prefabricated steel building suitably checkerboard painted for visibility. The high-voltage step-down transformers and switchgear cubicles feeding the substation shall be located outdoors but close to the FAA substation.

3.1.4.9 Switchhouse Structures and Equipment

A. All switchhouses shall be located inside airport airside operation areas close to runways and taxiways for ease of series lighting circuit distribution through ductbanks. Switchhouse structures shall be as per latest Leadership in Energy and Environmental Design (LEED) requirements and located above the 100-year worst flood water level.

B. Each switchhouse shall be complete with adequate lights, ventilation fans, radiant space heaters, security cameras, and fire alarm system. The layout of equipment inside shall ensure proper segregation of all high-voltage power equipment away from computerized control and monitoring systems.

3.1.4.10 FAA Control Tower Integration

All aviation light computerized control and monitoring systems through fiber optic cable networks shall be from FAA operators located inside the control tower. Location of all liquid crystal display (LCD) flat-panel

graphical touch screens for remote light control and monitoring shall be properly coordinated with the FAA control panel layout inside the tower.

- ❒ Reference Design Documents:
  - FAA Airport Design Advisory Circular AC 150/5340-30B
  - Crouse-Hinds Airport Design Guide Book
  - FAA Airport System Planning Process Advisory Circular AC 150/50-70-7
  - FAA Order No. 6850.2A: Visual Guidance Lighting Systems
  - FAA Advisory Circular AC 150/5340-17B: Stand-by Power for Non-FAA Airport Lighting Systems
  - PA Standard Aviation Installation Details and Procedures
  - Jaquith/VEGA Airport Hardware Details
  - FAA Specification No. FAA-STD-019C
  - IESNA TM-16-05: Technical Memorandum on Light Emitting Diode Sources and Systems

3.1.4.11 MEDIUM VOLTAGE POWER SYSTEM, EWR, JFK, AND LGA AIRPORTS

A. Medium voltage (over 600 volts) switchgear, transformers, and splicing chambers, which are installed indoors, shall be installed in electrical vaults.

B. The flood protection criteria for the electrical vaults shall be designed per the latest Port Authority Climate Resilience Design Guidelines. At a minimum, electrical vaults shall be located above the Base Flood Elevation (BFE). The design team shall work with the Climate Resilience Specialist to determine if a higher Design Flood Elevation (DFE) is required for the project.

C. The incoming service shall be designed with a minimum of two feeders with automatic switch-over operation. The service shall be either:

1. Primary Selective
2. Secondary Selective
3. Primary and Secondary
4. Selective Spot Network

D. Primary selective switchgear shall be arranged with a mechanically interlocked tie switch to allow one feeder to supply the entire load. Medium voltage switchgear shall be as manufactured by the S&C Company.

E. Each incoming service switch shall be provided with a grounding switch, arranged to ground the incoming feeder (line side of switch). Mechanical Interlocks shall be provided to prevent closing the grounding switch if the feeder is energized. A key interlocking system shall be provided for the incoming equipment (Load Interrupter Switch(s), Grounding Switch(s), Low Voltage Main Breaker(s), as applicable) in compliance with the “Interlocking and Grounding” procedures at each specific airport and for each specific application.

F. The interrupting rating shall be 270MVA minimum for JFK International and LaGuardia, Airports and shall be based on short circuit calculations or studies.

G. All incoming feeders shall be copper conductor, MV-105, 133% EPR insulated, Flat Strap Cable (FSC), in accordance with Port Authority of New York & New Jersey Standard Specification, Section 261000. Copper sheath cables are not permitted. The main feeder size shall be 500 kcmil for LaGuardia Airport and 500 kcmil or 750 kcmil for JFK Airport, as determined by the Port Authority of New York & New Jersey. The minimum tap size shall be 4/0 AWG. Cables shall be manufactured by a factory approved by Con Edison.

H. For indoor and outdoor installations, transformers shall be dry type cast coil construction (primary and secondary).

I. Drawings shall include a complete one-line diagram showing all primary connections, protective devises, relay protection, switching and interlocks; power sources, routing and feeder designations; size and type of feeder and conduit; KVA rating; types and voltages of all transformers; and all load data in justification of the amount of power requested (load letter). Power riser diagram can be provided in addition to One Line Diagram, but not in lieu of. Key interlock schematic & procedure for service substation(s) shall be included.

J. The load letter shall be prepared and submitted to the Port Authority of New York & New Jersey in a format similar to utility company letters and shall provide a breakdown of major types of loads, shall indicate the largest motor load, total anticipated demand, any assumptions for watts/square foot, etc.

K. Shop drawing and catalog cuts for the medium voltage switchgear, transformers, cables, splices, and terminations shall be submitted for approval.

L. Port Authority of New York & New Jersey specifications for the medium voltage installation shall be used.

M. A short-circuit current calculation, coordination study, harmonic calculations, and arc flash analysis, for the proposed power system shall be submitted for review.

N. Each incoming service shall be provided with required Port Authority of New York & New Jersey-approved metering current transformers (CTs) and potential transformers (PTs). The CTs and PTs shall be connected to the primary side of the incoming feeders.

O. Each Substation for JFK Terminals shall be Spot network type substation with four service feeders to provide second contingency for each JFK terminal substation.

P. Dual-power sources with automatic transfer from both incoming feeders' metering PTs shall be provided for a totalizer, if provided.

Q. Provide a fire-treated plywood backer board for mounting the required meter pans and other metering devices including conduits, fittings, and wires for the installation of Port Authority of New York & New Jersey meters and totalizer. Metering equipment to be installed outdoors shall have a National Electrical Manufacturers Association (NEMA) Type 4X stainless steel enclosure. Meters and totalizer will be provided by the Port Authority of New York & New Jersey and shall be installed by the tenant.

R. Underground conduits to be used for the medium-voltage power distribution system shall be concrete encased fiberglass reinforced epoxy (FRE). Minimum conduit size shall be 5 inch. Refer to Chapter 3.2.2 for ductbank separation and Chapter 4.3.8 for spare conduit requirements.

S. The maximum distance between The maximum distance between manholes in the medium-voltage power system shall not exceed 450 feet, the total bending radius for underground duct banks shall not exceed 90 degrees and shall utilize wide sweeps.

T. Calculations of maximum pulling tension for all medium-voltage cable to be installed into the underground duct banks shall be submitted for review.

U. All manholes shall be designed as per Port Authority (PA) Electrical Standard Details, which are available upon request. Size of manhole shall be not be less than size “A” for all high tension ductbanks. For areas where a PA-standard manhole is not appropriate, submit a proposed manhole design including all dimensions and design calculations for review.

V. Medium voltage power systems at EWR are provided and distributed by PSE&G. From PSE&G, the Port Authority primarily receives and distributes low voltage systems. In instances where the Port Authority distributes medium voltage power systems at EWR, the design shall conform to the standards and guidelines set forth above.

3.1.5 WTC

<<Under Development>>

3.1.6 Corrosion Control

The primary goals of the corrosion control program are to develop and maintain dependable and long-lived structures, equipment and systems; conserve energy; reduce costs due to corrosion; and ensure compliance with the New York State Department of Environmental Conservation (NYSDEC), the New Jersey Department of Environmental Protection (NJDEP), and other applicable regulations and guidance.

The design of the systems shall take into account the presence of stray currents and their impact on existing and proposed structures, and the impact of connecting structures into existing cathodically protected structures. All tenant hydrant fueling systems shall be electrically isolated from the Port Authority of New York & New Jersey fueling mains.

The design shall take into account the monitoring requirements for compliance with the respective state agencies and federal regulations for corrosion control. Provisions shall be made to allow the effectiveness of all installed dielectric isolation devices (flange isolation kits, etc.) to be tested periodically without the need for confined space entry into vaults, etc.

In New York, all cathodic protection systems shall be registered with the "Greater New York Corrosion Committee" and in New Jersey, all cathodic protection systems shall be registered with the "New Jersey Committee on Corrosion.”

3.1.6.1 Cathodic Protection

Corrosion protection shall be implemented for the structures listed under Cathodic Protection and Corrosion Protection to meet life cycle cost/reliability requirements of the respective discipline.

Structures that are required by regulation to be cathodically protected are:

- Airport fueling lines.
- Underground fuel storage tanks and associated piping.
- Aboveground fuel storage tanks and associated piping.
- Underground liquefied propane storage tanks and associated piping.

If applicable, the cathodic protection systems shall be compatible with the existing systems at the Port Authority of New York & New Jersey facility.

3.1.6.2 Corrosion Protection

A related goal is to maximize public safety by prevention of failures of critical structures due to corrosion. Structures that are to be considered for corrosion protection include:

- High pressure water mains, particularly firewater mains.
- Firewater storage tanks.
- Pier support structures (pipe piles, caissons, sheet piling).
- Steel reinforcement in concrete structures.
- Building foundation columns and other structural steel buried in soil or embedded in concrete.

3.1.6.3 Methods

Corrosion control keeps the effects of electrochemical or chemical attack on materials by the environment to a minimum. Corrosion control measures include:

- Corrosion Control by Design and Material Selection—Materials shall be selected based on resistance to corrosion in the respective environment in which they will operate.
- Use of protective coatings to reduce atmospheric corrosion and cathodic protection currents requirements.
- Use of cathodic protection to eliminate electrochemical reactions.
- Monitoring of effects of stray direct currents (DC) on structures adjacent to sources of current such as DC transit systems (e.g., AirTrain, PATH).

3.1.6.4 Designer Requirements

The design of all corrosion control/cathodic protection systems shall be performed by a National Association of Corrosion Engineers (NACE) International-certified Corrosion Specialist or Cathodic Protection Specialist.

Designers shall:

A. Be qualified in the field of corrosion protection, namely certified by NACE as a Corrosion Specialist or Cathodic Protection Specialist and be a registered Professional Engineer in the State of New York or New Jersey, as appropriate for the facility.

Use field surveys, field tests, and experience of installation personnel during the design phase.

Provide corrosion control systems that are fully coordinated and completely integrated with existing corrosion protection systems at the facility.

Specify the testing necessary for the final acceptance of the corrosion control system. Target values of system operating parameters will be part of this testing to ensure the facility will function within design limits upon completion of construction of the system.

Incorporate operability and maintainability into the overall design of the corrosion control systems. Designs shall provide minimum life-cycle cost over the facility life expectancy.

Provide detailed calculations and one-line diagrams at Stage I to show the magnitude and layout of the corrosion control system. For example, validate the use of pre-engineered tanks with

factory-installed cathodic protection through appropriate calculations and field tests. Calculations shall show that the specified cathodic protection system will satisfy design life requirements of the respective state regulations (NYSDEC and NJDEP).

Provide corrosion control system drawings to show location of equipment, test points, sampling points, potential cathodic protection interference, items requiring periodic maintenance, and installation details.

The following types of cathodic protection systems shall be used, with the following exceptions:

1. Impressed current type CP (ICCP) shall be used for existing underground storage tanks (USTs) and associated piping, and for fueling piping distribution systems.
2. ICCP shall not be used on pier and wharf structures where the cost of providing alternating current (AC) power supply to the rectifiers would be excessive and where system maintenance costs would exceed structure maintenance costs. Galvanic type systems shall be utilized for these structures.
3. Galvanic type systems shall be used for new UST systems and short runs of well-coated piping. All new piping shall be electrically isolated from other structures, including existing piping, USTs and the grounding system.
4. Galvanic type systems shall not be used where the structures to be protected cannot be electrically isolated from grounded structures or cannot be provided with an effective coating system.
5. Galvanic anode type systems shall not be used where stray currents influence the structures to be protected.

3.1.6.5 Design-Applicable Standards

- API Recommended Practice 1632, “Cathodic Protection of Underground Petroleum Storage Tanks.”
- NACE RP0169, “Standard Recommended Practice: Control of External Corrosion on Underground or Submerged Metallic Piping Systems.”
- NACE RP0285, “Standard Recommended Practice: Corrosion Control of Underground Storage Tank Systems by Cathodic Protection.”
- NACE RP0286, “Electrical Isolation of Cathodically Protected Pipelines.”
- NACE RP0572, “Design, Installation, Operation and Maintenance of Impressed Current Deep Groundbeds.”
- NACE RP0187, “Design Considerations for Corrosion Control of Reinforcing Steel in Concrete.”
- NACE RP0288, “Inspection of Linings on Steel and Concrete.”
- NACE RP0388, “Impressed Current Cathodic Protection of Internal Submerged Surfaces of Steel Water Storage Tanks.”
- NACE RP0190, “External Protective Coatings for Joints, Fittings and Valves on Metallic Underground or Submerged Pipelines and Piping Systems.”
- NACE RP0290, “Cathodic Protection of Reinforcing Steel in Atmospherically Exposed Concrete Structures.”

- NACE RP0390, “Maintenance and Rehabilitation Considerations for Corrosion Control of Existing Steel Reinforced Concrete Structures.”
- NACE RP0193, “External Cathodic Protection of On-Grade Metallic Storage Tank Bottoms.”
- NFPA 30, “Flammable and Combustible Liquids Code.”
- NFPA 30A, “Automotive and Marine Service Station Code.”

3.1.6.6 DESIGN CRITERIA

*3.1.6.6.1 **Operating Requirements***

Operational requirements will vary depending on the situation. In atmospherically exposed situations, corrosion protection may be affected through material selection and/or coatings. For structures buried in soil, immersed in water or embedded in concrete, cathodic protection systems may be applicable. Structures installed adjacent to transit systems and thereby subject to stray current interference, need consideration of stray current mitigation and monitoring provisions. Impressed current cathodic protection systems must be energized and adjusted by a NACE-certified Corrosion Specialist, after the installation has been completed. These systems require an AC power supply in order to energize the rectifier. Continuous operation of the system must be assured by monitoring the rectifier output through visual inspection of the rectifier meters or the inclusion of a remote monitoring system. Galvanic anode systems do not require an external source of power and are fully operational once the installation has been completed. However, the effectiveness of the system must be verified by measurements by a Corrosion Specialist.

*3.1.6.6.2 **Design Requirements***

In order to determine requirements for the corrosion control system of the facility structures under consideration, the following factors must be analyzed:

- Soil characteristics in the area of the installation.
- Atmospheric exposure conditions for above grade structures, including moisture content, temperature, pollution, and immersion conditions for marine structures.
- Dissimilar metals used in the different structures that comprise the structure being installed.
- Soil resistivity, pH, and chloride ion concentration in the area of the installation.
- Existence of stray current sources from DC-powered traction systems or impressed current cathodic protection systems.

If conditions indicate that cathodic protection is required, the design of the system must be such that the corrosion on the structure in question is mitigated, while not creating a condition that causes stray currents to discharge from other structures in the area.

A structure is considered to be protected from corrosion when it meets one or more of the following criteria:

- A negative (cathodic) potential of at least 850 mV with the cathodic protection applied. This potential is measured with respect to a saturated copper/copper sulfate reference electrode contacting the electrolyte. (See NACE RP0169 for consideration of voltage drops for valid interpretation of this criterion.)

- A negative polarized potential of at least 850 mV relative to a saturate copper/copper sulfate reference electrode. (See NACE RP0169 for definition of polarized potential.)
- A minimum of 100 mV of cathodic polarization between the structure surface and a stable reference electrode contacting the electrolyte. The formation or decay of polarization can be measured to satisfy this criterion.

All cathodic protection system designs and commissioning tests for fuel storage facilities in New Jersey shall be performed by an individual certified by the State of New Jersey as a Corrosion Specialist, in accordance with the requirements of Subchapter 13 of N.J.A.C. 7:14B of the New Jersey Department of Environmental Protection rules for underground storage tank facilities.

All cathodic protection systems shall be energized and tested by a NACE-certified Corrosion Specialist or Cathodic Protection Specialist. A report shall be prepared and submitted to the Port Authority of New York & New Jersey. The report shall document all settings, protection levels, and the impact of stray currents on all nearby structures. Recommendations for mitigation of said interference effects shall be included.

Where proposed, utility pipelines will run in proximity (within 100 feet) of DC-powered traction systems, provisions shall be incorporated into the design of the structures to measure the effects of stray currents on those structures.

*3.1.6.6.3 **Corrosion Control Test Stations***

In order to evaluate the corrosion status of buried structures, such as pipelines, underground fuel storage tanks and above grade vessels such as water storage tanks, test stations for the measurement of potential, current, and resistance shall be provided at the following locations:

- Pipe casing installations.
- Metallic structure crossings.
- Isolation joints.
- Waterway crossings.
- Bridge crossings.
- Valve stations.
- Galvanic anode installations.
- Rectifier installations, including deep anode groundbeds.
- Stray current areas adjacent to transit systems such as AirTrain, New York City Transit (NYCT), or foreign impressed current cathodic protection systems.
- For the interior surfaces of water storage tanks on which cathodic protection has been installed.

*3.1.6.6.4 **Electrical Continuity***

Electrical continuity is required for all buried piping that is either scheduled to be cathodically protected or will be affected by stray currents from transit systems or foreign cathodic protection systems. Continuity shall be established only by bonding across mechanical joints utilizing exothermic welding of the appropriate-sized conductors across the joints and between the components of the mechanical joints (follower rings, bolts, rods, etc.).

*3.1.6.6.5 **Electrical Isolation***

Electrical isolation devices such as flange assemblies, prefabricated joint unions, or couplings should be installed within piping systems where electrical isolation of portions of the system is required to facilitate application of external corrosion control. These devices should be properly selected for temperature, pressure, chemical resistance, dielectric resistance, and mechanical strength. Installation of isolation devices should be avoided or safeguarded in areas in which combustible atmospheres are likely to be present. Locations at which electrical isolating devices should be considered include, but are not limited to, the following:

- Points at which facilities change ownership, such as fuel transfer lines at interfaces with terminal hydrant piping systems.
- Connections to main-line piping systems.
- Connection of new piping to existing bare or electrically grounded piping.
- Locations at which electrical grounding is used, such as motorized valves and instrumentation.

The need for lightning and fault current protection at isolating devices should be considered.

When metallic casings are required as part of the underground piping system, the pipeline should be electrically isolated from the casings. Casing insulators must be properly sized and spaced and be securely tightened on the pipeline to withstand insertion stresses without sliding on the pipe. Casing seals should be installed to resist the entry of foreign matter into the casing.

3.2 TECHNICAL POLICY STATEMENTS

3.2.1 PVC – INSULATED WIRE, COATED STEEL & NM-PVC TYPE CONDUIT

NM-PVC conduits, PVC coated steel conduits and PVC insulated wire shall NOT be installed inside any structure. See Port Authority Standard Specification 260533 – Raceway, for additional requirements.

3.2.2 SEPARATION OF MEDIUM VOLTAGE FEEDERS AND DUCTBANKS

A. Underground conduits to be used for the medium-voltage power distribution system shall be concrete encased fiberglass reinforced epoxy (FRE). Minimum conduit size shall be 5 inch. (empty) conduits,

B. Ductbanks of alternate feeders shall be separated by a minimum of 20 feet, measured from the inside edge of the ductbanks, and terminated in separate manholes. If separation of 20 feet is not possible, then the distance between edges of the duct banks can be decreased, with Port Authority approval, to 10 feet minimum with 1-inch steel plate installed 6” above both duct banks. Ductbank cover shall be 30” minimum to the top of the ductbank

C. Between manholes in the medium-voltage power system, the total bending radius for underground duct banks shall not exceed 90 degrees and shall utilize wide sweeps. Average distance between manholes shall be 350 feet and shall not exceed 450 feet.

3.2.3 Standard for Medium Voltage Pull-Through

Where a medium voltage cable will be pulled through a manhole without a splice, it shall be trained around the manhole walls allowing for enough slack to allow a splice in the future. Pull-Tension calculation shall be performed for each high-tension cables pull between manholes

3.2.4 Medium Voltage Redundancy

The intent of the separation of duct banks and the configuration for primary/alternate and spot network requirements is to provide a consistent amount of redundancy to the medium voltage systems.

The purpose of duct bank separation is to provide protection to the duct bank system ensuring that if one duct bank is damaged during unrelated construction, the other is far enough away to remain in operation.

Every feeder shall be backed up by at least one feeder in a separate duct bank that has the spare capacity to accommodate the total load of the other feeder. This ensures that if a feeder trips or is taken out of service for maintenance, then the load can be picked up after automatic or manual transfer operations.

3.2.5 Low Voltage / Communication System Redundancy

Provide redundant and resilient communications systems that can maintain functionality and adapt to disruptions by incorporating N+1 systems over diverse communication pathways. This approach ensures that if one part of the system fails, others can take over, to prevent widespread failures and maintain overall system integrity.

3.2.6 Seismic Design Requirements

<<Under Development>>

3.2.7 Supports

<<Under Development>>

3.2.8 Classified Areas

<<Under Development>>

3.2.9 Climate Resiliency

The design of all new construction and major rehabilitation projects are to be evaluated for proper design flood elevations and for resiliency against potential power outages associated with severe storms. Designs shall adhere to flood protection criteria in Design Guidelines – Climate Resiliency chapter.

Where prohibiting factors preclude this criterion, the focus should be centered on critical project elements.

3.2.9.1 Critical Electrical Power Equipment

Consider design criteria for elevating or protecting critical power equipment. Designs shall include provisions for connection to portable generator(s).

3.2.9.2 Radio and Other Sensitive Electronic Equipment

Consider design criteria for elevating or protecting radio and other critical electronic equipment. designs shall include provisions for connection to portable generator(s) were feasible with appropriate load management. Consider more resilient HVAC designs for locations that house radio and electronic equipment, which may include redundant mechanical system design elements and standby power for the associated mechanical equipment.

4.0 DETAILS, NOTES, AND CUSTOM SPECIFICATIONS

4.1 SERVICE SUBSTATION

Included under this category are:

- ❒ 5kv to 480-volt spot network substation, where utility-furnished or PA provided High Voltage switchgear, stepdown transformers, network protectors and collector bus compartment are located on Port Authority of New York & New Jersey property.
- ❒ High-tension service where utility metering is at 2,400 volts or higher and the Port Authority of New York & New Jersey provides the stepdown transformers.

Not included in this section are 120/208-volt services from a low-voltage network.

Generally, the utility will provide low-tension (600 volts and below) or high-tension service (2,400 volts and higher), depending upon various considerations.

As early as possible during the design process, a load letter and a request for fault current availability must be sent to the utility. The load letter will enable the utility to identify service options, for example, voltage and contingency design (e.g., N-1, N-2), and to indicate associated time frames for availability. Request a minimum of N-1 contingency service from the utility. In some cases, the utility may provide N-2 service (second contingency) if that is standard for that service area (e.g., in Manhattan, Queens & Brooklyn).

The service option offered by the utility shall be reviewed by the Port Authority of New York & New Jersey for concurrence or for discussion of alternatives, as appropriate.

The fault current availability is critical for specifying the proper interrupting and withstand ratings of the service equipment and arc flash protection of personal. The utility will typically indicate the worst-case numbers, which may be based on anticipated network upgrades and could be higher than estimates based upon current installations at other Port Authority of New York & New Jersey facilities.

When service characteristics are firmed up, obtain from the utility's representative a list of current utility company-standard specifications that dictate what the customer is required to provide at a service substation. For example, Con Edison has a standard specification EO-2022 that describes the company's requirements for high-tension service. Such requirements basically provide minimum design standards that must be met. Additional standards beyond the utility requirements are mentioned later in this document.

Key interlock shall be provided between feeder circuit breaker and all downstream switches.

4.1.1 LOAD ANALYSIS/CALCULATIONS (SAMPLE LOAD LETTER)

Load calculations are necessary for properly sizing service equipment, as well as for communicating this information to the utility.

Preliminary demand load estimates may be based upon watts/sq. ft. for lighting, general power for different types of space utilization, and based upon similar design projects. Obtain load estimates from the Electronics, Mechanical and Civil Disciplines for new equipment including heating, ventilating, and air conditioning (HVAC), elevators, escalators, pumps, conveyors, and the like. Demand factors can vary widely for different types of facilities and should be determined individually for each project. In the absence of sufficient project design definition, the following factors may be applied to the connected loads.

Load Type	Demand Factor
Lighting (Offices)	100% @ 1.5 watts/sq. ft.
Receptacles (Offices)	60% @ 2 watts/sq. ft.
Elevators	See National Electric Code (NEC) Table 620.14
Baggage Conveyor Systems	80%
HVAC	70%
Electric Space Heating	100%. See NEC Article 220.51

A load letter to the utility or the Port Authority shall always show the connected kilovolt-ampere (KVA) and/or kilovolt (KW) for the different types of loads. Refer to the following example of load calculations, which could be an attachment to a load letter.

The Port Authority
Newark Liberty International Airport

UPPER LEVEL

Electrical Load Calculations:

Prepared By: URS Corporation
Date: 8/28/2007

Normal Power Load

No.	Load Description	No. of Units	Unit of Measure	Unit Load Watt or KW		Full Load Amperes	Connected Load, KVA	Connected Load, KW	Demand Factor	Demand Load, KVA	Demand Load, KW
1	Lighting (Ticket Area)	50,000	Area-SF	1.50	Watt/SF		75.00	75.00	100%	75.00	75.00
2	Lighting (ALTO Offices)	7,000	Area-SF	1.50	Watt/SF		10.50	10.50	100%	10.50	10.50
3	Receptacles (Ticket Area)	50,000	Area-SF	1.50	Watt/SF		75.00	75.00	50%	37.50	37.50
4	Receptacles (ALTO Offices)	7,000	Area-SF	1.50	Watt/SF		10.50	10.50	50%	5.25	5.25
5	Misc. Heating	1	lot	20.00	kW		20.00	20.00	100%	20.00	20.00
6	Port Authority Baggage Conveyor System	1	lot	-	-	620	606.14	515.22	80%	484.91	412.18
7	Removal of (6) Existing Ticket Counter Conveyor Systems	1	lot			-300	-293.29	-249.30	100%	-293.29	-249.30
			Sub-Total:				503.85	456.92		339.87	311.13
	Future Spare Capacity - 0%						0.00	0.00	100%	0.00	0.00
						Total Load:	503.85	456.92		339.87	311.13

Emergency Power Load

No.	Load Description	No. of Units	Unit of Measure	Unit Load Watt or KW		Full Load Amperes	Connected Load, KVA	Connected Load, KW	Demand Factor	Demand Load, KVA	Demand Load, KW
1	Lighting (Ticket Area)	50,000	Area-SF	1.50	Watt/SF		75.00	75.00	100%	75.00	75.00
2	Lighting (ALTO Offices)	7,000	Area-SF	1.50	Watt/SF		10.50	10.50	100%	10.50	10.50
			Sub-Total:				85.50	85.50		85.50	85.50
	Future Spare Capacity - 0%						0.00	0.00	100%	0.00	0.00
						Total Load:	85.50	85.50		85.50	85.50

Example of Load Calculations

In the load letter, include an estimate of future growth based upon discussion with the Facility Planners and/or the lead Engineering/Architectural Discipline, including time frames.

Typically, the utility will develop its own demand estimate based on its own experience, to determine the size of service equipment, such as transformers. However, the Port Authority of New York & New Jersey can ask for higher capacity collector bus and take-offs if the utility demand estimate is thought to be low.

4.1.2 SWITCHGEARS SELECTION

4.1.2.1 HIGH-TENSION SERVICE SUBSTATION

For 4.16 KV and higher, metal-clad switchgear as specified in PA Standard Specification 261326 shall be used. Specify ratings (e.g., 250, 350, 500, 1000, 1,500 MVA or 25kA, 40kA, 50kA, 63kA) that exceed the available fault current estimated by the utility.

Minimum protective relaying is dictated by the utility, depending upon whether the service is radial or parallel.

For radial service, include the following functional relays to trip the primary breaker:

- 50/51 (phase overcurrent) for each phase
- 50N/51N (ground overcurrent)
- Zero sequence voltage detection using 27(under voltage), 59 (overvoltage)
- 87T (differential) transformer

For parallel service, with two or more feeders paralleled on the secondary using delta-wye transformers, also include the following functional relays in addition to the relays for radial service:

- 67 (directional overcurrent)
- 32 (reverse power)
- 51(phase overcurrent) for transformer secondary breaker
- 51N (neutral overcurrent) for transformer neutral
- 87B (differential) bus

4.1.2.2 RELAY PROTECTION 480 VOLT SPOT NETWORK SERVICE

<<Under Development>>

4.1.3 ELECTRICAL SPACES LAYOUT

With exception to the following, spaces and clearances shall meet the requirements of NFPA 70:

- Two additional feet to the minimum required by code shall be provided to the rear access of medium voltage switchgear.

4.1.4 NETWORK PROTECTOR COMPARTMENTS, TRANSFORMER VAULTS, AND BUS ROOMS

A. Roofs and floors shall be constructed of reinforced concrete with a minimum thickness of 6 inches. Exposed metal decking shall not be allowed in transformer vault and network protector compartment ceilings. The compartment or vault shall be designed as a waterproof structure if any part of it is external to the building. There shall be no penetrations through the ceiling of any kind.

Walls shall be constructed of 8-inch concrete block with voids filled with cement mortar. Two fire-rated (3-hour) steel doors shall be provided for each compartment or vault. One door shall open to a public corridor or lobby and shall be fire rated and accessible at all times. The other shall open to an adjacent compartment or vault or to the public corridor if there is only

one compartment. Doors shall be located on diagonal of the high voltage switchgear room. Reinforcement bars shall clear all conduits into the compartment by at least 4 inches.

Building steel shall clear all conduit and bus openings by at least 8 inches in order to prevent induced heat build-up in the steel members. All steel shall be encased with a minimum of 2 inches of concrete. Nothing shall be installed above a network bus. No conduits, wires, pipes, ducts, etc. shall enter or pass through the vault or compartment that are not specifically required for the operation of the vault. Mechanical equipment shall be mounted outside the compartment, with wall louvers only. Mechanical ducts shall not be used within the compartment, but if required, they shall be non-metallic.

Aspiration-type smoke detectors shall be provided for the compartment. The smoke detection equipment shall be located outside of the compartment and only the aspiration tube shall enter the compartment to allow maintenance to be performed without entering the compartment.

Forced air ventilation shall be installed and maintained including controls and alarms. All ventilation for transformer vaults shall be directly to outside air. Ventilation opening to interior spaces shall have 3-hour fire-rated dampers.

All floor mounted equipment shall be installed on 4” high housekeeping concrete pad.

Separation of network compartment from associated transformer vaults shall not exceed 25 feet.

Each network protector shall be installed in a separate compartment.

4.1.5 GROUNDING

A. Grounding at Substations shall conform to New York City Building Code (NYCBC) and National Electrical Safety Code (NESC).

Grounding loop shall be provided around substation building or any structure with maximum resistance 5 Ohm. Grounding loop shall be 500 kcmil copper cable and shall be connected to the building ground grid at two diagonally opposite locations minimum.

Major equipment, such as switchgear, transformers, motor control centers, and control panels shall have integral ground buses connected to the building ground grid at two diagonally opposite locations.

Grounding calculations including step and touch calculation shall be submitted to the Port Authority for approval.

Ground rods shall be copper bonded steel, ¾-inch diameter and 10 ft. long.

Grounding test well shall be provided.

Ground cables shall be soft-drawn copper, class “B” stranding, and connected to the ground rods by exothermic welds only.

All bare ground cables run above grade, regardless of size, shall be installed in rigid galvanized steel conduit in order to protect them from physical damage.

Grounds from separate equipment shall individually terminate on a ground bus. They shall not be connected together or daisy chained to the ground bus.

Electrical panelboards, motors, and other equipment shall be grounded utilizing an insulated ground wire connected in accordance with the manufacturer’s recommendations.

All conduits shall contain an insulated ground wire bonded to all enclosures and sized in accordance with the requirements from NEC or as shown on contract drawings.

All clamps, connectors, and other hardware used with the grounding system shall be made of copper.

Ground-fault protection shall be provided for all receptacles and equipment, where required by NEC and where located near sinks or running water.

For underground grounding wire in the environments exposed to the excess sodium-chloride (seawater) at locations such as JFK and La Guardia Airports, Ports and other facilities, utilize tinned copper wire in lieu of bare copper conductor.

4.2 POWER DISTRIBUTION SYSTEMS - LOW VOLTAGE

4.2.1 LOAD ANALYSIS/CALCULATIONS (SAMPLE LOAD LETTER)

A. Service and power distribution system shall be designed, as a minimum, for 1st contingency or to match utility company contingency.

Load analysis shall be performed using connected load and demand factor in accordance with NEC Article 220. All load calculations shall be performed in KVA. Use a factor of 1.25 for continuous loads and a factor 1 for non-continuous loads. Allow a minimum of 25% spare capacity for future use.

Sample load letters available upon request.

Voltage drop calculations shall be performed for each feeder. Voltage drop should not exceed 2% from service switchgear/switchboard to the distribution panel and 3% from the distribution panel to each load.

The skin effects for alternating currents are negligible for conductors 500 thousand circular mil (kcmil) and less at 60 hertz (Hz). Therefore, the direct current resistance values can be used to calculate voltage drop.

Short circuit calculation shall be performed to determine required interrupting capacity of electrical equipment. SKM program shall be used for calculations. Final Calculations in electronic format shall be send to PA.

Coordination study shall be provided for system selectivity and circuit breakers (CBs) settings.

Arc flash hazard analysis shall be performed to determine the incident energy and PPE requirements.

4.2.2 EQUIPMENT SIZING

A. Electrical equipment shall be sized to support calculated load served by the equipment.

B. Electrical equipment shall be sized to withstand short circuit current calculated for this bus.

C. Electrical equipment shall be rated for required 480/277V or 208/120V, 3 phase, 4 wire.

D. Enclosures/cabinets for equipment located in interior heated areas shall be NEMA type 1.

E. Enclosures/cabinets for equipment located in unheated interior areas or interior areas subject to dust, oil, or dripping liquid shall be NEMA type 12.

F. Enclosures/cabinets for equipment located in exterior areas or in other areas that are subject to rain, dripping liquid, or hosing shall be NEMA type 4X, stainless steel.

4.2.3 LOW VOLTAGE SWITCHGEARS/SWITCHBOARDS

A. All low-voltage switchgear shall be metal clad. The switchgear shall be built in accordance with American National Standards Institute/Institute of Electrical and Electronics Engineers (ANSI/IEEE) standards, shall have copper buses, and shall have as a minimum the following meters: volts, amperes (phase–to-phase and phase-to-neutral), frequency, ampere demand (one/phase and one average three phases), KW-hours, KW and KVA demand, power factor, harmonic load content and percent (total harmonic distortion [THD]), and be UL listed.

Locate in dedicated electrical rooms accessible only to qualified personnel.

All switchgears/switchboards shall be UL listed.

Front accessible where possible, except service entrance equipment.

For service entrance equipment, provide rear access when possible.

Provide 4” housekeeping pad for all floor mounted switchgears and switchboards

Copper main bus: 100% capacity full length.

Copper neutral bus, if required: 100% capacity full length.

Copper ground bus: full length.

Main and feeder CBs arranged for compression connectors.

All CBs shall be NEMA constructed.

All CBs shall have provisions for lockout/tagout (LOTO).

All CBs shall include electronic interchangeable trips with adjustable long time pick-up (LTPU), long time delay (LTD), short time pick-up (STPU), short time delay (STD), and instantaneous (INST) functions. When required, provide integral ground fault pick-up (GFPU) and ground fault detector (GFD) functions.

When ground fault is required, provide two level protections (main and feeders).

Provide service entrance label when required.

Provide minimum 20% spare capacity.

Provide minimum 1-spare CB of each frame size used (excluding main).

CBs less than 100 amps shall not be permitted on switchgears or switchboards.

Specify provision for future bus extension and provide dedicated space for at least one future section.

Provide integral surge protection device (SPD) to meet requirements of National Fire Protection Association (NFPA) 780.

Where drawout CBs are specified, provide manufacturer’s overhead lifting device suitable for all CB sizes and locations.

Provide manufacturer’s test kit for all CB types and functions used.

Low-voltage substations shall be double ended with two main CBs and a tie CB. Substation shall be fed from two different sources.

Tie CB, main breakers, and generator main breakers (if required) shall be electrically operated and controlled by a separately located transfer panel/mimic panel. The transfer panel shall have control power with an uninterruptible power supply (UPS) back up.

The transfer panel shall have a Mode Selector Switch (MSS) to select automatic or manual mode. Automatic operation of the breakers shall be open transition if fed from different substations and closed transition if fed from the same substation. Manual operation of the breakers may be open or closed transition. If closed transition is desired a second closed transition selector switch (CTSS) shall be provided.

Key interlocks, supplemented by mechanical interlocks, shall be provided for safety interlocking between the medium-voltage equipment and the 480V switchgear main breakers.

Each main breaker shall be provided with metering equipment.

All main and tie breakers shall be connected to SCADA for remote monitoring and control. See SCADA for design requirements.

4.2.4 TRANSFORMERS

A. Review the project load profile and select transformers to obtain peak loading between 60 to 80%.

All windings shall be copper, Aluminum windings are not acceptable.

Transformers shall be energy efficient type and meet DOE 2016 Efficiency.

A fused disconnect or CB is required on the secondary of a transformer when the secondary conductor length is more than 25 ft. to the panelboard.

Special consideration shall be given to locate transformers 112.5 KVA and above in a location where vibration will not be an issue. Also, avoid locating transformers where transformer-generated magnetic fields could interfere with TVs, monitors, or other sensitive electronics equipment.

Adequate ventilation/cooling shall be provided for transformers enclosed in closets installed indoors.

Transformers shall be self-cooled with steel enclosures.

Transformers larger than 112.5 KVA shall be designed for pad mounting only. Smaller transformers may be wall mounted or pad mounted.

All transformers located inside the building shall be dry type.

All transformers less than 500 KVA located outside the building shall be dry type.

All transformers 500 KVA and higher located outside the building shall be dry type or liquid filled. Less flammable, environmentally friendly liquids shall be utilized.

Dry type transformers shall be cast coil construction (primary and secondary).

Transformers installed outdoors shall have all openings designed to prevent rain and snow from getting inside.

Liquid field transformers shall not be located within 15 ft. from any building opening.

Where a high concentration (60% or more) of harmonics creating loads (PCs, laser printers, electronic ballasts, VSDs, UPSs, or other similar type equipment) relative to other non-harmonic loads is anticipated, the following shall be provided:

4.2.5 PANELBOARDS

Panelboards shall have a main CB, 100% neutral bus, ground bus, 42 poles, copper buses, bolt-on type line CBs, and be UL listed. Each panelboard shall contain at least 25% space for future circuits, single pole breakers shall not be ganged to form multipole breakers and "Series" rated equipment is not acceptable.

A. Panelboards shall be rated 208/120 volt or 480/277 volt, 3 phase, 4 wire.

B. Panelboards used for serving electronic loads shall be provided with double size neutral

C. Panelboards shall be fully I.C. rated. Series rating of equipment is not acceptable. Minimum I.C. rating for 480v panel shall be 22,000 Amps, and for 208 volt panels 14,000 Amps.

D. Panelboard enclosures shall be galvanized steel or stainless steel. All outdoor panelboard enclosures shall be NEMA 4X stainless steel.

E. Provide SPD for all panelboards.

F. Panelboards shall have minimum of 25% spare capacity for future use.

G. Interrupting capacity of the panelboard shall be determined by short circuit calculation.

H. Panelboards shall be equipped with a main CB. Main lug only panelboards are acceptable only if used as a subpanel located next to the equipment containing a CB supplying power to the panel.

I. Panelboards shall be equipped with bolt-on type molded case CBs only.

J. Panelboards shall be installed in electrical closets or electrical equipment rooms whenever possible.

K. Panelboards shall not be installed in user spaces if possible.

L. Panelboards shall be surface mounted. Flush mounted shall only be utilized in areas such as hallways or office spaces. When flush mounting a panelboard, provide spare conduits, skirting, and other provisions to aid future modifications.

M. Panelboards with greater than 14,000 amperes (A) available fault current shall be located in areas that are accessible only to qualified personnel.

Where a high concentration (60% or more) of harmonics creating loads (PCs, laser printers, electronic ballasts, VSDs, UPSs, or other similar type equipment) relative to other non-harmonic loads is anticipated, the following shall be provided:

1. Full size individual branch circuit neutrals.
2. 200% panelboard neutrals.

4.2.6 CIRCUIT BREAKERS AND FUSES

A. Interrupting capacity of CBs in switchgear or panelboards shall be suitable for the power system feeding them.

B. When specifying CBs and fuses, consider the existing electrical system as well as all the changes and additions to the system, so that the proper coordination of the overcurrent protection is developed throughout the entire electrical distribution.

C. When molded-case CBs with field adjustable trip settings are installed, the set points shall be set according to a coordination study

D. Include make and model number of new CBs being specified for existing switchgear or panelboard.

E. Main CBs are to be sized according to NEC 450.3 (B) for any location. If a larger breaker is installed, then the appropriate trip plug must be installed.

4.2.7 MOTOR AND MOTOR CONTROL

A. Coordinate motor schedule and motor connections and required control with other trades.

B. All electric motors shall be supplied with equipment, apparatus, and/or appliances covered under non-Division 26 sections of the Port Authority of New York & New Jersey master specifications. The electrical trade shall set and connect all specified non-integral starting equipment, install all non-integral power conduits and wiring, and shall furnish and make all non-integral connections from starting equipment to motors as required to leave the apparatus in running condition.

C. Limiting the motor inrush current shall be investigated. Generally, 200 or 230 volt motors 25HP and over, and 460 volt motors 50 horse power (HP) and over need reduced voltage starting. Solid-state reduced voltage starters or variable frequency drives are typically recommended.

D. Provide a non-fused stand-alone motor disconnect (separate from starter) within sight of every motor.

E. Specify the use of a motor control center (MCC) if six or more starters are needed in the same room. Consider the motor control center's main horizontal and vertical bus amperage, and the short circuit bracing. New MCCs shall be designed and specified to contain at least 20% spare size-one spaces.

F. MCCs shall have copper horizontal main bus with 100% capacity full length, minimum 600A, and a copper ground bus full length. Vertical buses shall be copper with 100% capacity full length, minimum 300A.

G. MCCs shall have copper neutral bus, if required, with 100% capacity full length.

H. Bus assemblies shall be braced to withstand a short circuit current not less than 25 KA symmetrical.

I. When necessary for the delayed loading of generators, on-delay relays shall be used in motor starters to sequence the restarting of large motors.

J. Locate indoors where possible; avoid outdoor locations.

K. Locate MCCs in dedicated electrical/mechanical rooms accessible only to qualified personnel.

L. Each section shall be dead-front and dead-back construction, front access only.

M. Provide future bus extension and dedicated space for at least one future section.

N. Starters shall be combination type with motor circuit protector, contactor and LOTO provisions, electronic overload protection devices, Hand-Off Auto selector switch, start and stop buttons, running and stopped LED push to test indicating lights and 2 normally open and two normally closed auxiliary contacts.

O. Variable frequency drives (VFDs) shall be installed when requested by the Mechanical Engineer.

P. A manual by-pass is not typically required on a VFD. A by-pass should only be specified after discussing the requirements with the Mechanical Engineer.

Q. Avoid using feeder CBs in MCCs. Instead, feed from a power panel.

R. Do not mount panelboards or associated transformers in MCCs.

S. MCC enclosures in heated indoor spaces with no dust, oil, or dripping liquids shall be NEMA type 12.

All motors ½ HP and above shall be rated three phase 460 Volts.

Individual combination motor starters installed outdoors shall have NEMA 4X stainless steel enclosure.

4.2.8 ELECTRICAL SPACES LAYOUT

A. All electrical distribution equipment shall be located in a dedicated electrical room. No mechanical system is permitted in electrical room unless it serves this electrical room.

B. Switchgear, switchboards, and panelboard shall be located as required by NEC article 110.26. Working space shall be minimum as required by NEC.

C. Floor-mounted equipment shall be installed on a 3- to 6-inches high concrete maintenance pad. Pad shall extend out 6 inches from equipment edge on all sides.

D. Number of exit doors from electrical room shall comply with NEC requirements.

E. Doors to the electrical room shall be adequate size to bring electrical equipment in and out.

F. Clear passage shall be provided to exit doors and exit routes in case of equipment replacement.

Electrical closets shall have 2-duplex receptacles (one on an emergency power circuit and the other on a normal power circuit).

4.2.9 WIRE TYPES AND SIZING: INDOOR/OUTDOOR DISTRIBUTION

A. All wiring shall be copper conductors. Aluminum wiring is not permitted at any PA facilities.

B. All wiring less than size 8AWG shall be solid copper conductors.

C. All conduit and wiring runs shall be identified on drawings in the following format: 3-1/C #10 & 1-1/C #12 G in 1” C.

D. Minimum wire size shall be #12 American Wire Gauge (AWG) for power distribution and lighting service.

E. Control wires shall be not smaller than #14 AWG unless otherwise permitted by equipment manufacture and proved through voltage drop calculations.

F. Wire sizes shall be increased to compensate for voltage drop as follows:

1. 120V and 208V circuits longer than 70 ft. shall utilize minimum #10 AWG.
2. 277V circuits longer than 100 ft. shall utilize minimum #10 AWG.

G. Cables for outdoor distribution shall be triple-rated type USE-RHH-RHW.

H. Additional performance characteristics for wire and cables to be installed in subway areas, substations, tunnels: stringent flame retardancy, low smoke, low toxicity, good circuit integrity (per UL 2196) during a fire are required. All cables for these applications shall be a minimum #12 AWG and rated 90 C for wet and dry applications. Designations of these cables: XHHW-2 or THHN/THHW for indoor and USE-RHH-RHW-2 for outdoor installations.

I. Aerial installation is permitted for temporary installation only. Use messenger wire to support cables. Use multiconductor cable type thermoplastic high water-resistant, sunlight resistant, nylon coated (THWN).

J. For indoor general-purpose distribution use 75° cable type XLP high heat-resistant water-resistant (XHHW-2) for wet and dry locations. Use 90° cable type THHW in boiler and mechanical rooms.

K. For vertical risers use 75° cable type XHHW and support it as required by NEC or use special cable, which can be supported at longer vertical distance.

L. Wire splices shall be compression type.

M. All wire and cable shall be installed in conduit. Low-voltage control or signal cables, except for fire alarm cables, may be installed without conduit above accessible ceilings if the cable meets NEC and UL listing requirements for the application.

N. Fire alarm cable shall be certified per regional requirements (e.g. NYC Certified)

O. All fire alarm cables shall be installed in RGS conduits. No exceptions are permitted.

P. In areas where low-voltage or signal cables are to be run without conduit, air return plenum locations and plenum rated cables shall be used.

Q. The use of multiwire branch circuits with a common neutral is not permitted.

R. Run equipment-grounding conductors, sized as per the NEC, with all power and control circuits over 50V.

S. Wiring methods under raised floors shall be specified.

PVC conduits shall not be used within buildings. PVC conduits and PVC insulation for wiring other than that for communications systems or remote control, signaling, or power limited circuits shall not be used in the Lincoln, Holland and PATH tunnels.

No splices or joints shall be permitted in either feeders or branches except at outlets or accessible terminal, splice or junction boxes.

All wires shall be identified by circuits in all cabinets, boxes, wiring troughs and other enclosures, and at all terminal points, i.e., receptacle, etc.

4.2.10 Race way Types and Minimum Sizes

A. All wiring will be installed in metallic or non-metallic (for outdoor use only) raceway systems.

B. All exposed indoor conduit including but not limited to in MEP rooms and all electrical room shall be threaded rigid galvanized steel (RGS), ¾-inch diameter minimum.

C. Rigid galvanized steel conduit shall be used for all fire alarm system wires and cables.

D. Exposed outdoor conduits and supports shall be PVC-coated threaded rigid galvanized metal, ¾-inch diameter minimum.

E. PVC-coated rigid galvanized metal conduit shall not be used indoors. Open garages are considered outdoor areas and shall utilize PVC-coated threaded RGS conduits regardless of conduit size.

F. Use compression type fittings only for EMT conduits. For RGS and IMT conduits use threated fittings only.

G. Intermediate metal conduit (IMC) conduit shall not be used in wet locations or high-corrosive areas. Otherwise, NFPA 70 Article 342 fully applies. IMC is only acceptable in concealed locations.

H. Electrical metallic tubing (EMT) conduit may be installed in dry interior concealed areas. EMT conduit shall not exceed 2 inches in diameter. Conduit in wet locations or larger than 2 inches in diameter shall be threaded RGS conduit regardless of whether it is installed in an exposed or concealed location.

I. Connections to motors and building equipment that can be moved by hand for access and servicing shall be flexible metal conduit, no more than 18 inches long.

J. Conduits shall be independently supported; do not support conduits from ductwork. Vertical feeder conduits and bus duct shall be independently supported at each floor level.

K. Expansion fittings shall be installed in conduits crossing expansion joints.

L. MC cable is allowed inside the wall for receptacles connections and is not permitted for home runs in the walls or ceilings.

M. Conduits in finished areas shall be concealed and those in unfinished areas shall be surface mounted.

N. Underground conduit/ductbanks shall utilize PVC Schedule 40 conduit 2-inch diameter minimum. Conduits shall be concrete encased a minimum of 3 inches all around. All ductbanks shall have 30-inch cover minimum. PA Standard detail is available upon request.

O. All 600V and less ductbanks and communication ductbanks shall utilize 4” PVC conduits, unless otherwise directed by the Port Authority. Minimum size of underground conduits for outdoor lighting and aeronautical lighting shall be 2” PVC.

P. Direct buried conduits are not permitted.

Q. Ductbanks shall be designed with 25% spare conduits for future use. In small ductbanks provide one spare conduit minimum. Install a spare conduit when just one conduit is required to be installed underground.

R. Ductbanks shall be sloped toward the manholes to provide adequate drainage; no low spots are allowed.

S. Ducts under vehicular roadways or other areas (parking lots, garages, etc.) where trucks or other heavy equipment travel shall be rigid steel or heavy wall FRE.

T. Ductbanks for high voltage, low voltage and communication cables shall not be installed within the footprint of a structure. Existing utilities located within the footprint of a structure shall be relocated.

U. Top entries of conduits into electrical enclosures located in areas subject to water or condensation shall not be permitted.

V. The communication underground conduit system shall be designed in accordance with the latest issue of the TIA/EIA-758 “Customer-Owned Outside Plant Electronics Standard”, NFPA 70, requirements of OSHA and all other applicable codes and regulations. All electrical materials and equipment for which there is a nationally recognized standard, shall bear the conformance label of the nationally recognized third-party inspection authority, such as Underwriters Laboratories Inc. (UL), Factory Mutual (FM) or ETL. All electronics raceways shall be installed per the latest issue of the TIA/EIA-569-A Standards and shall comply with the National Electrical Code and all other applicable State and local codes and regulations.

W. Communication duct banks shall not be installed in close proximity with power duct banks. The proper separation can be found in the NESC, NEC, EN, ANSI/TIA/EIA standards, OSHA regulations. Communication duct banks shall not be shared with other wiring (such as power) systems.

X. A 1/0 AWG bare copper stranded guard wire shall be provided for the Federal Aviation Administration (FAA) buried cables and conductors not routed in ferrous conduit, except as noted below.

Exception: Guard wires are not required for penetration under runways, taxiways, or topographical features or for 15 kV concentric neutral power cables constructed in accordance with FAA-C-1391d, paragraphs 5.5.7 and 5.5.8. This exception does not apply to concrete-encased PVC duct bank with communication, data, or control cables or to spare ducts that do not contain a corrugated innerduct reserved exclusively for fiber optic cables.

1. The guard wire shall be configured as follows:

    a. Location. The guard wire should be located at least 8 in. below the finished grade, at minimum height of 10 in. above the cable or cable ductbank, and shall run parallel to the cable or cable ductbank path that is being protected.

    b. Number of Wires. Provide one guard wire when the width of the cable ductbank is less than 3-ft wide. Provide additional parallel guard wire runs for cables or cable ductbanks wider than 3 ft, in accordance with the Area of Protection criteria. The guard wires should be spaced approximately 12-in. apart to provide an area of protection for the cable duct bank.

    c. Area of Protection. This is the protected area encompassed within a 45 degree zone on either side of the guard wire as illustrated on drawing E7.

    d. Bonding to Earth Electrode System (EES). Guard wires shall be bonded to the EES at each end, and to ground rods located at approximately 90-ft intervals along the guard wire path using exothermic welds. The spacing between ground rods must vary by 10 to 20 percent to prevent resonance. Install the ground rods approximately 6 ft on either side of the duct bank trench.

4.2.11 MANHOLES AND HANDHOLES

A. Manholes shall be provided, where required, so that cables may be installed without exceeding allowable pulling tension and cable sidewall pressure.

B. Manholes and handholes shall be designed to accommodate the number of cables, wires, and conduits required and have room for splicing those cables.

C. Maximum distance between manholes shall not exceed 450 ft.

D. Separate manholes and handholes shall be provided for 27kV, 15kV, 5KV, 600V power systems and communication systems.

E. Conduits from manholes, handholes, or ductbanks into buildings or remote equipment locations shall be changed to RGS prior to emerging from below grade.

F. PA Standard detail is available upon request.

G. Avoid installing manholes and handholes on roadways and taxiways. Handholes and manholes shall not be installed on runways and whenever possible shall be placed outside of the runway safety area.

H. Provide grounding for manholes, handholes, and covers.

I. Manholes shall not be installed within the footprint of a structure.

J. Manholes shall be provided with galvanized cable racks or fiberglass racks as required to properly support the quantity of cables to be installed within the manhole including all future cables. All cable racks shall be grounded. See PA Electrical Standard Details.

K. Construction over existing duct banks and manholes shall not be permitted. Existing duct banks that fall within the footprint of the structure shall be relocated prior to commencing construction. Verify that existing duct banks to be relocated do not have asbestos conduits.

L. Precast manholes and handholes so that they are firmly and fully bedded at required grades. Cast-in-place manholes and handholes conforming in size and strength to the precast manholes and handholes may be substituted, subject to the approval by Authority.

M. Manhole build over existing ductbank is not permitted.

N. All High-tension manholes shall be size A, Smaller sizes manholes are not permitted.

O. Ductbanks shall be connected to the short side of manhole.

P. Manhole chimney shall not exceed 5 feet.

4.2.12 SUBMETERING

Submetering and associated recording shall be provided in accordance with latest ASHRAE 90.1 and local amendment requirements applicable to the project's jurisdiction.

For renovations or projects exempt from energy code submetering, methods of submetering shall be explored that will limit substantial system upgrades to equipment that has not exceeded its useful life. For example, meter data can be extracted from Variable Frequency Drives or distribution boards serving consolidated HVAC equipment.

In addition to energy code requirements, submetering for the following load categories shall be considered and evaluated against the project scope:

A. Total electrical energy

B. HVAC systems

C. Lighting

D. Dedicated tenant power

4.3 POWER DISTRIBUTION SYSTEMS- MEDIUM VOLTAGE (5KV - 35KV SYSTEM)

4.3.1 LOAD ANALYSIS/CALCULATIONS (SAMPLE LOAD LETTER)

A. Service and power distribution system shall be designed as a minimum for 1st contingency or to match utility company contingency.

B. Load analysis shall be performed using connected load and demand and diversity factors. All load calculations shall be performed in KVA. Allow minimum of 25% spare capacity for future use.

C. Sample load letters are available upon request.

D. Voltage drop calculations shall be performed for each feeder. Voltage drop should not exceed 2% from service switchgear/switchboard to the distribution panel and 3% from the distribution panel to each load.

E. The skin effect for alternating currents are negligible for conductors 500kcmil and less at 60Hz. Therefore, the direct current resistance values can be used to calculate voltage drop.

F. Short circuit calculation shall be performed to determine required interrupting capacity of electrical equipment.

G. Provide coordination study for the distribution system.

H. Short circuit study shall be performed in SKM and copy of software file shall be provided to engineering in SKM format and PDF format.

I. Arc flash hazard analysis shall be provided to assess incident energy levels and PPE requirements.

J. Perform Harmonic Calculations.

4.3.2 EQUIPMENT SIZING

A. Electrical equipment shall be sized to support calculated load served by the equipment.

B. Electrical equipment shall be sized to withstand short circuit current provided by utility company or calculated for this bus.

C. Basic impulse level (BIL) rating for the equipment shall comply with the utility requirements.

D. Electrical equipment shall be rated for required voltage.

E. Enclosures/cabinets for equipment located in interior heated areas shall be NEMA type 1.

F. Enclosures/cabinets for equipment located in unheated interior areas or interior areas subject to dust, oil, or dripping liquid shall be NEMA type 12.

G. Enclosures/cabinets for equipment located in exterior areas or in other areas that are subject to rain, dripping liquid, or hosing shall be NEMA type 4X, stainless steel.

4.3.3 SWITCHGEARS (NON-UTILITY INTERCONNECTION)

A. Primary selective switchgear shall be arranged with a mechanically interlocked tie switch to allow one feeder to supply the entire load in the event of one service failure.

B. Each service switch shall be equipped with a ground switch, arranged to ground the incoming feeder on line side of the switch. This switch shall be mechanically interlocked to prevent closing on energized feeder.

C. Provide Key interlock system for medium-voltage load interrupter switch, grounding switch, fuse compartment door, medium-voltage substation, and low-voltage main CB. Interlocking between the medium-voltage switch and the medium-voltage substation depends on the existing substation key interlock scheme.

D. Switchgear interrupting rating shall be 180 MVA for Public Service Electric and Gas (PSE&G) and 270 MVA for Con Edison (JFK and LGA Airports,).

E. Use vacuum CBs. Avoid using gas-filled CBs.

F. Provide CTs and PTs on each incoming feeder. Connect the PT(s) to the line side of the service switch and the CT(s) to the load side of the service switch. Connect their outputs to the metering equipment. Provide totalizer where required. Provide SCADA connections for remote monitoring. See SCADA for design requirements.

4.3.4 ELECTRICAL SPACES LAYOUT

A. All electrical distribution equipment shall be located in dedicated electrical room. No mechanical system permitted in electrical room unless it serves particular electrical room.

B. Switchgears shall be located as required by NEC article 110.34. Working space shall be minimum as required by NEC.

C. Floor-mounted equipment shall be installed on a 3- to 6-inch high concrete maintenance pad. Pad shall extend out 6 inches from equipment edge on all sides

D. Provide minimum of two exits from electrical substation room.

E. Doors to the electrical room shall be adequate size to bring or replace electrical equipment.

F. Clear pass shall be provided to the building exit door in case of equipment replacement.

4.3.5 VERTICAL DISTRIBUTION

A. Cables for vertical distribution shall be supported per NEC. Splicing or pulling chambers shall be provided where vertical cable support is required.

B. Provide special engineered cable if distance between supports shall be greater than allowed by NEC.

C. For 5KV and higher rated cables provide 3 hour rated chamber with 3 hour rated doors. See Design standards.

4.3.6 TERMINATIONS AND SPLICES

A. Provide UL-listed termination kit or pothead for termination of the medium-voltage cables.

B. Provide UL-listed splice kit for splicing medium-voltage cables.

C. All splicing shall be located in the manhole or splicing chambers.

D. Each termination and splice shall be tested per Port Authority of New York & New Jersey specifications.

E. Only certified splicers with a minimum of two years' experience in medium voltage splicing shall perform splicing of cables. Qualifications shall be submitted for approval, prior to splicing.

4.3.7 CABLE TYPES AND SIZING

A. All wires shall be identified by circuits in all cabinets, boxes, wiring troughs, and other enclosures and at all terminal points, i.e., receptacle, etc.

B. Minimum wire size shall be 500KCmil with minimum tap size #4/0AWG for medium-voltage power distribution.

C. 5kV cables shall be flat strap type. Copper sheath type cables are not permitted.

D. Cables insulation shall be EPR 133 percent insulation level, FSC.

E. Aerial installation is not permitted.

F. All cable shall be installed in conduit.

G. The use of multiconductor cable is permitted.

4.3.8 RACEWAYS TYPES AND MINIMUM SIZES

A. Direct buried cables are not permitted.

B. All underground conduits shall be concrete encased and installed as a ductbank.

C. Provide 100% spare (empty) conduits if ductbank configuration is 3x2 or smaller. Provide 50% spare (empty) conduits for larger ductbanks. There shall never be less than two spare (empty) conduits in each ductbank.

D. When new ducts are required for primary power system (>600V), submit a set of calculations showing the maximum tension placed on the cables during pulling and the maximum allowable tension the cables can withstand. Calculate also, from a pressure standpoint, the force exerted in each elbow or bend during pulling and the radius of each bend. The minimum radius for electrical duct banks is 3 ft. Calculations shall be performed in both directions with resultants indicating either direction of pull is allowable.

E. Exposed indoor conduit for 5kV and higher, shall be rigid galvanized metal, 5-inch diameter minimum and shall be marked every 5 feet with a high voltage warning label. Exposed 5kV conduits are only permitted in areas that are restricted to qualified personnel.

F. Service conduits shall be concrete encased up to service switch enclosure.

G. Exposed outdoor conduits for 5kV and higher shall not be permitted.

H. Underground ductbanks shall utilize Medium Wall UL listed FRE conduit 5-inch diameter minimum. Conduits shall be concrete encased a minimum of 3 inches all around. If

ductbank is installed under roadway, runway or taxiway, then RGS or heavy wall FRE conduits and reinforced concrete shall be used. All ductbanks shall have 30-inch cover minimum.

I. Ductbanks shall be arranged to provide maximum heat dissipation to the earth. Provide heat calculations where more than one high current cable is to be located within the same ductbank.

J. Ductbanks of alternate feeders shall be separated by a minimum of 20 ft. edge-to-edge and terminated in separate manholes.

K. Do not exceed 90° total bending radius between manholes or splicing chambers. Wide sweeps shall be utilized. If more than 90° total bending radius is required then provide pulling calculations supporting proper cable installation.

L. All ductbanks shall be ended in manhole. If it is unavoidable per field condition, then dead ended duct banks shall be finished with reinforced concrete and clearly marked on the ground. See standard detail.

M. Provide 6” minimum separation between ductbanks and any utilities at crossing. Refer to external stakeholders standards when crossing their utilities (i.e. PSE&G, ConEd, etc.)

N. Ductbanks shall be sloped toward the manholes to provide adequate drainage; no low spots are allowed.

4.3.9 PULL CHAMBERS AND SPLICE CHAMBERS

A. Pull chambers and splice chambers shall be provided inside the building for high-voltage distribution.

B. Size of the pull chambers and splice chambers shall be adequate to perform all required pulling and splicing.

C. Additional space near pull chambers for cable reel shall be provided.

4.3.10 MANHOLES

A. Manholes shall be provided, where required, so that cables may be installed without exceeding allowable pulling tension and cable sidewall pressure.

B. Manholes shall be designed to accommodate number and size of cables, wires, and conduits required and have room for splicing those cables.

C. Maximum distance between manholes shall not exceed 450 ft.

D. Conduits from manholes, handholes, or ductbanks into buildings or remote equipment locations shall be changed to RGS prior to emerging from below grade.

E. PA Standard detail is available upon request.

F. Avoid installing on roadways and taxiways. Manholes shall not be installed on runways and whenever possible shall be placed outside of the runway safety area.

G. Provide grounding for manholes and covers.

H. Manholes shall not be installed within the footprint of a structure.

I. Construction over existing duct banks and manholes shall not be permitted. Existing duct banks that fall within the footprint of the structure shall be relocated prior to commencing construction. Verify that existing duct banks to be relocated do not have asbestos conduits.

4.4 EMERGENCY POWER SYSTEMS

4.4.1 GENERATOR SYSTEMS

4.4.1.1 EMERGENCY GENERATOR

The emergency generator(s) shall be rated for 100% non-varying continuous load ("Standby" and "Prime" rating is allowed) with a built-in load bank wired through a shunt-trip CB. minimum Outdoor generators shall be in a sound-attenuated weatherproof enclosure for areas where general public can be disturbed. All enclosures shall be provided with adequate (as a minimum code mandated) working and clearance spaces with a panelboard connected to emergency power. Sound enclosure specifications shall be optimized with an ambient sound level survey to determine the best rating for the enclosure.

4.4.1.2 AUTOMATIC TRANSFER SWITCH

The ATS shall be four pole. the Port Authority, with override switches, UL 1008 listed, and shall have as a minimum the following meters: volts (phase-to-phase and phase to neutral), frequency, ampere demand (one/phase and one average three phase), and KVA demand. The requirement for a maintenance by-pass shall be reviewed with the facility and PA engineering.

4.4.2 BATTERIES

A. The batteries shall be valve-regulated lead acid (VRLA), Lead Acid or Ni-Cd type.

B. Batteries shall be sized for DC loads in a substation. In general, there are four types of DC loads in a substation:

1. Momentary Loads: These loads occur one or more times during the battery duty cycle and last for one minute or less. They occur as result from switchgear operation, motor-driven valves, isolating switches, field flashing of generators, and inrush currents.
2. Continuous Loads: These loads operate throughout the duty cycle of the battery continuously. The loads are relays, inverters, emergency lighting, energized coils, controls, and communication systems.
3. Non-Continuous Loads: These loads are either automatic or manually operated and powered during a certain portion of the battery duty cycle randomly at any time interval and may continuing operating to the end of duty cycle. These loads are motor driven valves, fire protection system actuators, and emergency lighting.
4. Future Loads: Generally, load growth occurs in momentary loads. For this reason, batteries are generally oversized in terms of ampere-hour.

C. While sizing the batteries, the ambient temperature and end-of-battery-life conditions must be taken into account. These, together with design conservatism, the batteries sizes are significantly larger. This leads to over sizing lead-acid substation batteries. The latest version of IEEE 485 and other applicable standards should be used for sizing the batteries for substations.

D. Provide battery sizing calculations.

4.4.3 UNINTERRUPTIBLE POWER SYSTEMS (UPS)

- ❒ UPS and their topologies.
- ❒ System configurations.
- ❒ Bypass source considerations.
- ❒ UPS AC load distribution coordination.
- ❒ Selection and sizing of batteries for UPS backup.

4.5 LIGHTING SYSTEMS

4.5.1 APPLICABLE CODES AND STANDARDS

A. IESNA - Illuminating Engineering Society of North America

1. Roadway and Parking Facility Lighting Standard
2. RP-8-14: Roadway Lighting
3. RP-20-14: Lighting for Parking Facilities
4. RP-22-11: Tunnel Lighting
5. RP-33-14: Lighting for Exterior Environments
6. RP-37-15: Outdoor Lighting for Airport Environments
7. G-1-16: Security Lighting for People, Property & Infrastructure

B. Building Code of the City of New York

ANSI - American National Standards Institute

ASHRAE - American Society of Heating, Refrigeration & Air Conditioning Engineers

AASHTO – The American Association of State Highway Transportation Officials

ASTM - American Society for Testing Materials

NEC - National Electrical Code

NEMA - National Electrical Manufacturers' Association

NFPA - National Fire Alarm Protection Association

OSHA - Safety and Health Standards (29 CRF 1910) U.S. Department of Labor

UL - Underwriter' Laboratories, Inc.

4.5.2 LIGHTING TERMINOLOGY

A. The following terminology will be used throughout when referring to the different elements of lighting design criteria and lighting luminaires:

1. Color Rendering Index (CRI) - a measure of a light source's ability to show object colors realistically or naturally compared to a familiar reference source, either incandescent light or daylight.

2. Correlated Color Temperature (CCT) - specification of the color appearance of the light emitted by a lamp, relating its color to the color of light from a reference source. Measured in degrees Kelvin (K). The CCT rating for a lamp is a general "warmth" or "coolness" measure of its appearance.
3. Curfew – The IESNA gives recommendations for pre-curfew and post-curfew light levels to limit light trespass.
    a. Pre-curfew from dusk until 11:00 p.m., when the area being illuminated is more likely to be in use.
    b. Post-curfew from 11:00 p.m. to 7:00 a.m.
4. Footcandles (fc) – Unit of measurement of amount of light (luminous flux over area)
5. Glare - Visual sensation caused by excessive or uncontrolled brightness.
    a. Discomfort glare - is the sensation of annoyance or even pain induced by overly bright sources.
    b. Disability glare - is the reduction in visibility caused by intense light sources in the field of view to the point where the task cannot be distinguished.
6. Illuminance
    a. Illuminance is the amount of light that falls onto a surface. Illuminance is measured as the amount of lumens per unit area either in footcandles (lumens/ft2) or in lux (lumens/m2)
        1) Eavg: minimum maintained average illuminance
        2) Emax: maximum illuminance
        3) Emin: minimum illuminance
    b. Vertical illuminance is the amount of illuminance that lands on a vertical surface. For most exterior applications, the required vertical illuminance levels are at 5’-0” above finished grade.
7. Light Pollution – a by-product of night time lighting. It includes effects such as sky glow, light trespass, and glare. Minimizing light pollution and wasted energy is achieved by lighting to appropriate levels of illumination, choosing efficient luminaires and lamps, and extinguishing lights when not needed.
8. Light Trespass – Unwanted light is cast onto adjacent property.
9. Luminaire – The light fixture assembly consisting of lamp, reflector, diffuser, ballast, wiring, housing and mounting apparatus.
10. Luminaire BUG Rating: Backlight, Uplight, Glare
11. Luminance - Luminance is the amount of light that reflects from a surface in the direction of the observer. It is often referred to as the “brightness” of the surface.
    a. Lavg: minimum maintained average luminance
    b. Lmin: minimum pavement luminance
    c. LVmax: maximum veiling luminance
12. Nighttime Outdoor Activity Level Definitions

a. High – Areas with relatively high volume of pedestrians and/or vehicles during dark hours. Typically, areas with consistently high volumes or extreme swings of very high volume over short periods over time. Typical of large population centers.

b. Medium - Areas with relatively moderate volume of pedestrians and/or vehicles during dark hours. Areas with consistent activity over extended periods over time. Typical of moderate to small population centers

c. Low - Areas with relatively low volume of pedestrians and/or vehicles during dark hours. Areas with little activity over extended periods over time. Typical of suburban and rural population centers.

13. Nighttime Outdoor Lighting Zone Definitions

a. LZ4 – High Ambient Lighting

1.) Areas of human activity where residents and users are adapted to high light levels.

2.) Lighting is generally considered necessary for safety, security and convenience.

3.) Lighting is mostly uniform and continuous.

4.) After curfew lighting may be extinguished or reduced in areas as activity levels decline.

b. LZ3 – Moderately High Ambient Lighting

1.) Areas of human activity where residents and users are adapted to moderately high light levels.

2.) Lighting is generally desired for safety, security, and convenience.

3.) Lighting is mostly uniform and continuous.

4.) After curfew lighting may be extinguished or reduced in areas as activity levels decline.

c. LZ2 – Moderate Ambient Lighting

1.) Areas of human activity where residents and users are adapted to moderate light levels.

2.) Lighting may be used for safety, security, and convenience.

3.) Lighting is not necessarily uniform or continuous.

4.) After curfew lighting may be extinguished or reduced in areas as activity levels decline

d. LZ1 – Low Ambient Lighting

1.) Areas where lighting may adversely affect flora and fauna or disturb the character of the area.

2.) Areas where human residents and users are adapted to low light levels.

3.) Lighting may be used for safety and convenience.

4.) Lighting is not necessarily uniform or continuous.

5.) After curfew, most lighting should be extinguished or reduced in areas as activity levels decline.

e. LZ0 – No Ambient Lighting

1.) Areas where lighting will seriously and adversely affect the natural environment.

2.) Impacts include disturbing biological cycles of flora and fauna and/or detracting from human enjoyment and appreciation of natural environment.

3.) Human activity is subordinate in importance to nature.

4.) The vision of residents and users is adapted to darkness.

5.) When not needed, lighting should be extinguished.

14. Veiling Luminance

a. Luminance which reduces contrast.

b. Produced by bright sources or areas in the visual field that results in decreased visual performance and visibility.

4.5.3 EXTERIOR LIGHTING DESIGN

A. The purpose of exterior lighting is to permit the use of outdoor space for productivity and enjoyment. Appropriate lighting provides comfort as well as a sense of security. Efficient lighting design conserves energy to the greatest extent possible as well as minimizes adverse visual impacts including glare and obtrusive light. Responsible lighting design helps protect natural environment from adverse effects of artificial lighting and helps preserve the night sky for astronomy and enjoyment.

B. Night time tasks, such as driving automobiles, have very specific lighting requirements so people can perform these tasks safely. More light is not always better for these purposes. Adaption effects have significant safety implications. Low level light adaption effects both safety and comfort. Total dark adaption takes about 30 minutes whereas light adaption takes happens quickly, usually in less than a minute. Once eyes have adapted to low light levels they are very sensitive to white light and will lose their low level adaption almost immediately.

C. Transitions between areas of very different levels of illumination will cause a temporary loss of visual acuity. Smoother transitions minimizes adaption effects and permits better vision. If color perception is necessary for a night time task, it is important to provide enough illuminance for the task.

D. IES Guidelines indicate that calculated levels of illumination that differ by more than 10% of target values should be addressed. If illumination is 5% below recommended level than a significant percentage of users may find it not acceptable. If illumination exceeds recommendation by more than 10% than potential over-lighting and energy misuse.

E. One of the most important ongoing outdoor lighting issues that the lighting designer must be concerned with is unwanted light in the night time environment. Lighting pollution, light trespass, glare and sky glow have become significant issues. Unnecessary, unwanted or wasted light degrades the nighttime luminous environment and negatively impacts humans and other species. Use of cut-off luminaires and well shielded light sources should be considered to reduce contribution to these conditions.

4.5.4 LIGHT FIXTURE SELECTION CRITERIA

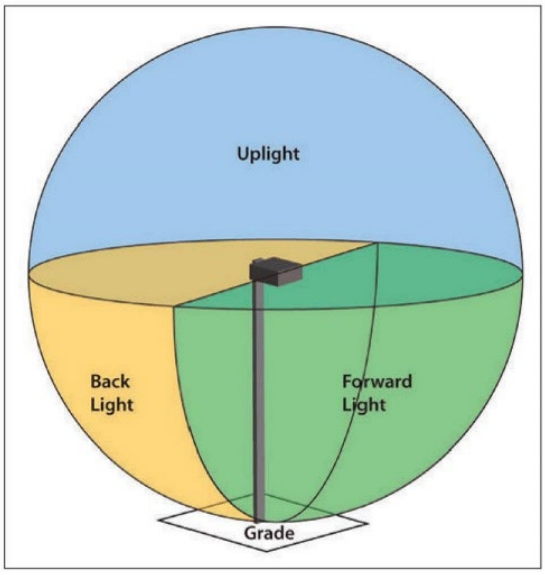
A. Certification: All luminaires should be UL rated or ETL rated.

B. Photometric Performance: Luminaires shall be selected to provide the required level of illumination as well as appropriate visual comfort. All luminaires shall be provided with an independent test lab report in an IES format file.

C. Durability: All luminaires should be durable and suitably rated for the environment where they are intended to be installed. Luminaires near waterways should be provided with marine grade finish.

D. Operations Cost: Luminaires should be selected to provide the appropriate photometric performance with the highest efficacy to minimize operating costs.

E. Ingress Protection (IP) Rating. All luminaires shall have the appropriate IP Rating for protection against water and/or dust infiltration for the intended area of installation.



F. BUG Ratings: All luminaires shall be selected to provide illumination where intended and limit light trespass and unwanted light form adjacent areas:

1. Backlight to be avoided with appropriate reflector design and, if necessary, accessory shields. Backlight is light distribution into adjacent areas or property that is not intended to be illuminated.
2. Uplight to be avoided with appropriate housing and reflector design. Provide full cut-off where possible. Uplight causes artificial skyglow.
3. Glare to be minimized through reflector and diffuse design and appropriate light output for identified tasks. Glare is uncontrolled brightness; it can be classified as discomforting or disabling.

4.5.5 EXTERIOR LIGHTING LEVELS

LOCATION	PANYNJ AVG. Foot Candles1	PANYNJ Vertical Foot Candles2	Uniformity Eavg:Emin	Justification of Lighting Level Increase at PANYNJ Facilities
ROADWAYS4				
Expressway	**2**	1	3 : 1	• High traffic volumes • Distracted motorists
Collector	**3**	1.5	3 : 1	• High traffic volumes • Distracted motorists
Intersection	**3**	1	4 : 1	• High traffic volumes • Distracted motorists • High pedestrian traffic
ELEVATED ROADWAY[4]				
Roadway	**3**	1.5	3 : 1	• Potential icing • Potential high winds
Approach	**3**	1	3 : 1	• Curvature impacts visibility

LOCATION	PANYNJ AVG. Lavg cd/m^2	AVG Uniformity Ratio Lavg:Lmin	MAX Uniformity Ratio Lavg:Lmin	MAX Veiling Luminance Ratio Lavg:Lmin	Justification of Lighting Level Increase at PANYNJ Facilities
AIRPORT ROADWAYS[4] (LUMINANCE)					
Expressway (Approach to Airport from major highway)	**1.2**	3	5	0.3	• High traffic volumes • Distracted motorists
Collector (Connecting roads not intended for long distance travel)	**1**	3	5	0.4	• High traffic volumes • Distracted motorists
Local Roads (Surrounding buildings)	**0.8**	6	10	0.4	• High traffic volumes • Distracted motorists • High pedestrian traffic

LOCATION	PANYNJ AVG. Foot Candles[1]	PANYNJ Vertical Foot Candles[2]	Uniformity (Eavg: Emin)	Justification of Lighting Level Increase at PANYNJ Facilities
AIRPORT DROP-OFF/PICK-UP AREAS				
Curbside Baggage Check	**20**	**5**	3 : 1	• Document confirmation • Facial recognition • High traffic volume • High Pedestrian traffic • Sense of security
Covered Area	**4**	**2**	4 : 1	• High Pedestrian traffic • Distracted Pedestrians • Distracted motorists • Sense of security
Uncovered Area	**5**	**2**	4 : 1	• High Pedestrian traffic • Distracted Pedestrians • Distracted motorists • Sense of security
Walkways from Airport to Parking Areas	**5**	**1**	4 : 1	• High Pedestrian traffic • Distracted pedestrians • Assist with wayfinding • Sense of security

LOCATION	PANYNJ AVG. Foot Candles[1]	PANYNJ Vertical Foot Candles[2]	Uniformity Eavg:Emin	Justification of Lighting Level Increase at PANYNJ Facilities
BUS TERMINAL ROADWAYS[4]				
Roadway	**3**	**1**	3 : 1	• High traffic volume • High Pedestrian traffic • Distracted Pedestrians • Distracted motorists
Covered Area	**4**	**2**	4 : 1	• High Pedestrian traffic • Distracted Pedestrians • Distracted motorists • Sense of security
Uncovered Area	**5**	**2**	4 : 1	• High Pedestrian traffic • Distracted Pedestrians • Distracted motorists • Sense of security
Boarding Area	**15**	**3**	4 : 1	• Document confirmation • Facial recognition • Sense of security
Pedestrian Transaction Area	**5**	**3**	5 : 1	• High pedestrian traffic • Distracted pedestrians • Sense of security
Pedestrian Transaction Counter	**30**	**5**	3 : 1	• Document confirmation • Facial recognition • Sense of security
Transaction Machines	**--**	**3**	--	• Minimum vertical illuminance over entire face of pay machine • Lighting should not obscure reading task on screens or windows.

LOCATION	PANYNJ AVG. Foot Candles[1]	PANYNJ Vertical Foot Candles[2]	Uniformity Eavg:Emin	Justification of Lighting Level Increase at PANYNJ Facilities
PARKING LOT				
Drive Aisles / Parking Areas	**4**	**2**	15 : 1	• High traffic volume • High Pedestrian traffic • Distracted Pedestrians • Distracted motorists • Assist with wayfinding • Improve color recognition
Transaction Areas	**5**	**2**	15 : 1	• Sense of security
Parking Payment Machines	**--**	**3**	--	• Minimum vertical illuminance over entire face of pay machine • Lighting should not obscure reading task on screens or windows.

LOCATION	PANYNJ AVG. Foot Candles[1]	PANYNJ Vertical Foot Candles[2]	Uniformity Eavg:Emin	Justification of Lighting Level Increase at PANYNJ Facilities
PARKING GARAGE				
Drive Aisles / Parking Areas	**4**	**2**	10 : 1	• High traffic volume • High Pedestrian traffic • Distracted Pedestrians • Distracted motorists • Assist with wayfinding • Improve color recognition
Ramps / Corners / Turns	**5**	**2**	10 : 1	• High traffic volume • Distracted motorists
Vehicle Entry and Exit Daytime5	**50**	**25**	10 : 1	• Transition zone to or from Daylight • High traffic volume • Distracted motorists
Vehicle Entry and Exit Night Time	**4**	**2**	10 : 1	• High traffic volume • Distracted motorists
Drop-Off / Pick-up Areas Valet Areas	**4**	**2**	10 : 1	• High traffic volume • High Pedestrian traffic • Distracted Pedestrians • Distracted motorists

LOCATION	PANYNJ AVG. Foot Candles[1]	PANYNJ Vertical Foot Candles[2]	Uniformity Eavg:Emin	Justification of Lighting Level Increase at PANYNJ Facilities
				• Sense of security
Vehicle Transaction Area	**4**	**2**	10 : 1	• Sense of security • Assist with wayfinding
Pedestrian Transaction Area	**5**	**3**	10 : 1	• Document confirmation • Facial recognition • Sense of security
Patron Transaction Counter	**30**	**5**	3 : 1	• Document confirmation • Facial recognition • Sense of security
Transaction Machines	**--**	**3**	--	• Minimum vertical illuminance over entire face of pay machine • Lighting should not obscure reading task on screens or windows.
Pedestrian Stairs	**5**	**2.5**	5 : 1	• Sense of security • Assist in Wayfinding
Roof Deck				• Same as Parking Lot

LOCATION	PANYNJ AVG. Foot Candles[1]	PANYNJ Vertical Foot Candles[2]	Uniformity Eavg:Emin	Justification of Lighting Level Increase at PANYNJ Facilities
TOLL PLAZA				
Approach and Departure Zones	**5**	**2**	4 : 1	• High traffic volume • Change in vehicle speed • Change in lane widths • Distracted motorists
Toll Collector Island6	**5**	**2**	3 : 1	• Identify objects and obstructions
Toll Collector Area7	**30**	**5**	3 : 1	• Document confirmation • Facial recognition • Sense of security
Walkways	**--**	**10**	3 : 1	• Pedestrian Toll Collector safety • Sense of security
BRIDGES				
Roadway4	**3**	**1.5**	3 : 1	• Potential icing • Potential high winds
Approach	**3**	**1.5**	3 : 1	• Curvature impacts visibility
TUNNELS				
REFER TO RP-22-11				

LOCATION	PANYNJ AVG. Foot Candles[1]	PANYNJ Vertical Foot Candles[2]	Uniformity Eavg:Emin	Justification of Lighting Level Increase at PANYNJ Facilities
UNDERPASS				
Roadway	**3**	**1.5**	3 : 1	• High traffic volume • Change in vehicle speed • Change in lane widths • Distracted motorists
Pedestrian (Daytime)	**10**	**5**	3 : 1	• Sense of security • Assist in wayfinding • Facial recognition
Pedestrian (Nighttime)	**4**	**2**	3 : 1	• Sense of security • Assist in wayfinding • Facial recognition
PEDESTRIAN / CYCLIST PATHWAY				
Near Roadways	**4**	**1.5**	4 : 1	• Sense of security • Assist in wayfinding • Facial recognition
Away from Roadways	**2**	**0.7**	4 : 1	• Sense of security • Assist in wayfinding • Facial recognition
PATH PLATFORM				
Platforms	**15**	**3**	3 : 1	• High pedestrian traffic • Safety & security • Distracted pedestrians
Platform Seating	**15**	**5**	3 : 1	• Provide light levels consistent with adjust platform
Platform & Car Threshold	**15**	**3**	2: 1	• High pedestrian traffic • Safety & security • Distracted pedestrians
Open Stairs & Escalators	**20**	**7**	2 : 1	• High pedestrian traffic • Safety & security • assist in wayfinding
Turnstiles	**20**	**7**	4 : 1	• High pedestrian traffic • Safety & security • Distracted pedestrians • Assist in wayfinding

LOCATION	PANYNJ AVG. Foot Candles[1]	PANYNJ Vertical Foot Candles[2]	Uniformity Eavg:Emin	Justification of Lighting Level Increase at PANYNJ Facilities
RAILWAY CROSSING				
Roadway4	**3**	**1.5**	3 : 1	• Safety & security for motorists • Improve recognition of track locations
Supplement on Train8	**--**	**1**	5 : 1	• Safety & security for motorists • Improve recognition of train cars from greater travel distance.
RAILWAY YARD				
Yard Body	**2**	**1**	10 : 1	• Safety for workers • Identify objects and obstructions
Control Tower Area	**5**	**10**	5 : 1	• Improved visibility for security monitoring
Hump Area9	**5**	**5**	5 : 1	• Safety for workers • Identify objects and obstructions
Switch Points	**5**	**5**	10 : 1	• Safety for workers • Identify objects and obstructions
Sides of cars	**--**	**5**	5 : 1	• Safety for workers • Identify objects and obstructions

LOCATION	PANYNJ AVG. Foot Candles[1]	PANYNJ Vertical Foot Candles[2]	Uniformity Eavg:Emin	Justification of Lighting Level Increase at PANYNJ Facilities
CONTAINER YARD				
General	**10**	**1.5**	5 : 1	• Safety for workers • Identify objects and obstructions
Slipway	**15**	**10**	5 : 1	• Safety for workers • Assist in wayfinding • Improve color recognition
Gangways	**5**	**1.5**	3 : 1	• Safety & Security
Loading Areas	**10**	**5**	4 : 1	• Safety for workers • Identify objects and obstructions • Improve color recognition
Catwalks	**5**	**1**	10 : 1	• Safety & Security
Stairs and platforms	**10**	**3**	5 : 1	• Safety for workers • Identify objects and obstructions
Storage Area Active	**10**	**2**	5 : 1	• Safety for workers • Identify objects and obstructions
Storage Area Inactive	**3**	**0.5**	10 : 1	• Safety for workers • Identify objects and obstructions
SECURITY LIGHTING / GUARD POST ENTRY				
Access Control Points (Search Area)	**10**	**5**	3 : 1	• Document confirmation • Facial recognition • Safety & Security
Access Control Zone (General Area)	**5**	**3**	4 : 1	• Document confirmation • Facial recognition • Safety & Security

LOCATION	PANYNJ AVG. Foot Candles[1]	PANYNJ Vertical Foot Candles[2]	Uniformity Eavg:Emin	Justification of Lighting Level Increase at PANYNJ Facilities
DE-ICING FACILITY				
Aircraft De-Icing	**10**	**10**	4 : 1	• Safety for workers • Assist in wayfinding • Improve recognition of materials on surfaces
Pump Area	**10**	**10**	5 : 1	• Safety for workers • Identify objects and obstructions
Tank Truck Loading Point	**15**	**7**	5 : 1	• Safety for workers • Identify objects and obstructions
General Control Area	**15**	**15**	5 : 1	• Improved visibility for security monitoring
Control Panel	**20**	**20**	5 : 1	

ILLUMINATED SIGNS					
	Ambient Light Level	Sign Luminance[10]	PANYNJ Vertical FC	UNIFORMITY	COMMENTS
Externally Illuminated Signs	Low	22 – 44 CD/M^2	10 – 20	2 : 1	• Assist with legibility • High traffic volume • Distracted motorists
	Medium	44 - 89 CD/M^2	20 – 40	2 : 1	
	High	89 - 175 CD/M^2	40 – 80	2 : 1	
Internally Illuminated Signs	Low	240 CD/M^2	NA		
	Medium	520 CD/M^2	NA		
	High	1000 CD/M^2	NA		
LIGHT TRESPASS					
Maximum Vertical	**Pre-Curfew Vertical FC[3]**		**Pre-Curfew Vertical FC[3]**		**COMMENTS**

Illuminance at Property Line			
LZ4	1.5 MAX	0.6 MAX	• Limit unwanted light on adjacent property
LZ3	0.8 MAX	0.3 MAX	
LZ2	0.3 MAX	0.1 MAX	
LZ1	0.1 MAX	0	
LZ0	0.01 MAX	0	

FOOTNOTES:

1. Horizontal footcandles at grade
2. Vertical footcadles at 5 ft above finished grade
3. Horizontal Luminance (cd/m2) at grade
4. Assume Pavement R2/R3 (Mixed or Slightly Specular)
5. Refer to Section 4.5.6-G. 6
6. Refer to Section 4.5.6-H. 2
7. Refer to Section 4.5.6-H. 3
8. Supplement on trains: Vertical plane at center of track from grade up to 13 ft above grade
9. Refer to Section 4.5.6-O. 4
10. Based on dark background with white letter reflectance value of 70%

4.5.6 EXTERIOR LIGHTING DESIGN CONSIDERATIONS

A. ROADWAYS

1. An important consideration for roadway lighting design is supporting the motorists' visual task. The ability to adequately see the road ahead and observe traffic or pedestrians and avoid conflicts is integral to the driving task. Lighting significantly improves the visibility of the roadway, increases sight distance, and makes roadside obstacles more noticeable to the driver, and therefore more avoidable.
2. Appropriate roadway lighting contributes to traffic safety as well as a sense of security for pedestrians, bicyclists, and transit users as they travel along and across roadways. Shadows or high contrast reduce visibility and personal security, and walking, bicycling or ancillary roadway activities may become uncomfortable or unsafe. Making certain that the lighting system provides minimum acceptable levels of illumination is important to all users of a roadway environment.
3. Roadway pavement luminance ratios are critical and are a combined result of the pavement material selection and the lighting system design. The calculation of pavement luminance requires information about the directional surface reflectance characteristics of the pavement.
4. Most common pavement groups can be classified into a limited number of Road Surface Classifications.
    a. R1: Mostly Diffuse
    b. R2: Mixed (Diffuse and Specular)
    c. R3: Slightly Specular
    d. R4: Mostly Specular.
5. Sight distance is the length of roadway that is visible to the driver. The available sight distance on a roadway should be sufficient to enable a vehicle traveling at or a near the design speed to stop before reaching a stationary object in its path.
6. Luminance is the amount of light that reflects from a surface in the direction of the observer. It is often referred to as the "brightness" of the surface or "apparent brightness" it is a more complete metric than illuminance because it takes into account the amount of light that reaches a surface as well how much of that light is reflected towards the driver.
7. Vertical illuminance is the appropriate measurement for determining the amount of light landing on pedestrians.

ELEVATED ROADWAYS

1. Elevated roadways and overpasses are visual extensions of the roadway but the roadbed is constructed on a structural deck. Road surfaces may be slippery or freeze before the roadway leading to the overpass.
2. High winds and vibration due to vehicle traffic is a concern and can be an issue for lamp and equipment life.
3. It is good practice to limit pole heights and use equipment that can withstand vibration.

AIRPORT ROADWAYS

1. The roadways surrounding an airport require careful selection and placement of light luminaires to prevent ground lights from causing interference with pilot approaches as well as Air Traffic Controllers. Uncontrolled light from fixture back light and glare cause reflectance off ground surfaces. Uplight creates skyglow and potential glare.
2. Control Tower Issues
    a. Air traffic controllers are responsible for safety and movement of terminal air traffic.
    b. Height restrictions should be taken into consideration when designing outdoor lighting layouts so that luminaires do not protrude into the controllers' line of sight.
    c. The tower controllers' vision should not be impaired by glare, reflected light from paved surfaces and direct high angle luminaires.
    d. Light luminaires selected should have well designed optical systems with low B-U-G Ratings: Backlighting should be minimized; Uplight should zero with no light emitted above 90 degrees; Glare should be controlled with the majority light emitted at low angles.
3. The roadways leading into an airport may be considered Expressways - a highway designed for fast traffic, with controlled entrance and exit, a dividing strip between the traffic in opposite directions, and typically two or more lanes in each direction.
4. Many of the roadways within an airport may be considered Collectors – roadways servicing traffic between major and local roadways and used for traffic movement within an area but do not handle long through trips.
5. Illuminance for Vehicle-Pedestrian Intersections:
    a. The IESNA Recommends that all Airport Pedestrian Intersections be considered High Pedestrian Conflict Areas.

AIRPORT DROP-OFF/PICK-UP AREAS

1. Departure and arrival areas are classified as High Pedestrian Conflict Areas with significant numbers of pedestrians expected to be on the sidewalks or crossing the read/street during darkness.
2. Nighttime outdoor lighting zone should be considered LZ4 – High Ambient Lighting.
3. It is important to provide visibility for the driver as well as pedestrians, in order to create a reasonably safe environment.
4. Vertical surfaces such as buildings and structures, as well as pedestrians, should also be illuminated in order to create a bright environment.
5. Glare from luminaires should be restricted by paying careful attention to fixture mounting height, light output and distribution.

BUS TERMINAL ROADWAY

1. Some of the roadways around a Bus terminal may be considered Collectors – roadways servicing traffic between major and local roadways and used for traffic movement within an area but do not handle long through trips.
2. Most of the roadways around a Bus Terminal would be consider local roads, surrounding buildings and facilities. Frequent stopping and interruption.
3. All Pedestrian Intersections be considered High Pedestrian Conflict Areas.

4. Drop-Off/Pick-Up Areas
    a. Departure and arrival areas are classified as High Pedestrian Conflict Areas with significant numbers of pedestrians expected to be on the sidewalks or crossing the read/street during darkness.
    b. Nighttime outdoor lighting zone should be considered LZ4 – High Ambient Lighting.
    c. It is important to provide visibility for the driver as well as pedestrians, in order to create a reasonably safe environment.
    d. Vertical surfaces such as buildings and structures, as well as pedestrians, should also be illuminated in order to create a bright environment.
    e. Glare from luminaires should be restricted by paying careful attention to fixture mounting height, light output and distribution.

PARKING LOT

1. It is important to provide visibility for the driver as well as pedestrians, in order to create a reasonably safe environment.
2. Parking areas should be classified as High Pedestrian Conflict Areas with significant numbers of pedestrians expected.
3. Nighttime outdoor lighting zone should be considered LZ4 – High Ambient Lighting.
4. Glare from luminaires should be restricted by paying careful attention to fixture mounting height, light output and distribution.

PARKING GARAGE

1. It is important to provide visibility for the driver as well as pedestrians, in order to create a reasonably safe environment.
2. Parking areas should be classified as High Pedestrian Conflict Areas with significant numbers of pedestrians expected.
3. Nighttime outdoor lighting zone should be considered LZ4 – High Ambient Lighting.
4. Glare from luminaires should be restricted by paying careful attention to fixture mounting height, light output and distribution.
5. Lighting should assist in orientation and wayfinding.
6. Covered parking garages require daytime transition lighting at entry and exits due to contrast from daylight. This helps to ease the motorist visual adaption.
7. Roof Deck Lighting Criteria to be same as Parking Lot.

TOLL PLAZA

1. Approach and Departure Zones:
    a. The approach zone of a toll plaza is the area in advance of the toll plaza and includes a transition area and a queue zone:
        1.) The transition area where the pavement widens from main roadway to the width of the plaza toll lanes.
        2.) The queue zone, with no taper, before the front edge of the toll islands
    b. This area is most critical area for drivers due to lighting level changes and proximity to collection booths.

c. This area should provide a comfortable transition from the ramp or roadway to the collection island.

2. Toll Collection Island:
   a. The toll collector island consists of the vehicle queue area, the toll island slab / canopy area and the departure zone.
   b. This area requires increased illumination due to varying tasks.
   c. The toll collector canopy protects against weather but also provides locations to mount light luminaires to provide the required levels of illumination. The canopy also provides mounting locations for signage and the visibility of the signage needs to be considered.
3. Toll Collection Area:
   a. The toll collection area consists of the toll collection booth and the task area where money is collected (or deposited in automatic collector)
   b. he toll collection booth requires multiple visual tasks:
      1.) Interior illumination for the attendant to function inside the booth.
      2.) Ability to see money received from the driver.
   c. Ability to see and identify vehicles approaching the collection area. Walkways:
   d. Walkways around the toll collection island are critical. They are used by the toll attendants to move between booths.
   e. Due to congestion and obstructions the driver may not readily see a pedestrian.
   f. Appropriate vertical illumination should be provided for walkways:
4. Infield
   a. The infield is the common name given to the unpaved open areas within and around the plaza. They provide clear lines of sight for motorists to assess traffic conditions.
   b. In some instances, there are buildings or storage facilities located here. There are also parking areas located in these spaces.
   c. Lighting for these areas is provided for security purposes and especially pedestrian safety.

BRIDGE ROADWAY

1. Most bridge roadways could be considered Expressways - a highway designed for fast traffic, with controlled entrance and exit, a dividing strip between the traffic in opposite directions, and typically two or more lanes in each direction.
2. Roadbeds can freeze before the lead in roadway.
3. There is a transition zone for access ramps to bridge roadway.

TUNNEL

1. Refer to IES RP-22-11

UNDERPASS

1. A structure is considered to be an underpass when the length and physical configuration of the structure substantially limit the driver's ability to see objects ahead.
2. Underpasses are often shared by roadways and pedestrian/bike pathways. Providing uniformity and vertical illumination is essential for visual acuity and safety.
3. No supplemental daytime lighting is required for underpasses or structures less than 80 ft in length.
4. Vibration due to vehicle traffic is a concern and can be an issue for lamp and equipment life.

PEDESTRIAN/CYCLIST PATHWAY

1. Pathways can accommodate walking, jogging, rollerblades, cycling, etc. Lighting to provide sense of security and allow for safe movement of individuals on the pathways. Areas of shadow and sharp contrast should be avoided.
2. Vertical illumination is important to identify others at a distance as well as gauge movement.
3. Changes of elevations, stairs and ramps to be taken in to account in locating luminaires.
4. If adjacent to roadways may not need separate lighting system.

PATH PLATFORM

1. It is important to provide good visibility in order to create a reasonably safe environment for a high pedestrian volume area.
2. Lighting to provide sense of security and allow for safe movement of individuals on the platforms. Areas of shadow and sharp contrast should be avoided.
3. Vertical illumination is important to identify others at a distance as well as gauge movement.
4. Uniform illumination and vertical illumination should be provided at platform edge for safety during train arrival and departure.
5. Vertical surfaces of building and structures should be illuminated in order to create a bright environment.
6. Changes of elevations, stairs, escalators and ramps to be taken in to account in locating luminaires.
7. Lighting should assist in orientation and wayfinding

RAILWAY CROSSING

1. Appropriate lighting required to prevent accidents during night time train operations and assist motorist in identifying train tracks and traffic control devices at night.
2. Moving trains block the crossing at night. Provide supplemental light to provide vertical illumination on sides of train cars.
3. Illuminate the conflict area on each side of the crossing to 30 meters in each direction
4. Lighting at and adjacent to crossings may supplement traffic control devices. Locate poles to limit glare for drivers and pedestrians. Full cut off luminaires recommended.
5. Supplemental vertical illuminance on train cars (centerline of track).

Railroad Grade Crossings

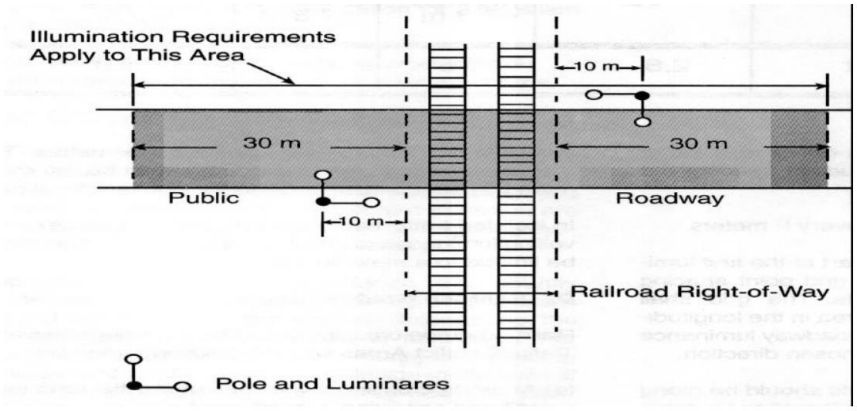


Fig D-4

Min of 10 lux vertical illumination on railroad cars

"Seven Years into Illumination at Railroad Highway Crossings" by Dick Mather; Signal Crossing Specialist with the Oregon Public Utility Commission

Reprinted from RP-8-00

benesch – Ramesh C. Gupta
Chicago, IL

RAILWAY YARD

1. High concentration of train rails and train cars require appropriate lighting for safe and secure operation. It provides workers with a safe environment to perform their duties safely, effectively and comfortably.
2. Lighting systems should provide uniform illumination over large areas, allowing for accurate color rendering, and with minimal glare so that workers can easily and safely discern their surroundings.
3. Placement of luminaires to be considered for areas of higher activity such as switch points.

4. Placement of luminaires to be considered for changes of elevations such as hump areas.
5. Lighting system must be able to withstand the harsh conditions of a wet marine environment, including high winds, heavy rains, corrosive salt fog, and extreme temperatures.

CONTAINER YARD

1. Proximity to waterfront and use of industrial equipment require appropriate lighting for safe and secure operation. It provides workers with a safe environment to perform their duties safely, effectively and comfortably.
2. Lighting systems should provide uniform illumination over large areas, allowing for accurate color rendering, and with minimal glare so that workers can easily and safely discern their surroundings.
3. Lighting system must be able to withstand the harsh conditions of a wet marine environment, including high winds, heavy rains, corrosive salt fog, and extreme temperatures.

SAFETY AND SECURITY / GUARD POST ENTRY

1. Providing a sense of safety and security are critical functions for exterior lighting. Proper levels of illumination are required to identify hazards or obstructions. Low glare light luminaires allow for better visual adaptation.
2. Safety and security lighting also involves perception and the application of higher light levels is not always appropriate; the quality of light - not quantity -is relevant. Implementing layers of light, such as minimal amounts of ambient light with highlighting, helps to create appropriate contrast and sense of distance and scale.
3. Appropriate amounts of vertical illumination reduce silhouette and shadow for easier identification of objects and especially faces. Vertical illumination assists in observation and identification.
4. Light fixture selection and locations should not interfere with security camera operation.

DE-ICING FACILITY

1. Sufficient lighting is required to allow crew to evaluate night time de-icing prevent treatment of wings and flaps.
2. Lighting should be adequate for visual inspection of all aircraft surfaces.
3. Appropriate lighting required to prevent accidents during night-time operations. Multiple vehicles will be in operation and application if de-icing fluid may create steam and limit visibility.
4. Lighting systems should provide uniform illumination over large areas, allowing for accurate color rendering, and with minimal glare so that workers can easily and safely discern their surroundings.
5. De-icing fluids may have adverse effects on the materials used to construct the lighting system and taken into account when selecting luminaires and mounting devices.

ILLUMINATED SIGNS

1. Signage will be viewed by motorists travelling at a high rate of speed and needs to be identified quickly and easily legible.

2. Amount of illumination on signage, reflectance of the signage surface and brightness of surrounding area contribute to legibility.
3. Placement of luminaires should not create glare which obscures the signage for motorists.

LIGHT TRESPASS

1. Light trespass is a result of unwanted or intrusive light in the nighttime. This results in glare, obtrusive light and skyglow.
2. When the level of the ambient light causes visual discomfort or loss of visibility, it is called glare.
3. Skyglow results from light that is unnecessarily directed upward and is scattered by the atmosphere, rather than being focused directly on the target area.
4. Obtrusive light is light that is distributed where it is not wanted or needed. It is also commonly referred to as spill light, which is light that falls outside the boundaries of the property on which the lighting installation is located.
5. Light trespass is visually disabling and aesthetically unappealing. It also wastes costly energy. The complaints arising from it are wide ranging, from issues of aesthetics to concerns about safety, health, and conserving energy resources.

4.5.7 Exterior Lighting Controls

All permanently installed exterior lighting shall have automatic controls capable of turning off exterior lighting when either sufficient daylight is available or the lighting is not required during nighttime hours.

Lighting not designated for dusk-to-dawn shall be controlled by a time switch.

Either a photo sensor or astronomical time switch shall control dusk-to-dawn lighting.

A. Exceptions

1. Lighting in parking garages, tunnels, and large covered areas that require lumination during daylight hours.
2. Lighting for steps or stairs that require lumination during daylight hours.
3. Lighting that is controlled by a motion sensor and photoelectric switch.
4. Lighting for facilities that have equal lighting requirements at all hours and are designed to operate continuously (such requirements shall be demonstrated to the satisfaction of the inspecting authority).

4.5.8 Interior Lighting

4.5.8.1 Interior Lighting Levels

Interior Light Levels for PA Transportation Facilities

Area	Luminance*	Uniformity**	Notes
Passenger waiting room	20	3:1	Provide 8 to 12 vFC at walls (except full-height fenestration)
Facility circulation/queuing	10 to 15	4:1	

Area	Luminance*	Uniformity**	Notes
Enclosed circulation (corridors, vestibules)	10 to 15	3:1	Provide 8 to 12 vFC at walls
Vertical circulation elements	20	6:1	Measured horizontal at each tread (stairs and escalators) and within elevator cab
Facility ticketing	15 to 25	3:1	Provide for 15 to 20 vFC at telephones and TVMs
Bus roadway	3 to 5	4:1	
Boarding area	10 to 15	4:1	
Offices	30 to 40	6:1	At task
Janitor closets/storage	20	6:1	
Electrical & mechanical rooms	20	6:1	20 to 30 vFC on face of equipment

* Foot Candles
** Average to Minimum

All lighting levels listed in the table are average, maintained values. All light levels are horizontal (h) unless noted as vertical (v). All vertical luminance values assume the use of wall washing or similar design approaches and are given as average, maintained utilizing an average-to-minimum ratio of 10:1. All horizontal luminance levels (unless otherwise noted) are to be measured at the floor.

4.5.9 Lighting Calculation Requirements

1. Luminance and Uniformity Criteria Achievement

   Lighting calculations for both normal and emergency lighting shall be submitted. Analyses shall be computer generated and inclusive of photometric data for all luminaires utilized. Calculations shall show lumination levels attained in foot candles. Analyses must consider all engineering data, such as coefficient of utilization (CU) and light loss factors (LLFs).

   Computer-generated lighting calculation analyses for all typical public and select, typical non-public areas should at minimum display the following information:

   a. Fixture location in context with facility architecture.

   b. Horizontal average luminance (typically, maintained); calculation points to be located on 2-ft. centers or less for interior spaces; on 10-ft. centers for exterior areas.

   c. Vertical surface average luminance where required by criteria.

   d. Average-to-minimum and maximum-to-minimum ratios (uniformity).

   e. Derivation of LLFs used.

   f. Statistical data regarding types of luminaires used.

   g. Statistical data regarding type of lamps and lumen output.

   h. Independent laboratory photometric test data for each fixture type, including lumen distribution curve.

i. Part plan design drawings for all calculation areas and sections/elevations showing relative location of luminaires and associated components.

2. Luminaire Characteristics

All luminaires must be UL listed, specification-grade, and furnished complete with all required mounting hardware. Standardization of lamps, luminaires, and system components is essential to ensure suitability for a wide range of applications and to enable cost-effective procurement and inventory simplicity. It is recommended that all expendable lighting elements (lamps, ballasts, lampholders, etc.) be standard products and limited in total quantity to facilitate procurement and competitive pricing.

Luminaires, whether part of an integrated system or stand-alone, must be durable and suitable for a minimum 30-year life cycle. This standard of durability shall include the ability for luminaires and components to withstand vibration, moisture, and vandalism.

Luminaires must be selected on the basis of appropriate performance, appearance, and cost-effectiveness. Selection characteristics include:

- Adaptability and appearance
- Total luminaire efficiency
- Commonality of lamping
- Ease of maintenance (e.g., tool-less access for common tasks such as relamping)
- Adherence to a reasonable standard of durability
- Consideration for maintenance is important for all facility spaces and can determine, in large measure, typical luminaire location parameters.
- Lighting components must be located so that they can be feasibly maintained. Lighting equipment located over VCEs and other open areas should not be located directly overhead, unless they are very long life (5 to 10 years average rated life) or unless specific maintenance strategies are identified for these areas.
- A minimum mounting height of not less than 8 ft. 6 inches (in.) above finish floor (AFF) should be maintained in all public areas. In all cases luminaires may not be located lower than 80 in. AFF.
- Public area luminaires located below 7 ft. AFF must comply with ADAAG requirements and must be vandal-resistant.
- Under no circumstances should cooled air pass directly over unlensed, bare linear fluorescent sources. It will cause lamp discoloration and reduced lumen output.
- In office areas, recessed fluorescent luminaires compliant with the applicable caveats of IESNA RP-1-04 should be provided.

4.6 Life Safety & Security Systems

4.6.1 Fire Detection and Alarm Systems

These guidelines cover fire detection and alarm systems; they do not cover HVAC requirements for smoke venting or purging that are included in the Mechanical section.

A. The fire alarm system shall comply with the latest applicable provisions of the national, state, and local codes and their amendments to the National Fire Alarm Code (NFPA 72) and Port Authority of New York & New Jersey technical specifications.

B. The fire alarm system shall be a voice evacuation system and have fully addressable, intelligent, four-wire system, with digital communication, and peer-to-peer communications between fire alarm panels and between their associated devices.

C. The fire alarm system shall consist of class ”A” Style ”7” Signaling Line Circuits, Class ”A” Style ”Z” Notification Appliance Circuits, and Class ”A” Style ”D” Initiating Device Circuits.

D. Upon completion of the project the entire fire alarm system and each major component such as zones, loops, circuits, panel components, power supplies, etc. shall have a minimum of 20% spare capacity.

E. All fire alarm wiring shall be installed in rigid metal conduits. Installation of plenum rated wire above hang ceiling is not permitted. All fire alarm conduits in non-finished areas and concealed conduits shall be painted fire alarm red. Fire alarm enclosures (pull boxes, junction boxes, and mounting boxes) shall also be painted fire alarm red.

F. In New York City, all fire alarm conduits in non-finished areas and concealed conduits shall be painted fire alarm red.

G. Field wiring for initiation and/or notification circuits or loops shall be installed in dedicated conduits, pull box or enclosure.

H. Consult the facility for the type of emergency voice/alarm communications:

1. One-Way Voice (Public Address) Communications System: One-way voice/alarm (Public Address) shall be dual-channel, permitting the transmission of an evacuation signal to one or more zones and simultaneous manual voice paging to other zones, selectively and in any combination.
2. Two-Way (Firemen's Telephone) Communications System: Survivability requirements for this system shall be in accordance with NFPA 72. (An acceptable way to meet this is to have widely separated dual risers and to feed approximately half the speakers on each floor from each riser.) The fireman's telephone system, if provided, shall indicate the location of each phone station in use and shall permit selective calling and party line operation.
3. All equipment supplied must be specifically listed for the purpose for which it is used and installed in accordance with any manufacturer’s instructions included in its listing.

J. The system shall have multiple access levels so authorized personnel can disable individual alarm inputs or normal system responses (outputs) for alarms, without changing the system's executive programming or affecting operation of the rest of the system.

K. The fire alarm control panel (FACP) shall be located for convenient, rapid access. When not located in a public or normally occupied area, a remote annunciator (RA) with audible-visible trouble indication is required. (Consult with the Facility Manager prior to locating the FACP and any RA or printer.)

L. The FACP and all other control equipment locations, including any transponders, sub-panels, and booster power supplies, must be protected by a spot-type smoke detector located within 15 ft. of the equipment (measured horizontally).

M. Smoke control system fans (pressurization or exhaust), or smoke purge fans, shall be provided with hand-auto-off switch(es) in or adjacent to FACP or RA. They must be clearly

labeled, and fire alarm system-monitored or provided with status indicator lights. (In New York City provide a New York City Fire Department key.)

N. The FA printer shall be powered from a FA 120 volts alternating current (VAC) panel circuit.

O. The graphic FA annunciator shall have a minimum of one screen per horizontal floor and one vertical screen. The graphics shall be based on the latest edition of AutoCAD used by the Port Authority of New York & New Jersey.

P. The speaker/strobes shall comply with the latest NFPA and Americans with Disabilities Act (ADA) requirements and shall be installed such that the no area is without coverage.

Q. Smoke detectors shall not be installed where the following conditions exist: vehicle exhaust, nearby cooking, ambient temperatures in non-conditioned spaces, or very high humidity. Heat detectors should include the rate-of-rise feature.

R. Each FA system with automatic fire detection, or which monitors a sprinkler system, shall be equipped with a 4-channel (minimum) digital alarm communicator transmitter (DACT) for transmission of fire alarm, supervisory, and trouble signals to a central station, remote supervising station, or proprietary supervising station. For buildings where full-time on-site staffing assures response, an area bell and high-power strobe light could be an effective means of signaling alarm.

S. Spot-type smoke detectors shall not be used where ceiling height exceeds 25 ft. because it makes access for maintenance very difficult and could impede response.

T. A detector installed where accidental damage (mechanical equipment rooms [MERs]) or deliberate abuse is expected shall be provided with a guard that is listed for use with it.

All air duct or plenum detectors must have a remote alarm indicator lamp.

The initiating device loops shall be limited to 30 devices.

There shall be no splices in the system other than at device terminal blocks or on terminal blocks in cabinets.

Permanent wire markers shall be used to identify all connections at the FACP and other control equipment, at power supplies, and in terminal cabinets.

Signaling line circuits shall be wired with type FPL/FPLR/FPLP fire alarm cable, AWG 18 minimum (unless manufacturer's installation instructions unequivocally require, or state preference for, the use of unshielded cable for the system), low-capacitance, twisted shielded copper pair. Cable shield drain wires are to be connected at each device on the loop to maintain continuity, taped to insulate from ground, and terminated at the FACP. In underground conduit, use Type TC or PLTC cable (PE insulated) to avoid problems from moisture.

Interface modules (used for all contact type initiating devices) must be located in a conditioned environment that does not exceed listing test parameters, to prevent failures due to temperature/humidity extremes.

Notification appliance circuit booster (NACB) power supplies must be individually monitored for integrity and are not permitted to be located above a ceiling or in non-conditioned space. NACBs shall be located in a conditioned environment that does not exceed listing test parameters (77° for batteries) and shall must be protected by a spot-type smoke detector located within 15 ft. (measured horizontally) of the NACB.

All junction boxes shall be painted red prior to pulling the wire. Those installed in finished areas are permitted to be painted outside to match the finish color.

All connections to the FACP and the system's programming shall be done only by the manufacturer or by an authorized distributor that stocks a full complement of spare parts for the system. The technicians who do this are required to be trained and individually certified by the manufacturer, for the FACP model/series being installed. This training and certification must have occurred within the most recent 24 months.

All fire alarm signals shall be transmitted to a central station monitoring system by approved methods. Facility-specific requirements must be included in signal transmission.

Existing fire alarm systems must be made compatible with central station alarm monitoring systems. New or altered fire alarm systems must be fully addressable and compatible with the central station monitoring system.

Any additions, alterations, replacements, or new installations of any fire detection, suppression, or signaling system at an existing Port Authority of New York & New Jersey facility shall require the complete fire alarm system to conform to the latest edition of the municipal Building and Fire Codes.

Tenant fire alarm systems serving the areas outside of the Port Authority of New York & New Jersey responsibility shall be interconnected with the Port Authority of New York & New Jersey base building or facility-wide fire protection system.

Tenant fire alarm systems shall be designed to control all systems and equipment installed by the tenant and shall be fully integrated into the building or complex fire protection system to support HVAC, smoke purge, and life safety fire response procedures.

The fire alarm system annunciation and communication between the Port Authority of New York & New Jersey and the tenant fire alarm system shall satisfy the following requirements:

1. The tenant fire alarm panel shall be of the same manufacturer as the Port Authority of New York & New Jersey base building fire alarm system or shall be an approved equal that is fully compatible.
2. The tenant shall engage the Port Authority of New York & New Jersey fire alarm system maintenance contractor to furnish and install the interface connection to the Port Authority of New York & New Jersey fire alarm system.
3. The Port Authority of New York & New Jersey fire alarm system maintenance contractor shall be responsible for coordination his/her work with the Port Authority of New York & New Jersey facility tenant liaison office.
4. The tenant shall provide all conduit, wiring, and interconnections.
5. The tenant fire alarm system shall transmit all addressable points to the Port Authority of New York & New Jersey fire alarm system in order to provide the complete status of all alarms, supervisory, and trouble signals.
6. The audible and visual devices in the tenant’s leasehold shall be fully integrated with the Port Authority of New York & New Jersey base building system and work in conjunction with Port Authority of New York & New Jersey audible and visual devices so that all devices in a fire zone are activated simultaneously.

The tenant fire alarm system shall be fully addressable and comply with all requirements for installation as identified by applicable codes and standards. A fully addressable fire alarm

system shall be able to clearly identify the type of alarm, the location of origin, and the status of the system and device.

The tenant fire alarm system must be compatible with and able to extend the Port Authority of New York & New Jersey base building voice evacuation system.

Bus Terminal Tenant Fire Alarm System Requirements:

All fire alarm cables shall be New York City-approved, shielded, twisted pair #14 AWG, solid copper, 200-degree C, 600V, except control circuits shall be unshielded.

1. Tenant Alarm Fire System
    a. General
        1.) The design of tenant fire alarm system shall comply with the Building Code of the City of New York and the Electrical Code of the City of New York, and shall be compatible with the existing base building bus terminal fire alarm system.
            - The tenant fire alarm system shall utilize both automatic and manual initiating (detection) devices and audible and visual notification (signaling) appliances:
            - Systems shall utilize either conventional or multiplex technologies. The use of addressable/intelligent systems is required.
            - In cases where microprocessor software programmable systems are utilized, a fully functional and manufacturer's licensed copy of the software program, manuals, and accessories shall be provided to the Port Authority of New York & New Jersey as part of the system.
            - In all cases, the occupants of the facility shall be able to clearly hear and, as required, clearly see the system alarm signal(s).
            - All system components (detectors, signals, modules, etc.) shall be UL listed and cross listed for use with the system control panel.
        2.) Power to the smoke detection and fire alarm equipment shall be taken via fused cutouts connected to the line terminals of the nearest emergency electrical panel.
    b. The tenant fire alarm system shall be fully compatible with the existing base building bus terminal system.
2. HVAC Smoke Detectors
    a. The tenant shall provide smoke detectors in the HVAC systems that UL listed and approved by the New York City Building Department of the particular application. Detectors shall sense products of combustion. Detectors shall not be subject to an alarm due to the rapid change of humidity.
    b. Duct detectors shall be fully compatible with the tenant fire alarm system.
3. Area Smoke Detectors
    a. The tenant shall provide smoke detector over each leasehold entrance to the public corridor.
    b. The area detector shall be fully compatible with the tenant fire alarm system.

4. Local Control Panel and Emergency Power Supply
    a. The local control panel shall be duly compatible with the base building bus terminal fire alarm system.
    b. Emergency power supply for local control panel shall have a back-up battery supply system of ample capacity and approved by the Port Authority of New York & New Jersey.
    c. The local control panel shall be wired with provisions for tie-in with the building's fire alarm system. Tenant shall provide conduit and wire to the nearest point of connection to the building fire alarm system. Terminations to the building fire alarm system shall be performed by the Port Authority of New York & New Jersey.
    d. All tenant-required sprinkler alarms shall be wired to compatible addressable device adapter modules.
5. Emergency Smoke Purge Manual Pull Station
    a. The tenant shall install a manual pull station with break glass rod, provided with an engraved nameplate with the legend "EMERGENCY SMOKE PURGE." The pull station shall be fully compatible with the tenant fire alarm system.
    b. For Smoke Purge Activation, see the Mechanical Design Guidelines. (1)
6. Sprinkler Alarms

    Sprinkler alarms have been provided by the Port Authority of New York & New Jersey. However, should the tenant require his/her own internal alarm, he/she must conform to the paragraph titled, Local Control Panel and Emergency Panel Supply.

4.6.2 EMERGENCY POWER

These guidelines cover emergency power supply for building services; they do not cover specialty requirements such as computer network or electro-medical health equipment requirements.

Note: All buildings shall have an emergency power system separated from normal building power. Having the entire building on generator power does not satisfy code-mandated emergency power systems.

A. Emergency power system may consist of storage battery systems, lighting unit equipment, or generators and shall provide a minimum of 6 hours or more if required by code requirements and/or regulations.

B. Installations of the stationary engine/generator and emergency power system shall be designed in strict accordance with local codes that amend ANSI/NFPA 70 - National Electrical Code, NFPA 37 - Stationary Combustion Engines and Gas Turbines and NFPA 110 - Emergency and Standby Power Systems. Products incorporated into the emergency power system shall be UL listed and labeled and factory mutual (FM) approved.

C. Emergency power system shall be sized for the total of the following:

    1. Existing emergency peak (demand) load.
    2. All known future and proposed projects.
    3. All current code-mandated emergency loads that are currently grandfathered.
    4. 40% spare capacity greater than the above items 1 & 2 (items [1, 2, & 3 times 1.4]).

The size of the emergency power system equipment shall be adjusted (per manufacturers recommendations) for increased THD content (UPS systems, fire pump VFDs, electronic ballasts, computer equipment, elevator drives) and voltage sags in excess of installed solid-state drive parameters.

For extra reliability it is preferable to install two, or more, emergency generators with paralleling switchgear in lieu of one large size generator.

The following loads shall be used for sizing and selecting the emergency electrical power system equipment:

- ❒ Emergency lighting systems.
- ❒ Alarm systems.
- ❒ Fire extinguishing systems.
- ❒ Code mandated life safety systems.
- ❒ Elevators.
- ❒ Code-mandated ventilating and smoke control systems.
- ❒ Fire pumps.
- ❒ Communication systems.
- ❒ Other facility-warranted systems (electric eye-operated systems).
- ❒ Water pipe heat tracing for life safety systems (sprinkler, standpipes, etc.).

Emergency power system for buildings shall be rated 480 volts unless otherwise required by the facility.

Assess the need for additional emergency power redundancy through portable, truck-mounted generators and outdoor power receptacles.

Preferably the engine/generator supplier shall supply the main ATS. The ATS shall be an open-transition and utilize by-pass isolation for any ATS-rated 600 amperes or larger.

4.6.3 SMOKE CONTROL AND PURGE

These guidelines cover electrical power systems; they do not cover mechanical requirements, which include control functions.

Note: For code-mandated smoke control and purge systems the fire alarm system monitors all inputs, processes the smoke control logic, and then operates fans and dampers through relays that capture the device controllers. This means the fire system is in control. The fire alarm system communicates fire events and conditions to the building automation system.

A. Smoke control systems are broken into two major categories: Dedicated and non-dedicated systems. Dedicated systems are simply those that do not perform any other function. The fans and dampers are not used for everyday ventilation, only for smoke control events. They often are found in stairwells and elevator shafts. Typically these areas are pressurized to prevent the spread of smoke through exit passageways in the building. In atria, these are typically used for smoke exhaust, in order to control the smoke layer. Non-dedicated systems are those that provide HVAC in the building every day but are captured by the smoke control system in the event of a fire.

B. Code-mandated smoke control is part of the building fire alarm system. The system smoke purge panel (firefighters' smoke control station) is on the fire alarm peer-to-peer communication system. The layout and devices (switches, lights, and manual overrides buttons) on the smoke purge panel are the responsibly of the Mechanical trade and can be found under the Mechanical section. The code requirement for the smoke purge panel graphic representation of the building is also described under the Mechanical section.

C. All code-mandated smoke control dampers connected to the fire alarm system shall be UL listed for smoke control.

D. The smoke purge panel and control wiring for all devices on the panel are to be included in the electrical estimate.

E. Smoke and fire/smoke dampers in code-mandated smoke control and purge systems shall be supplied from the fire alarm 120 VAC emergency power panel.

F. Codes require duct smoke detectors to operate smoke and fire/smoke dampers. Most ventilation systems require duct smoke detectors within 5 ft. of the supply duct (upstream) to the smoke and fire/smoke dampers (there are systems that require duct smoke detectors at both supply and return ducts).

Smoke and fire/smoke dampers require a fire alarm relays within 3 ft. of dampers for both damper operation and for system monitoring (positive feedback).

4.6.4 CCTV

4.6.4.1 Video Surveillance System Overview

Unless otherwise noted, the facility surveillance video (CCTV) will be an expansion of the Authority-centralized Verint based Internet Protocol (IP) existing Video Control and Distributed Recording System. The facility CCTV components shall be based on the Authority system standards and shall support the program in concordance with Authority Technology Department (TD) policy as well as meeting engineering requirements.

Design documents shall provide a fully functional surveillance video (CCTV) system including, but not limited to video surveillance cameras, network switches, network/video/power cabling, conduits/raceways, power supplies, programming and software, connectivity and all appurtenances necessary to provide a fully integration with the Authority Video Control and Distributed Recording system.

Design of VSS shall provide adequate level of coverage for security video surveillance based on facility areas of concern and best engineering practices. Where applicable, the Architectural discipline shall design the signs letting everyone know that video surveillance in use on these premises. Signs shall be highly visible, rustproof and screen-printed on heavy-duty aluminum.

4.6.4.2 Video Surveillance Camera

Video surveillance cameras shall be strategically deployed throughout the facility areas in order to act as a force multiplier, providing forensic investigation for any security incidents.

The interior camera coverage shall include of common areas, entrances and exits, elevator cars, roadways, ramps, walkways, stairways, emergency help communication stations, access-controlled doors (telecommunication, electrical and mechanical rooms) and other locations as deemed critical to the operation and security of the facility,

The exterior camera coverage shall include the perimeter roof and exterior wall lines, entrance and exit roadways and perimeter fence line.

Cameras shall be installed in low profile, minimum footprint type and shall be installed based on the optimum camera placement to obtain the best visible surveillance of all areas. Each camera location, position, surveillance coverage area shall be coordinated with the Authority. Camera lenses shall provide the specified fields of view. Select lenses based on camera placement to obtain the best viewable surveillance of the specific area, and as acceptable to the Authority.

All surveillance cameras shall be terminated at the facility telecommunication rooms. All surveillance cameras shall be connected to the Authority existing VSS over the Authority security network.

A. The fixed video surveillance camera shall meet the following requirements:

1. IP (Internet Protocol) based camera.
2. Cameras shall be listed (approved and certified) on the latest Symphia (Cognyte) Video Management Software (VMS) supported IP camera list.
3. Multicasting capability - simultaneous transmission of multiple video streams across the Local Area Network (LAN) and Wide Area Network (WAN) to dedicated network digital video recorders and remote viewing stations.
4. Cameras shall transmit high quality video across the network for remote viewing and recording with a maximum video transmission rate of 30 fps at with a minimum image quality of 1920x1080 pixels (1080p HD)
5. Camera shall employ optimized compression protocols based on the H.265 codec
6. Isolated power input, powered by 24 VAC or Power Over Ethernet (PoE) in accordance with IEEE802.3af/IEEE802.3at
7. Color, day/night
8. Automatic gain control (AGC)
9. Backlight compensation.

The PTZ (Pan/Tilt/Zoom) video surveillance camera shall meet all requirements listed above and shall support the following features:

1. 360° continuous pan rotation
2. Adjustable iris and focus, including auto-iris and auto-pan
3. Presets
4. Patterns
5. Macros
6. Alarm Inputs
7. Auxiliary Relay Output and/or Open Collector Auxiliary Output.

Where applicable, each elevator cabin shall be equipped with video surveillance camera. The elevator cabin fixed video surveillance camera shall meet the fixed video surveillance camera requirements listed above and comply with the following:

1. The camera viewing geometry shall result in 100% coverage of the elevator cabin volume and provides excellent probability of occupants and activity identification.

2. The cabin surveillance camera shall be as unobtrusive and as small as possible since the elevator car is a confined area and space is at a premium.

4.6.4.3 Video Surveillance System Monitoring, Control, Recording and Storage

Unless otherwise noted, there will be no local VSS monitoring, control, recording and storage Head-End equipment installed. The contract documents shall provide details for connection the local CCTV cameras to the Authority-centralized existing Video Control and Distributed Recording system via Authority security network. The Authority Control Center will perform the facility video surveillance monitoring, control, recording, and storage remotely. The final configuration with Authority Control Center VSS will be performed by the Authority security provider (no substitution permitted)

A. Refer to PANYNJ “Agency CCTV Standards” (Confidential guideline) latest revision for details and additional information.

4.6.5 Control Center

<<Under Development>>

4.6.6 Command Center

<<Under Development>>

4.6.7 PIDS

<<Under Development>>

4.6.8 Radio

Where applicable, the facility Land Mobile Radio System shall consist of an independent subsystem providing RF coverage service for Public Safety (PS). The PS radio system shall provide RF coverage for first responder organizations per NFPA 72 and NFPA 1221, NJ IFC 2013 and other local code requirements within the facility. Information on specific frequencies for each agency will be provided by the Authority.

A. Radio System Head End

The telecommunication room, shall be located in a centralized position in the facility, and shall be provided with a Channelized (Narrowband) Bi-directional amplifier (CBDA) for each band of service, along with directional donor antennas.

Where applicable, the band specific CBDA RF signals will be cross band coupled, converted to optical and distributed via single mode fiber cables (RF over fiber) to the remote radio rooms. Each fiber from the head end RF fiber master optical panel to the remote fiber BBDA shall be one continuous fiber strand with no intermediate splices and shall terminate on APC connectors at each end.

The RF switches shall be controlled by the system monitoring NMS which will automatically send a control signal to all IDF uplink (UL) and downlink (DL) RF switches to toggle to the standby system in the event of a service side equipment failure alarm. The RF switch control signals shall be transmitted over the Data Network to digital I/O modules located in the remote radio room. The I/O modules trigger a dry contact closure upon receipt of the command which activates the RF switches.

Public Safety Radio Distributed Antenna System (DAS)

The contract documents shall provide a public safety DAS system that is physically separate and independent from the cellular DAS system per NFPA 72 and IFC 510. In order to mitigate the possibility of intermodulation or other interference issues, the DAS system shall consist of separate DL and UL antenna systems. The output of the DL and UL RF switches shall be distributed via plenum rated (or low smoke zero halogen (LSZH), where required) coaxial cable to a series of splitters and directional couplers which will direct the available RF UL or DL signal power as required to meet the project RF performance requirements. The DAS cabling shall be spatially and diversely routed. The DAS components provided shall include redundancy, and the DAS shall demonstrate survivability and resiliency such that no single point of failure shall result in a loss of RF coverage delivered by the DAS. The antennas will be ceiling or wall mounted tri-band model and in some cases may require the use of radiating cable.

The antennae shall be spaced to provide even, consistent signal levels throughout the facility for clear voice communications and accurate data transmission via handheld police, fire and other public safety radios.

Radio System Performance

The RF coverage provided shall be 99% ubiquitous coverage for talk-out and talk-in reliability for all elevator shafts, egress stairways, electrical/mechanical rooms, fire department command center(s) and areas surrounding fire standpipes. Reliability for voice radio is defined as a minimum DL signal level of -95 dBm and Delivered Audio Quality (DAQ) of 3.4 at 99% of the samples taken within the above defined areas. The measurements shall be made in the facility using a handheld Anritsu type analyzer, or approved equal, and portable radio. The system performance verification testing shall follow the TSB88.3-D guidelines for public safety radio operations.

Radio Channel/Talk Group Audio Recording

Specific public safety radio channels broadcasted within the facility shall be recorded by the existing PA audio logging recorder. The channels planned to be recorded shall include the Local Fire Department conventional channels. The recorder shall capture all talk-in/talk-out activity on the above channels regardless of whether the audio is related to the facility activity.

TOC Dispatch Console

Where applicable, the contract documents shall provide the facility with an IP-based dispatch console system for use in dispatcher radio communications on a subset of the Public Safety channels. The system shall be managed by a redundant pair of servers with one located in the facility telecommunication room, and the other located in the redundant telecommunication rooms. The Dispatch console shall be provided with the following features:

1. A touch screen monitor for radio channel selection and system control
2. An instant recall recorder
3. Speakers
4. Foot Pedal for PTT activation
5. Headset
6. Goose neck microphone

Radio channel audio shall be provided to the console with the use of a series of mobile radio control stations interfaced to Radio over IP (RoIP) Controllers, which shall perform the analog to digital conversion of the audio as well as remote monitoring and control. The RoIP controller shall forward the digitized audio IP packets over the IP network to the dispatch controller servers, which then forward the packets on to dispatch console position and audio recorder.

Additional Radio System Design Provisions

The following are additional provisions of the PS and Operations radio systems:

1. All equipment associated with the PS and Operations radio system shall be provided with a minimum of 4 hours of inline UPS battery backup.
2. All public safety radio equipment, associated fiber optic equipment and UPS/battery backup modules shall be installed in NEMA 4X enclosures. These will either be wall mounted or free-standing cabinets. The PS and Operations radio system shall have the capability to be continuously monitored by a Network Management System (NMS). NMS monitoring shall utilize SNMP. Coordinate forwarding of alarms with the Authority.
3. The area surrounding the roof top radio antennas should be fenced off along the posting of yellow or red FCC radiation exposure caution signage.

4.7 ELECTRONIC SYSTEMS

4.7.1 ELECTRONICS SYSTEM OVERVIEW

The Electronics systems include, but not limited to:

- Telephone
- Public Address
- Multi-User Information Displays
- Wireless Local Area Network Access
- Cellular Distributed Antenna
- Telecommunication Room
- Structured Communication Cabling System

4.7.2 DESIGN REQUIREMENTS

A. Design shall be performed to meet or exceed all applicable codes, standards and Authority guidelines.

Design shall be performed to be comparable to industry best practices.

The manufacturer's most current product that meet or exceed the specified performance and features of the equipment for each electronics system shall be provided.

Design and construction documentation shall include all necessary electronics engineering design details. Items include, but shall not be limited to, the following: system block diagram per each system, riser diagrams, point-to-point details, schematics, floor plans showing each system components, elevations, and details as necessary for the construction stages and

final installation. Equipment shall be supported by catalog cuts or equivalent manufacturer published documents.

All electronics system components shall be submitted to the Authority for approval.

The design needs to coordinate the system and support elements with all relevant stakeholders and all engineering disciplines.

Calculations relevant to each electronics system shall be prepared and submitted. Items include but shall not be limited to the following: bandwidth calculations, optical budget loss calculations, voltage drop for electronics systems, low voltage power supply sizing.

The test plans and procedures for each testing phase for the review and approval of the Authority shall be provided. The test plan for each phase shall detail the objectives of all tests.

4.7.3 ELECTRONICS SYSTEM CRITERIA

The following general requirements are applicable to all electronics systems and its infrastructure unless otherwise noted:

A. Equipment Environmental Conditions

All electronics equipment shall be rated for continuous operation and capable of withstanding the environmental conditions without mechanical or electrical damage or degradation of operating capability:

1. Interior, Controlled Environment:

   Electronics equipment installed in temperature-controlled interior environments shall be rated for continuous operation in ambient conditions of 32 degrees Fahrenheit (F) to 122 F dry bulb and 20 to 90 percent relative humidity, noncondensing. NEMA 250, Type 1 enclosure.

2. Interior, Uncontrolled (temperature only) Environment:

   Electronics equipment installed in non-temperature-controlled interior environments shall be rated for continuous operation in ambient temperatures of 0 F to 122 F dry bulb and 20 to 90 percent relative humidity, noncondensing. NEMA 250, Type 3R enclosure.

3. Exterior Environment:

   Electronics equipment installed in locations exposed to weather (high/low temperature, wind, rain, snow, moisture, dust) shall be rated for continuous operation in ambient temperatures of minus 30 F to plus 122 F dry bulb and 20 to 90 percent relative humidity, condensing. Rate for continuous operation when exposed to winds up to 105 mph. NEMA 250, Type 4X enclosures.

The electronics and electrical hardware, structural materials, and equipment housings, required for a fully operational, integrated, real-time system shall operate on a 24 hours-per-day, seven days-per-week basis, with system reliability of 99.98 percent or greater.

All electronics equipment that are to be installed in a locations and application where they may be subject to abuse and attempts to damage them shall have a Vandal-Proof and Tamper-Resistant housing enclosure to utilize the adequately protection.

All Authority network switches shall be Cisco. Substitution to Cisco shall not be permitted

All Authority head-end (core) electronics equipment shall be redundant (duplication of equipment and/or functions) and configured to provide for continuous operation of the system in the event of the failure of the primary equipment. The redundant head-end electronics equipment shall be located in other than primary head-end electronics equipment location to provide physical redundancy.

All electronics equipment shall be provided with redundant source of electrical power to supports all electronics systems on loss of primary power source. In addition to redundant source of electrical power, all electronics systems shall be provided with local Uninterruptible Power Supplies (UPS) to achieve more comprehensive power loss protection and correcting common utility power problems:

1. Backup generator start-up time delay. For electronics systems (excluding life safety and public safety radio), UPS equipment shall be provided to ensure 15 minutes (unless otherwise noted) of runtime at full load for all connected electronics systems. For life safety electronics systems and public safety radio, 2 hours (unless otherwise noted) of battery back-up shall be provided.Voltage spike or sustained overvoltage
2. Momentary or sustained reduction in input voltage
3. Noise, defined as a high frequency transient or oscillation
4. Instability of the mains frequency
5. Harmonic distortion.

All electronics components and its infrastructure shall be new/unused and 100% tested for defects in installation and to verify components performance under installed conditions.

4.7.4 TELEPHONE

The design shall integrate the service telephones, and emergency station communication stations with the Authority-wide IP-based existing telephone system via Authority security network. The existing main VoIP server/PABX will manage connected telephone sets and communication panels, and control call routing and overall system functionality. The design shall indicate that the service telephone sets shall be furnished, configured and installed by the Authority. However, the emergency help communication stations shall be furnished and installed by the Contractor and configured by the Authority.

Design shall provide ADA-compliant emergency help communication stations for two-way communication between the emergency help communication stations and the Authority existing Control Center to offer immediate assistance to individuals and to help quickly assess emergency situations. Design documents shall indicate that all work regarding the interfacing the emergency help communication stations with Authority Control Center shall be coordinated with the Authority prior to any commencement of work. The selected emergency help communication stations model and design details shall comply with the following requirements:

A. The station shall be highly visible. Each station location shall be identified with highly visible sign. The Architectural design shall include the Way Finding Signage to provide nearest station location. The station shall be easily accessible. The area around the station shall be well lit. The light atop the station shall be provided for making it easily visible from long distances. Coordination with the Electrical discipline is required.

The station shall be activated by pressing the call button on the front operating panel, which will automatically call the Authority Control Center. At the same time, a high-intensity strobe light at the top of the station shall be activated, providing a beacon for the police or firefighters to locate the person in distress.

A visual indication on the same operating panel as the call button shall be provided, that is activated by Authority Control Center, to acknowledge that communication link has been established. After the call acknowledgment signal is sent, the two-way voice communication shall be available between the station and Authority Control Center personnel.

The visual indication shall be extinguished when the communication link is terminated. The communication between the station and Authority Control Center, once established, shall be disconnected only when Authority Control Center personnel terminate the call.

The station shall be hands-free.

In addition to redundant power sources for the station electronics and communication equipment, the station's illumination and strobe lights shall be also automatically transferred to an alternate source(s) of power when the primary power source fails.

Operating instructions shall be incorporated with or adjacent to the "PHONE" push button.

The station shall meet all latest ADA regulations and requirements including but not limiting to the operating panel lettering, Braille signage & engraved labels, a call status indicator light, a call button mounting height.

Each Emergency Help Communication Station shall be integrated with video surveillance system. Refer to the CCTV section for design details and requirements.

4.7.5 PUBLIC ADDRESS

The Public Address (PA) design shall provide audio-visual public announcements and emergency messages. The designed PA subsystem shall be an expansion of the Authority-wide existing centralized PA system, connected over the Authority existing or new security network. The design shall provide a complete and operable PA subsystem, inclusive of, but not limited to, all components, wiring, connections software, configuring, programming, testing and associated appurtenances. The designed PA subsystem shall be fully compatible with the Authority-wide existing PA system to provide communication with all features and flexibility.

The systems shall be loud enough, possess clarity, and cover the areas with uniformity. Distributed speakers shall consist of new ceiling mounted units or surface mounted units appropriately spaced according to the ceiling or mounting height and based on the acoustical, aesthetic, and functional aspects of the area requiring coverage. In addition, ambient noise operated level control shall be provided in select spaces to automatically accommodate changes in ambient noise levels. The speaker placement shall be coordinated with the reflected ceiling, lighting, surveillance camera and signage designs.

Coordinate with the Authority if design will require a local dedicated microphone paging station.

In accordance with local and national code and as required by ADA, all voice emergency messaging and other audible announcements in public areas shall be duplicated in text form and displayed on the Multi-User Information Displays (MUID). This will help ensure that the hearing impaired, as well as occupants in noisy areas, will receive emergency messaging and public announcements pertinent to them. The audible and visual messages and announcements will be activated simultaneously. Where MUID is required, it will be an extension of the existing Centralized MUID system. Refer to the MUID system section for design details and requirements.

4.7.6 MULTI-USER INFORMATION DISPLAYS

Where Multi-User Information Displays (MUID) are required, the design shall include but not limited to, all components, wiring, software, configuring, programming, mounting, testing and all associated

appurtenances. The designed local MUID will be an extension of the Authority existing MUID system. The design documents shall indicate all necessary network connections and configurations as required. All system configurations shall be coordinated and approved by the Authority. MUID shall be IP-based, commercial-grade, color, high-brightness HD (1920x1080 progressive-scan resolution) based on LED-backlit technology with a wide viewing angle. The selected display shall be rated for 24/7 continuous use, and contain technologies designed to reduce image retention (or image "burn-in"). The display shall consist of colors to be used in any screen format from a palette of no less than 65,000 colors. The monitors will provide a variety of digital and analog inputs to permit flexible use. Monitors shall contain replaceable/upgradable small form factor PC and IPTV tuner, to support next-generation network-based video distribution systems. MUID shall be fully compatible with the Authority existing MUID system to enable all features and flexibility.

4.7.7 Wireless Local Area Network Access

The wireless local area network (WLAN, also known as wireless fidelity "Wi-Fi") system shall be a segment of the basic network infrastructure and will utilize "plug and play" style wireless access points (WAPs) mounted on walls or ceilings to provide wireless network access where needed. WAPs shall be provided that support IEEE 802.3af/802.3at Power over Ethernet (PoE), thereby eliminating the need for separate power cabling and reducing infrastructure costs. Physical connectivity shall be provided as part of the structured cabling system.

Access points shall provide 802.11ac Wave 2 coverage, as well as the latest 802.11 protocols and standards. The Wi-Fi network shall support older standards, such as 802.11a, b, g and n for backwards compatibility. WAPs shall be configured with segregated, individually secured network SSID's to allow efficient and secure access for stakeholders which include the Authority and the general public. Dual-band 2.4GHz and 5GHz wireless access points (WAP)s shall be leveraged to provide greater flexibility in coverage and capacity and greater manageability for providing segregated access to various parties.

Advanced security features shall be implemented to protect non-public wireless networks from unauthorized access, such as WPA2-Enterprise encryption and password protection, disabling of SSID broadcast for administrative networks, and other measures as coordinated with the Port Authority, TEC and other stakeholders. Use of VPN tunnels may also provide security, encrypting traffic as it traverses the network.

The public WiFi coverage shall provide an RF signal level of -67 dBm ubiquitous coverage over a minimum of 95% of the facility, and associated spaces. WAP placement and spacing shall also be based upon anticipated user density, and not strictly signal coverage. The contract documents shall indicate that areas of high user density can supply a minimum of 5Mbps usable downlink bandwidth at peak occupancy times. WiFi signals/channels shall not cross or interfere with one another.

4.7.8 Cellular Distributed Antenna

Where applicable, the facility shall be provided with full voice and data cellular coverage. The cellular distribution system shall be a completely independent distributed antenna system (DAS) and not associated with the public safety, facility operations and/or Wi-Fi systems.

RF signals from each of the major carriers (including AT&T Wireless, Verizon Wireless, Sprint-Nextel, T-Mobile and MetroPCS) shall be transmitted via coaxial cable to a neutral-host wireless multi-band combiner. The wireless combiner system shall distribute the multi-carrier signals using RF over single mode fiber to a series of optical remote amplifiers installed in dedicated radio rooms or wall/ceiling mounted locations throughout the facility. The amplified signals shall be distributed over plenum rated (or low smoke zero halogen (LSZH) where required) coaxial cables to ceiling or wall mounted multi-band antennas ensuring

adequate downlink signal levels of (-75 dBm) for 700 MHz LTE and (-85 dBm) for Cellular/PCS/AWS Services throughout 95% of the facility.

In order to provide for the capability of all current wireless carriers to utilize the neutral host System, verify that the frequency bands, services and carriers are up to date.

A UPS shall be provided at each remote amplifier location to provide for a minimum of 30 minutes of backup power. The Distributed Antenna System (DAS) shall be provided in the general areas, inclusive of but not limited to the following equipment:

A. Plenum rated coaxial cable with N type connectors

RF splitters

RF Directional couplers

Ceiling-mounted multi-band antennas

Multi-carrier headend unit

Amplifiers

OS2 single mode fiber optic cabling and connectivity

Housings and mounting hardware

Coverage is defined as providing 99% ubiquitous coverage for talk-out and talk-in reliability for all elevator shafts, egress stairways, electrical/mechanical rooms, fire department command center(s) and areas surrounding fire standpipes. All other public access areas shall be provided with coverage of 95% for both talk-out and talk-back reliability. In order to avoid uplink (UL) and downlink (DL) interference, the design shall provide separate UL and DL multiband antennas and cabling. The cellular wireless system shall have the capability to be monitored by an SNMP-based Network Management system which will provide for alarm, configuration and control of all optical, amplifier and UPS components. The cellular wireless system shall provide capacity for the potential expansion with the possible addition of remote fiber optic amplifier(s), DAS coaxial cabling and multiband antennas.

4.7.9 TELECOMMUNICATION ROOMS

Design shall consider the following requirements:

A. Location

1. The telecommunication rooms located near the center of the facility to minimize the cable run distances.
2. The telecommunication rooms located on different floor should be stacked to reduce the number of bends in vertical distribution pathways.
3. Telecommunication rooms shall be located above the FEMA Flood Level.
4. Telecommunication rooms shall be located so as not to be a flood threat. Areas having floor drains shall be avoided.
5. Telecommunication rooms shall be located away from sources of electromagnetic interference (e.g., electrical power supply transformers, motors, generators).
6. Telecommunication rooms shall be located to allow delivery of large equipment.

Access, Monitoring and Control

1. Telecommunication rooms shall be located in an accessible area (e.g., hallway).
2. Telecommunication rooms shall be equipped with access control card readers with keypad.
3. The fixed video surveillance camera with wide-angle lens shall be installed outside, above the telecommunication room door, facing downward to cover the area in front of room exterior entrance. In addition, the interior areas of all telecommunication rooms shall be covered with video surveillance.

Size

1. Size all telecommunication rooms shall be in accordance with the latest BICSI Telecommunications Distribution Design Manual. The equipment clearances in all telecommunication rooms shall be considered as required by the National Electric Code.
2. The size of the room should allow for the identified equipment plus room for future expansion.

Architectural

1. Rooms shall have open ceilings to deck above. No finished ceilings shall be permitted.
2. Anti-static flooring shall be installed in all communication rooms to avoid transient voltage transfer to electronics equipment through human contact. Carpeting in communications rooms is prohibited.
3. Telecommunication room wall construction shall be slab to slab. Walls will be constructed of poured-in-place concrete, tilt-up walls, cinder block, brick or steel.
4. Telecommunication room doors must be 1-3/4 inches thick and constructed of 12-gauge steel clad, hollow core metal. Doorframes shall be of appropriate strength. Double doors should have at least one door secured from the inside with sliding deadbolts at the bottom and top. Hinges shall be on the inside of the door or pinned so they cannot be removed. Door hinge pins shall be non-removable (peened, pinned or spot-welded) or installed inside the room.

Environmental

1. All telecommunication rooms shall be provided with primary and redundant Heating and Air Conditioning (HVAC) units with individual microprocessor control, independent thermostat 24 hours per day for 365 Days per year. Both units shall load share the capacity and be able to each handle the full room load independently.
2. Unit shall provide room temperatures ranging from 65 – 75° F and relative humidity from 30 – 55% (non-condensing), positive pressure.
3. Sizing of HVAC system shall be based on amount of heat produced by all anticipated electronics and other (UPS, power distribution, lighting, etc.) equipment contained in the telecommunication room plus oversizing for the installation of additional electronics equipment or future expansion.
4. HVAC units shall be provided with redundant source of electrical power to maintain telecommunication room temperature and humidity on loss of primary power source.
5. Sensors shall be installed in telecommunication rooms to monitor temperature and humidity.

6. The telecommunication room HVAC units shall be connected to the Authority existing Building Management System (BMS) for monitoring and controlling the HVAC unit status and parameters.
7. Cold, hot water distribution or condensate lines shall not be installed in or above the telecommunication rooms. Telecommunication rooms shall not be equipped with floor drains.
8. The telecommunication rooms shall be protected from contaminants and pollutants that could affect electronics equipment.

Fire protection

1. Each telecommunication room shall be equipped with fire detection, fire extinguishing system and prevention devices. The fire detection devices shall be connected to the Parking garage fire alarm system. A minimum of two smoke detector shall be installed in each telecommunication room.
2. A combination of a clean agent system and pre-action system is an acceptable fire protection approach for telecommunication rooms.
3. All telecommunication room through-wall and through-floor penetrations shall be sealed with an approved fire stop solution to maintain the integrity of the penetrated element.

Electrical

1. Each telecommunication room shall contain its own power panel for circuits specific to the equipment within that room.
2. Redundant source of electrical power for telecommunication rooms where an active Head-End equipment is located shall be provided. In addition, an independent Uninterruptible Power Supply (UPS) in each telecommunication room to achieve more comprehensive power loss protection shall be provided.
3. A redundant source of electrical power for telecommunication room HVAC units and lighting shall be provided.
4. Primary, redundant and UPS electrical power requirements for each telecommunication room shall be based on the electronics and other (HVAC, lighting) equipment power consumption.
5. Dedicated 20A 120VAC nominal, NEMA 5-20R, non-switched, double duplex electrical receptacles, each on a separate branch circuit, above each equipment rack and cabinet for electronics equipment electrical power shall be provided.
6. Additional dedicated 20A 120VAC nominal, NEMA 5-20R, non-switched, double duplex electrical receptacles, each on a separate branch circuit, mounted on each wall to provide power to wall mounted electronics equipment shall be provided.
7. The perimeter of the telecommunications room shall have convenience 20A 120V NEMA 5-20R duplex outlets mounted 6” AFF at 6 feet intervals around perimeter walls for general use.
8. Electrical feeders/branch circuits shall not be placed or run through any telecommunications room, except as required to service those rooms.

Lighting

1. Communications room lighting circuits shall be fed from a power panel other than from within the communications room.

2. Lighting shall be an integrated switch/sensor control that is located at the entrance of the room. Additional sensors may be required to sense that the room is occupied.
3. Communications room illumination shall be uniform throughout the room at a minimum of 500 lux (50 foot candles) measure 3' AFF in all aisles between cabinets and racks. Luminaires shall be installed at a minimum height of 9'-0" AFF and in the middle of all aisles between cabinets and racks.
4. Communications rooms shall have emergency lighting and signs installed such that the absence of primary lighting will not hamper emergency exit.

Communication

1. Each telecommunication room with two VoIP based wall mounted telephone sets to support facility staff needs shall be provided. One telephone set shall be located near the entry door.
2. Each telecommunication room shall be equipped with a minimum four data outlets (one on each wall).

Electronics Equipment Cabinets, Patch Panels and Appurtenances

1. Floor mounted electronics equipment cabinets as required in quantities and sizes to provide sufficient capacity to install all necessary components and cabling as required to fulfill the system requirements with a minimum of 30% spare capacity for the installation of additional electronics equipment or future expansion. All cabinets shall be provided with the following minimum requirements:
    a. The enclosure shall be a UL listed, EIA compliant 19" horizontal distribution rack
    b. Minimum (42) EIA standard 19" rack units (RU) 42" minimum depth
    c. Front and rear adjustable rack rails
    d. Metal front and rear access door with lock
    e. Top cabinet panel with adequate knock-outs and brushed grommets
    f. Internal vertical cable manager(s) with fingers at each rack unit
    g. Cable collecting rail and wire management system
    h. Vertical Power Distribution Unit (VPDU)
    i. Grounding busbar
    j. Grounding kit for all points to be grounded
    k. Frame levelers or leveling feet
    l. Vertical wire management solution with fingers at each rack unit
2. Wall-mounted electronics equipment enclosures in quantities and sizes to provide sufficient capacity to install all necessary components and cabling as required to fulfill the system requirements with a minimum of 30% spare capacity for the installation of additional components or future expansion. All wall-mounted enclosures shall meet the following requirements:
    a. The enclosure shall be a UL listed, EIA compliant 19" horizontal distribution rack
    b. Minimum (26) EIA standard 19" rack units (RU)
    c. 30" minimum usable equipment mounting depth

d. Metal front door with lock
e. Adjustable rack rail
f. Integrated cable management
g. Electrical knock-outs for conduits on rear section/pan
h. Vertical Power Distribution Unit (PDU)
i. Grounding kit for all points to be grounded
j. Vertical wire management solution with fingers at each rack unit
k. Position and install rack so as to permit full swing of rack away from wall without obstruction.

3. Fiber Optic Patch Panels (FOPP) in sufficient quantities to support all fiber terminations.
   a. All housings: Rack or wall-mounted fiber optic enclosures with FOPP in sufficient quantities to terminate all incoming fiber optic strands.
   b. Housings and FOPP shall have minimum 20% spare slot capacity for future growth.
   c. Fiber optic slack loop inside of housings shall be neatly routed in a figure “8” style.
4. Modular Category 6 patch panels in sufficient quantities to support all Category 6 cabling terminations. Patch panels shall be 48-port EIA/TIA-568B wired Category 6 rated, with labeling windows.
5. Modular Category 6A shielded patch panels or unpopulated patch panel with shielded Category 6A jacks in sufficient quantities to support all Category 6A shielded cabling terminations. Shielded patch panels shall be 48-port EIA/TIA-568B wired for Category 6A shielded or unpopulated, with labeling windows.

4.8 CORROSION CONTROL

Corrosion control is to be provided for all projects by a combination of the following five primary methods:

- Materials Selection
- Coatings
- Inhibitors/Water Treatment
- Cathodic Protection
- Stray Current Monitoring, Mitigation, and Control

4.8.1 MATERIALS SELECTION

Corrosion shall be reduced through knowledge of the application and the selection of materials that are inherently corrosion resistant in the given application. Examples include stainless steel and cadmium plated components.

Corrosion effects shall be reduced by the proper selection of materials and design of the structure so as to avoid:

- Dissimilar metals in contact with each other
- Ponding of water in contact with the metals
- Crevices where oxygen concentration cells can form

4.8.2 COATINGS

Coatings shall be utilized on all underground steel pipelines per the following NACE Standard Practice (SP) and Recommended Practice (RP) guidelines:

- SP0169-2007, *Control of External Corrosion on Underground or Submerged Metallic Piping Systems*
- RP0394-2002, *Application, Performance and Quality Control of Plant-Applied Fusion Bonded Epoxy External Pipe Coating*
- RP0105-2005, *Liquid Epoxy Coatings for External Repair, Rehabilitation and Weld Joints on Buried Steel Pipelines*
- RP0190-1995, *External Protective Coatings for Joints, Fittings and Valves on Metallic Underground or Submerged Pipelines and Piping Systems*
- SP0185-2007, *Extruded Polyolefin Resin Coating Systems With Soft Adhesives for Underground or Submerged Pipe*
- RP0375-2006, *Field Applied Wax Coating Systems for Underground Pipelines: Application, Performance and Quality*
- RP0188-1999, *Discontinuity (Holiday) Testing of Protective Coatings*
- RP0274, *High-Voltage Electrical Inspection of Pipeline Coatings*
- RP0602-2002, *Field-Applied Coal Tar Enamel Pipe Coating Systems: Application, Performance and Quality Control*

Coatings on aboveground structures shall be provided as per the following Port Authority of New York & New Jersey standard specification:

- Division 9, Section 09910, “Painting”

4.8.3 INHIBITORS/WATER TREATMENT

Use industrial water treatment to reduce corrosion, scale forming deposits, and biological growths in heating and cooling systems.

Apply corrosion inhibiting compounds in chronic corrosion areas.

4.8.4 CATHODIC PROTECTION SYSTEMS

4.8.4.1 DESIGN SURVEYS

Surveys shall be conducted before any design of underground utilities is performed.

The objectives of the design survey shall be to assess the environment in which the structure is to be installed and its susceptibility to corrosion that would affect the structure’s useful life, increase the risk of failures, or pose a risk to the public if it were to experience corrosion.

The objectives of the design survey shall also be to allow the determination of the need for cathodic protection or stray current monitoring, mitigation, and control, as well as provide the parameters that will be used in the cathodic protection design evaluation and calculations.

4.8.4.2 TESTS TO BE PERFORMED

The survey shall include general information on the terrain along the route of the pipeline including:

- Type of terrain and vegetation, paving, drainage, etc.
- Visible relevant features and crossings (rivers, canals, roadways, railways, other pipelines).
- All other information that is considered relevant to the design of a cathodic protection system.

Soil resistivity measurements shall be taken along the route of the pipeline at pipeline depth. The number of measurements shall be based on the total length of the pipeline and on changes in terrain, features, etc.:

- For each type of soil, readings should be taken in at least two different locations. At each location a minimum of two measurements shall be carried out.
- Acceptable methods for soil resistivity measurements are:
  - Four terminal resistivity method (Wenner - ASTM G57).
  - Soil sample (soil box) resistivity method.

When the soil resistivity measurements are used to locate suitable places for surface groundbeds, the four-terminal method shall be used to determine the resistivity at greater depths (30 ft. maximum).

*4.8.4.2.1 **Soil Investigation***

To determine the existence of aggressive soil characteristics, samples of soil at depths representative of the depths at which structures are to be buried shall be obtained and tested in the laboratory for pH, chloride ion, and sulfate ion concentration.

*4.8.4.2.2 **Current Drainage Tests***

When designing a cathodic protection system for existing pipelines, buried or on-grade storage tanks, a current drainage test shall be performed to determine the current requirement and optimal current distribution. This may necessitate installation of one or more groundbeds and DC power sources (e.g., batteries, portable rectifiers), timer-units, and test facilities to the pipeline/tank under investigation. Pipeline isolation may need to be installed before meaningful current drainage tests can be carried out. The required current is determined when, after full polarization is achieved, the “OFF” potentials measured at regular intervals along the pipeline or around the tank perimeter are within the values indicated in the appropriate NACE Standard Practice (SP0169 for pipelines, RP0285 for USTs, and RP0193 for aboveground storage tanks).

*4.8.4.2.3 **Stray Currents***

The designer shall investigate possible sources of detrimental DC stray currents and include provisions in the design of the corrosion protection system for mitigating the effects of such stray currents. If the effects of the stray currents cannot be measured or predicted prior to construction of the structure(s), the design shall incorporate testing, monitoring, and control provisions to allow the assessment of stray current effects on the structure(s) and the installation of the required mitigation and control provisions as a change order to the contract.

4.8.4.3 Documentation of Results

4.8.4.3.1 Tabulation of Data

All data obtained during the cathodic protection design survey shall be tabulated in a format approved by the Port Authority of New York & New Jersey Corrosion Protection Engineer, and shall include, as a minimum:

- Date and time
- Name of tester
- Test conditions, visual observations
- Instruments used (model, serial number)
- Diagrams of meter connections
- Data obtained at each test location, organized by test type (potentials, current drainage tests, soil resistivity)
- Plan drawing showing locations of tests, soil samples taken
- Laboratory results for soil investigation (pH, chloride ion concentration, sulfate ion concentration)

4.8.4.3.2 Analysis of Corrosivity

The designer shall perform an analysis of the data and draw conclusions regarding the aggressiveness of the soil/water environment and the need for the consideration of extraordinary corrosion protection measures. Characterization of the corrosivity shall be made as to “severely”, highly”, “moderately”, or “slightly” is usually made to provide a measure of the significance of corrosion that will affect the structure to be buried. Most lists use resistivity as a leading indicator of the potential for corrosion.

4.8.4.3.3 Recommendations for Cathodic Protection

Once the analysis of corrosivity has been made, recommendations for the implementation of corrosion protection measures shall be made in accordance with the applicable NACE Standard Practice.

4.8.4.4 Design Basis

4.8.4.4.1 Applicable Standards

All cathodic protection designs shall be performed in accordance with the following NACE Standard SP and RP guidelines:

- SP01269-2007, *Control of External Corrosion on Underground or Submerged Metallic Piping Systems*
- RP0193-2001, *External Cathodic Protection of On-Grade Carbon Steel Storage Tank Bottoms*
- RP0285-2002, *Corrosion Control of Underground Storage Tank Systems by Cathodic Protection*
- RP0388-2001, *Impressed Current Cathodic Protection of Internal Submerged Surfaces of Carbon Steel Water Storage Tanks*

- RP0196-2004, *Galvanic Anode Cathodic Protection of Internal Submerged Surfaces of Steel Water Storage Tanks*

4.8.4.4.2 Cathodic Protection Criteria

The criteria for determination of adequate protection from corrosion shall be as per the appropriate recommended practice listed above.

4.8.4.4.3 Maintainability

The cathodic protection system shall be designed so as to allow all system components to be maintained in accordance with the referenced standards, and state and federal regulations. All equipment shall be installed in protected but accessible locations where they can be easily accessed for inspection, periodic monitoring, and maintenance. No other equipment shall be permitted to be stored or placed in front of or on top of the rectifiers, junction boxes, or test stations.

4.8.4.4.4 Testing/Monitoring Requirements

A testing schedule shall be clearly defined in the design documents, indicating the types of measurements, the locations that they are to be made, and the frequency of the measurements. The instrumentation and the data collection requirements shall also be specified.

4.8.4.5 Galvanic Anode Cathodic Protection Systems

Galvanic systems are also known as sacrificial anode systems because an anode (usually zinc or magnesium) corrodes instead of the protected metal. Because the anode corrodes instead of the metal that it is protecting, the anode is said to sacrifice itself. Sacrificial anodes are connected directly to the structure to be protected by either welding or mechanical connection of lead wires. Galvanic systems are generally limited to those tank components that are well coated with a dielectric material (sti-P3 ® tanks or fusion-bonded epoxy-coated steel piping) because the available current output of these systems is low. Attempts to protect long runs of uncoated piping or uncoated tanks generally are not practical because the useful life of the anodes is too short or the number of anodes needed is too great.

4.8.4.5.1 System Design Life

The minimum design life for galvanic anodes shall be 15 years.

4.8.4.6 Impressed Current Cathodic Protection Systems

Impressed current systems are sometimes called rectifier systems because they utilize a device (a rectifier) to convert an external AC power source to the required DC power source. In this type of system, anodes are installed in the soil around the structure to be protected and the DC power is supplied to the anodes through buried wires. The AC power to the rectifier cannot be interrupted except when conducting maintenance or testing activities. Normally, a dedicated and protected circuit is provided for the impressed current system so that the power cannot be inadvertently cut off. In impressed current systems the protected structure is bonded to the DC power system to complete the electrical circuit. It is critical that the anodes are connected to the positive terminal and the protected structure to the negative terminal of the rectifier. Reversal of the lead wires will make the components of the tank system anodic and can cause a rapid failure of the tank system due to corrosion. In addition, it is critical that all wire connections and splices are well insulated. Any breaks in the wiring insulation will allow current to leave the wire at that point and a rapid failure of the wire can occur due to corrosion. Impressed current systems are generally installed on those tank systems that were installed prior to the effective date of the UST regulations since these tanks usually

do not have a good dielectric coating. The level of cathodic protection provided by an impressed current system can be adjusted since the voltage produced by the rectifier can be changed. Because conditions that affect the level of cathodic protection needed are likely to change over time, adjustment of the rectifier is frequently necessary.

Impressed current anodes shall be selected to provide a minimum 30-year life.

Impressed current anode cables and anode connections shall be designed to withstand the harsh environments, including acids and petroleum products found at Port Authority of New York & New Jersey facilities.

System designs shall include the provisions for measuring individual anode currents where practical.

4.8.4.7 CALCULATIONS

Calculations shall be provided for all cathodic protection system designs.

For galvanic anode systems, calculations shall include the following steps:

A. Calculation of surface area of structure to be protected.

B. Estimated cathodic protection current requirements based on assumed current density and bare surface area (% holidays).

C. Selection of anode type and calculation of anode-to-electrolyte resistance.

D. Calculation of anode output current based on the calculated resistance and the open circuit potential between the anode and the protected structure.

E. Calculation of number of anodes required to deliver the total calculated current requirement for the structure based on the individual anode current output and paralleling factors.

Calculation of system life based on the anode current output, consumption rate and efficiency of the anode alloy, and the weight of the anode.

For impressed current systems, calculations shall include the following steps:

A. Calculation of surface area of structure to be protected, as for galvanic anode system design, except the option of performing current requirement tests to establish the total current required may be utilized if it is practical to perform those tests.

B. Determination of the total circuit resistance for the proposed impressed current anodes, cables, etc.

C. Determination of rectifier voltage using the total resistance and the total current required.

4.8.4.8 ELECTRICAL ISOLATION

*4.8.4.8.1 **Applicable Standards***

Electrical isolation of pipelines to be cathodically protected shall be provided in accordance with the following NACE RP guideline:

- RP0286, *Electrical Isolation of Cathodically Protected Pipelines*

4.8.4.8.2 Design Approach

The pipeline to be protected shall be electrically isolated from other piping systems that are of the following characteristics:

Pipelines connected to grounded structures or facilities or to existing structures that are uncoated or poorly coated.

Pipelines connected to tenant facilities (e.g., fuel transfer lines serving an airport terminal).

4.8.4.9 Document Preparation

4.8.4.9.1 Area Plan Drawing

4.8.4.9.2 Location of Existing Cathodic Protection Systems

4.8.4.9.3 Locations of Major Cathodic Protection System Components

4.8.4.9.4 Locations of All Cathodic Protection Test Stations

4.8.4.9.5 Specifications

Specifications shall be prepared specifically for the system to be installed and shall include as a minimum:

Quality Assurance Provisions—Qualifications of the personnel performing the design and all other work associated with the installation and testing of the system.

Materials—Complete materials specifications for all items including anodes, rectifiers, cables, splicing materials, test stations, reference electrodes, junction boxes, and remote monitoring equipment.

Installation of the system, including testing and documentation of the results.

Actions that should be taken to resolve deficiencies and issues such as stray current interference.

4.8.4.10 System Commissioning

4.8.4.10.1 Tests To Be Performed

After the installation of a cathodic protection system, it should be commissioned and the following tests performed:

Impressed current operating characteristics (voltage and current).

Impressed current anode current output levels.

Initial potential survey-structure-to-electrolyte potentials shall be measured at each test station. Baseline potentials shall be obtained and compared to the energized and polarized potentials.

Effectiveness of all installed electrical isolation devices.

Galvanic anode current output levels.

4.8.4.10.2 Rectification of Deficiencies

After performance of tests listed above.

4.8.4.10.3 Stray Current Interference Testing and Resolution

4.8.5 Stray Current Monitoring, Mitigation, and Control

In areas where the results of stray current tests indicate severe stray current effects will be felt on the structures to be installed, stray current mitigation, control, and monitoring provisions shall be incorporated into the design of the structures. These measures shall include:

4.8.5.1 Electrical Continuity Bonding

4.8.5.1.1 Bonding Across Push-On Joints

4.8.5.1.2 Bonding Across Bolted Joint Assemblies

4.8.5.1.3 Bonding Across Gasketed Joint Assemblies

4.8.5.1.4 Bonding Across Vaults

4.8.5.1.5 Bonding of Components of Mechanical Couplings

4.8.5.2 Test Facilities

Test wires connected to buried pipes, reinforcing steel, and other metallic structures.

Permanent reference electrodes installed adjacent to the buried structures under test.

4.8.5.3 Stray Current Control

Bonding cables of suitable gauge to allow drainage of stray currents from buried structures to substation negative bus

Bonding stations including current measuring shunts to allow measurement of

4.8.5.4 Remote Monitoring Systems

Remote monitoring systems shall be provided where it is necessary to monitor the trends in stray current levels, due to changing characteristics in the stray current sources, such as PATH rail facilities, which are subject to increased stray current levels as the rail-to-earth resistance decreases, or train operating loads increase.

The remote monitoring system shall be designed with a sufficient number of channels to measure all required parameters with provisions for expansion by adding additional channel modules.

The remote monitoring systems shall be interfaced with the local data network via an ethernet connection.

4.9 Lightning Protection

4.9.1 Reference

Port Authority of New York & New Jersey Technical Specifications Division 26, Section 264100, Lightning Protection for Structures

NFPA 780, Standard for the Installation of Lightning Protection Systems

NEC, Article 250

The Lightning Protection Institute, LPI 175

UL Standard #96 and 96A

Evaluate need to provide Lightning Protection System (LPS) for the building/structure using NFPA 780, Annex L – Lightning Risk Assessment Calculation Guide to determine the risk of damage to the building due to lightning. Consider the surrounding structures and any attached structure to the building for lightning risk evaluation.

LPS consists of the following elements working together to provide a permanent low-impedance electrically conductive path designed and intended to carry lightning current to the ground and prevent damage from lightning:

Air terminals

Conductor

Bonds with metallic bodies

Ground terminations and

Surge arrestors

Specify size for all elements according to NFPA 780, Chapter 4, for Class II Structures. Type of materials and labeling shall be as specified in the Port Authority of New York & New Jersey Specification Section 16670.

Specify size of air terminals and ground terminals as per Port Authority of New York & New Jersey Specification Section 264100. Air Terminals shall be provided for metal stacks, flues, and mechanical equipment having a metal thickness of less than 3/16" and not within a zone of protection of an air terminal. Equipment with metal thickness 3/16" or greater shall be bonded per code requirement.

Minimum conductor size shall be #2/0 AWG, bare-stranded copper conductor.

Interconnect all ground rods with #4/0 AWG bare-stranded copper conductor 3 ft. below grade and to power system grounding electrode conductor in accordance with the NEC Article 250.

Provide a note on the contract drawing stating, “Lightning Protection System shall meet all applicable requirements of NFPA 780 and UL 96A. The final installation shall meet and shall be certified as UL Master Label System.”

Follow NFPA 780 design guidelines to design LPS.

Structural steel of existing structures may be substituted for down conductors. Bond the conductors to steel columns. Building steel shall be grounded at the interval of 85 ft. around the perimeter of the building using 5/8 in. x10 ft.-long copper-clad ground rod.

For underground grounding wire in the environments exposed to the excess sodium-chloride (seawater) at locations such as JFK and La Guardia Airports, Ports and other facilities, utilize tinned copper wire in lieu of bare copper conductor

4.10 DISTRIBUTED ENERGY RESOURCES (DER) AND ELECTRIC VEHICLE CHARGING SYSTEMS

For all projects containing DER and EV systems, the designer shall submit a TAA Package to the PANYNJ for Electrical Engineering review at the beginning of the project.

4.10.1 UTILITY COORDINATION

The designer shall engage the local utility very early in the design of any Photovoltaic (PV), Battery Energy Storage Systems (BESS), or Electrical Vehicle (EV) charging systems to ensure that they are provided with the most current standards and requirements for their project. As utility requirements are rapidly evolving within this space, actively engaging the utility and ensuring that all their appropriate groups are consulted on these installations is crucial to ensure compliance and mitigate cost and schedule impacts to projects at later stages.

In addition to complying with standard utility interconnection processes and requirements for these systems, the design shall also detail the generation and load profiles associated with these systems for review. For all jurisdictions, a visible-blade disconnect dedicated for each type of technology (PV, BESS, and EV) as a means to rapidly shutdown the systems by the utility will be expected in each case.

After initial engagement and coordination of requirements with the utility, a formal application shall be submitted in compliance with the most current guidelines for the jurisdiction. It shall include details on equipment installations such as:

A. Documents showing applicant representation of the owner, where required.

B. Drawings showing all electrical components proposed for the installation and their connections to the existing on-site electrical system from that point to the point of common coupling (PCC).

C. For projects containing existing services and equipment, new vs existing equipment shall be clearly identified. Account and meter numbers shall be provided.

D. Description/narrative of the project and site proposed.

E. Technology types, equipment specifications or selections (inverters, modules, batteries, etc), and system configurations. Include the manufacturer's product data sheet for the interface equipment. Include basis of design products as well as list of approved manufacturers that contractors will select from.

F. Project and/or system size shall be clearly identified in kW.

G. Proposed metering strategy.

H. Certificates showing system/component compliance with UL 1741.

I. A single line diagram showing the following:

   a. Number, individual ratings, connection configurations, and type of all major electrical components such as generating units, step-up transformers, auxiliary transformers, grounding transformers, neutral reactors, and switches/disconnects of the proposed interconnection, including the required protection devices (instrument transformer configuration and polarity if applicable) and circuit breakers.

   b. Proposed inverter protection settings (and relay equipment settings if applicable).

c. For those systems proposed to be interconnected at a system voltage of 1,000 volts or greater, the drawings shall be sealed by a Professional Engineer licensed in the respective state.

d. Control system designs, phase sequencing, differential relay settings, ground connections, and metering transformer connections.

Drawing shall include basis of design intent as well as list of approved manufacturers that contractors will select from.

4.10.2 POWER SYSTEMS STUDIES

For projects where PV, BESS, or EV charging systems are included, designers should conduct a power system analysis and consider these systems for their impact on harmonics and determine if there are needs for filters or other measures to mitigate their impact. Designers should coordinate with manufacturers to collect the performance information of their systems to conduct the analysis.

4.11 PHOTOVOLTAIC (PV) SYSTEMS

This Guideline focuses on the application of PV systems, primarily rooftop system installations under 500kW nameplate. Larger systems should also be considered for application on projects where real-estate is available. Designer shall engage PANYNJ Office of Sustainability for procurement methods of large systems, potentially through a Power Purchase Agreement (PPA).

Engineer shall coordinate with all entities private and public, including but not limited to Department of Buildings, Utility, PANYNJ Stakeholders, and Federal Aviation Administration (FAA). Glare study shall be performed and approved by FAA, where required.

4.11.1 CODES, STANDARDS, AND REFERENCES

PV systems shall be designed in accordance with, but not limited to, the following:

- ❒ NFPA 70 – NEC Articles per current edition adopted by the applicable state. Sections of particular interest are:
  - 690 – Solar Photovoltaic (PV) Systems
    - Circuit Sizing and Current Calculations compliant to 690.8
    - Overcurrent Protection compliant to 690.9
    - Rapid Shutdown of PV Systems compliant to 690.12
    - PV Disconnection means compliant to 690.13 and 690.15
    - PV System wiring compliant to 690.31
      - PV system marking and labeling compliant to 690.31(G)(3)
    - PV System grounding complaint to 690.41 thru 690.47, and 690.50
    - PV System rapid shutdown labeling compliant to 690.56
  - 705 – Interconnected Electric Power Systems
    - PV systems interconnections for both load side and land side shall be compliant to 705.12
  - 706 – Energy Storage Systems
    - When PV systems are co-located with Energy Storage Systems, the Storage Systems shall both be compliant with Article 706
- ❒ UL
  - 35
  - 1741
- ❒ IEEE
  - 519

- 1547
- C62.92.1

❒ IEC
- 60068
- 61000-6-2,4
- 61400, BDEW
- 61683
- 61727
- 62109-1,2
- 62116

❒ Refer to Sections 4.2 and 4.3 of this document as applicable for interconnections to Low Voltage and Medium Voltage Electrical Systems.
❒ PANYNJ 'Solar-Ready Design Manual'
❒ Designers shall review and design to the most recent NYC BC Local Laws, including 92 and 94
❒ New Jersey Net Metering and Interconnection Requirements - https://www.njcleanenergy.com/renewable-energy/programs/net-metering-and-interconnection
❒ New York Solar Guidebook for Local Governments - https://www.nyserda.ny.gov/All-Programs/NY-Sun/Communities-and-Local-Governments/Solar-Guidebook-for-Local-Governments
❒ PJM Interconnection Requirements - https://www.pjm.com/-/media/documents/manuals/m14g.ashx
❒ New York State Interconnection Requirements - https://dps.ny.gov/system/files/documents/2023/07/may-2023-sir-final.pdf

4.11.2 DESIGN CONSIDERATIONS

PV systems shall be considered on all new and deep retrofit construction projects. Implementation of PVs shall be an integral part of the roof space allocation design, along with design of other building systems and sustainable technologies. The decision to utilize available space for PVs or other technologies shall be evaluated on a case by case basis, considering which technology would be most beneficial to the project goals.

PV modules can be applied very modularly where space allows, whereas other carbon-reducing technologies may be more impactful at reducing net energy consumption of a building. Technologies that are more valuable to carbon reduction, such as Air-Source Heat Pumps, should be prioritized in allocated available roof space where areas are available.

At a minimum, PV systems shall be provided in accordance with current local jurisdiction mandates.

If a PV system is not included in the project scope, all new building electrical systems and deep retrofit projects shall at minimum be designed to be 'PV-ready'. Design shall be in accordance with the PANYNJ 'Solar-Ready Design Manual' and shall at minimum include the following:

❒ Capacity in electrical system to interconnect future PV

❒ Spare breakers/spaces in switchgear/switchboards

❒ Spaces for PV electrical equipment within electrical rooms such as:
- Electrical distribution equipment
- Utility-required disconnection equipment at grade

- Inverters
- Monitoring and communications equipment

❒ Pathways and/or conduits from electrical rooms to PV locations

❒ Exterior locations for PV equipment such as:

- Utility-required disconnection equipment at grade
- Combiner panel, inverters, and associated local disconnecting means
- Monitoring and communications equipment at roof or on grade

PV systems can be connected either in front of the meter (line side) or behind the meter (load side) on an individual building or standalone electrical distribution systems. In addition to compliance with local jurisdiction requirements and in coordination with relevant stakeholders, the following criteria should be evaluated when producing the interconnect scheme:

A. Metering schemes shall be evaluated against the latest available incentive programs and local restrictions. Behind the meter (load side) systems are likely to be more cost-effective for smaller installations. Designers shall perform an analysis for the proposed PV system protection against the building loads to determine if incidental PV loads are expected to exceed building loads for a significant portion of annual energy production, then designers shall evaluate the value of utilizing net metering on the project.

B. If there is a desire to control when PV energy is used or to provide resilience to the building, it is recommended to connect behind the meter and pair with a Battery Energy Storage System.

C. For existing buildings, the electrical system and associated distribution equipment shall be evaluated for capacity to support a PV system per guidance of NFPA 70 Articles 690 and 705. If deemed adequate, a behind the meter installation shall be explored. If not, the constructability/cost implications of upgrading to support this interconnect shall be compared with the feasibility of installing a system in front of the meter.

PV system physical design with respect to panel tilt and orientation shall be prescriptive to individual projects to best optimize the layout while consider glare and other limitations. Where required by FAA guidelines, designers shall conduct solar glare analysis in compliance with FAA standards.

System shall be designed to ensure adequate access for regular maintenance are provided. When mounted directly to roof structure, modules shall be spaced to allow for walking pathways between units.

When buildings are being considered for roof replacements, refer to the PANYNJ ‘Solar-Ready Design Manual’ to determine the viability of PV as part of the replacement project.

On newer roofs that are not in need of replacement, only ballasted systems shall be evaluated as a measure to protect against disruption to the existing structure and minimize any risk of water damage or voided warranties through the PV project. Roofs due for replacement should evaluate the tradeoffs between fastened and ballasted systems.

For installation on existing buildings or structures, a thorough field investigation shall be performed to assess the local conditions and issues that may impact a PV installation. Items to investigate include but are not limited to:

A. Existing condition of roof or other surface where PVs will be installed.

B. Survey areas for potential locations of system components such as inverters and system

disconnects

C. Area available for system

D. Sources of system shading

E. Potential safety hazards with installation or maintenance of equipment

F. Investigation options for tie-in to existing electrical system, including vertical pathways for wiring

   a. It is recommended to tie into the distribution system as close as possible to the point of utility service to simplify installation.

   b. It is recommended that PV systems remain offline during a utility outage unless they are coupled with energy storage and generator systems.

4.12 BATTERY ENERGY STORAGE SYSTEMS (BESS)

Guideline focuses primarily on the application of electrochemical battery systems, in which the current market is dominated by Lithium-ion systems. Designers shall consider current market trends and availability and confer with the PANYNJ Mechanical Engineering, Plumbing and Fire Protection Engineering and the Facility in the early stages of the design.

Engineer shall coordinate with all entities private and public, including but not limited to the Quality Assurance Division (QAD), the applicable Utility, PANYNJ Risk Management, the appropriate Fire Marshal for the facility, the local Building Department or Fire Department if necessary, and Federal Aviation Administration (FAA). For facilities that do not report to the local fire marshal and other equivalent entities as ministerial AHJs and instead are self-governed by PANYNJ, it is still recommended to engage all non-ministerial entities on BESS projects as stakeholders to include their recommendations for safe practices in designing and implementing these systems. Designer shall coordinate with PANYNJ for engagement of these entities through their typical channels.

4.12.1 CODES, STANDARDS, AND REFERENCES

BESS systems shall be designed in accordance with, but not limited to, the

following:

- ❒ NFPA 70 – NEC Articles per current edition adopted by the applicable state. Sections of particular interest are:
  - 480 – Storage Batteries
  - 705 – Interconnected Electric Power Systems
    - Energy Storage System interconnections for both load side and land side shall be compliant to 705.12
  - 706 – Energy Storage Systems
    - Energy Storage System Disconnection means compliant to 706.7
    - Circuit Sizing and Current Calculations compliant to 706.20
    - Overcurrent Protection compliant to 706.21
- ❒ NFPA 855 – Standard for the Installation of Stationary Energy Storage Systems Articles per current edition adopted by the applicable state. Sections of particular interest are:
  - Hazardous mitigation analysis for AHJ approval shall be compliant to 4.1.4
  - Large-scale fire testing prescriptive to required scenarios for AHJ approval shall be compliant to 4.1.5 which is in accordance to UL9540A
  - Indoor installations shall be compliant to 4.4.2
  - Outdoor installations shall be compliant to 4.4.3

- Rooftop and garage installations shall be compliant to 4.4.4
- Maximum Energy Storage Ratings shall be compliant to 4.8 and Table 4.8
- Exhaust ventilation shall be compliant to 4.9
- Smoke and Fire detection shall be compliant to 4.10
- Fire Control and Suppression shall be compliant to 4.11

❒ UL
- 35
- 1741
- 1973 – Energy Storage System Testing and Certification
- 9540 – Energy Storage System Safety Standards
- 9540A – Thermal Runaway Testing

❒ IEEE
- 519
- 1547
- C62.92.1

❒ IEC
- 60068
- 61000-6-2,4
- 61400, BDEW
- 61683
- 61727
- 62109-1,2
- 62116

❒ Refer to Sections 4.2 and 4.3 of this document as applicable for interconnections to Low Voltage and Medium Voltage Electrical Systems.
❒ International Building Code
❒ International Fire Code
❒ New Jersey Fire Code
- 608 – Stationary Battery Storage Systems

❒ New York City Fire Department and Department of Buildings Design Criteria
- “Outdoor Stationary Storage Battery Systems” - 3-rcny-608-01.pdf (nyc.gov)
- “SAFETY CONSIDERATIONS for RENEWABLE ENERGY SYSTEMS” - https://www.nyc.gov/assets/buildings/pdf/2018_SafetyConsiderations_Renewable_Energy_Systems.pdf
- “Current Certificate of Approval for Energy Storage Systems” - https://www.nyc.gov/assets/fdny/downloads/pdf/business/coa-energy-storage-systems.pdf

❒ New York City Administrative Code – Title 29: New York City Fire Code
- Section FC 608: Stationary Energy Storage Systems

❒ Con Edison Energy Storage System Guide - https://cdnc-dcxprod2-sitecore.azureedge.net/-/media/files/coned/documents/save-energy-money/using-private-generation/specs-and-tariffs/energy-storage-guide.pdf?rev=982c1939b37a432ea563f17aaba3da51
❒ PJM Interconnection Requirements - https://www.pjm.com/-/media/documents/manuals/m14g.ashx
❒ New York State Interconnection Requirements - https://dps.ny.gov/system/files/documents/2023/07/may-2023-sir-final.pdf

4.12.2 DESIGN CONSIDERATIONS

4.12.2.1 USE CASES

BESS Systems are primarily intended to be included as a tool for augmenting carbon reduction strategies like PV, electrification of buildings, and EV charging. The intent is to help balance load profiles to reduce costs and be designed in a manner that allows dispatch to be adapted as utility rates and economic drivers evolve.

4.12.2.2 GUIDANCE ON SITING STORAGE SYSTEMS

Storage systems shall be located in compliance with aforementioned applicable codes and standards and coordinated with stakeholders at PANYNJ to minimize impacts to existing operating procedures.

In addition to applicable codes and standards, AHJ signoff plays a substantial role in dictating where battery systems may be sited. In the current climate, approval of indoor applications are highly unlikely and rooftop applications are limited to smaller systems. Majority of system shall be considered for outdoor on grade installation, although designer shall review applicability as codes and AHJ risk tolerances shift over time.

Systems over 600kWh in or near buildings require UL9540A testing, prescriptive site-specific protection systems per AHJ requirements, and additional chemistry and manufacturer requirements to comply with all the fire/life safety requirements. Indoor systems that are even under this threshold have still been historically blocked in conventional AHJ approval processes and are therefore not recommended in PANYNJ facilities in the current state of the industry. Systems larger than this must undergo a Large-Scale Fire Test per 4.1.5, and is still subject to AHJ approval. Even upon passing this test, the AHJ still holds the ultimate decision whether or not to allow systems larger than this threshold to be allowed, and what additional fire life safety measures may be required for approval.

Under current code requirements dictated by NFPA 855, there is a minimum of 10ft separation between BESS systems and buildings, lot lines, or other exposures except for electrical equipment associated with systems directly supporting the BESS. Designer shall provide site plan showing proposed location for PANYNJ review in accordance with current separation requirements.

BESS systems are not currently acceptable as a source of backup power for NEC Article 700 Emergency and Legally Required Loads. It is only acceptable as a source of optional standby backup power. If a BESS supports a building that has full generator backup, it may run in parallel to the generator to optimize fuel consumption if they are configured as a microgrid. Additionally, including a BESS would allow for the possibility of using PV when a system is islanded in the event of utility loss, however this is still a large operational complexity that needs to be evaluated by designers when defining a sequence of operations.

4.13 ELECTRIC VEHICLE (EV) CHARGING STATIONS

Guidance focuses primarily on the application of electrochemical battery systems, in which the current market is dominated by Lithium-ion systems. Designer shall evaluate battery technologies in the current market for the project-specific application.

Engineer shall coordinate with all entities private and public, including but not limited to Department of Buildings, Utility, QAD, and Federal Aviation Administration (FAA).

4.13.1 CODES, STANDARDS, AND REFERENCES

EV Charging systems shall be designed in accordance with, but not limited to, the

following:

- ❒ NFPA 70 – NEC Articles
  - 625 – Electric Vehicle Charging System
- ❒ International Building Code
- ❒ Refer to Sections 4.2 and 4.3 of this document as applicable for interconnections to Low Voltage and Medium Voltage Electrical Systems.
- ❒ New Jersey Statutes *(FOUND HERE - https://afdc.energy.gov/fuels/laws/ELEC?state=NJ)*
  - 40:55D-28
  - 40:55D-89
  - 40A:12A-7
  - 40:55D-4
  - 40:55D-5
  - 40:55D-66.2
  - 40:55D-66.20
  - 40:55D-66.21
  - 40:55D-66.19
- ❒ New York Statutes *(FOUND HERE- https://dos.ny.gov/system/files/documents/2021/06/2021-06-09-tb-2008-ev-charging-stations- final.pdf)*
  - 19NYCRR 1221
  - 19NYCRR 1227
- ❒ New York City Building Code
  - 1106.8 Electric Vehicle Charging Stations
- ❒ The New York City Administrative Code
  - 406.4.10

4.13.2 DESIGN CONSIDERATIONS

Electric vehicles can be interconnected to common infrastructure shared by other buildings and systems, or may be established as a standalone, dedicated system. The following criteria shall be considered in determining electrical distribution topology:

- ❒ Spare capacity on existing infrastructure
- ❒ Utility rate costs of blended or standalone EV charging. Some standalone EV charging can attain a more favorable, cheaper rate depending on the design and the current availability of these rates
- ❒ Lead times of implementation for both strategies
- ❒ Future flexibility/master planning goals and design criteria
- ❒ Operational requirements

Due to the growing demand for EVs, charging infrastructure should, to the extent possible, be capable of expansion to accommodate installation of additional charging in the future.

To ensure compatibility, precedence of specific charger and charge management system integration must be available when selecting this equipment. Qualifications and experience criteria in response to RFPs shall include details on the joint project experience of the different equipment vendors.

4.13.2.1 BUSINESS CASES

Designer shall engage Facility, Office of Sustainability and Central Automotive on their current EV charging and electrified fleet goals at the early stages of design for implementation on all projects.

Beyond installing the minimum amount of EV charging stations, or the provisions for future stations as required by local jurisdiction, the designers shall evaluate what additional amount of charging is necessary under the scope of work, shall coordinate the various use cases and charging types with PANYNJ to support its needs to support its evolving fleet and business cases. It is much more feasible for high levels of support for longer layover charging since the necessary charge rates are lower, but consideration should be made for shorter layover lots with faster charging. There can be a business case made to support charging in additional areas such as short layover fast charging for which customers will pay a premium for faster charging.

4.13.2.2 TECHNOLOGY APPLICATIONS

Designer shall consider Level 2 Charging and Level 3 DC Fast Charging (DCFC) dependent on project application.

- ❒ For short layover applications, DCFC of rates 50kW or greater are recommended. Such examples may include:
    - Short term parking lots for public facing
    - Pickup/dropoff idle lots
    - Taxi lots
    - Fleet vehicles that get heavy use in an emergency (Storm, Snow, Security Event)
- ❒ For employee/tenant day lots (~8hrs), Level 2 is recommended. However, implementation of select DCFC stations should be explored based on intended use and currently available technologies since this market is rapidly expanding.
- ❒ For longer layover applications, Level 2 charging is recommended. Such examples may include:
    - Long Duration Public Lots
    - Fleet charging

4.13.2.3 CHARGE MANAGEMENT

EV Chargers shall be procured and evaluated comprehensively with charge management systems to allow for loads to be controlled as needed within the host site. Charge management systems are necessary for large-scale EV charging sites to optimize energy costs, mitigate utility POI limits, and aid in construction of their intended business case for charging.

The following use cases shall be considered when selecting a charge management system:

- ❒ Port-side operations (highest priority for continuity) - Chargers shall not require revenue collection capabilities in charging port vehicles.
- ❒ Tenant lots (medium priority for continuity) - Chargers shall not require revenue collection capabilities in charging port vehicles.
- ❒ Public-side operations (lowest priority for continuity) - Chargers need to be procured with revenue collection capabilities.

Under emergency scenarios, port-side operations and charging shall be prioritized when power is limited. Load shedding priorities shall be configured through charge management systems, microgrid controls, or other means to attain the Port's desired level of operations.

4.13.2.4 OTHER CONSIDERATIONS

Emergency and backup power requirements shall be coordinated with the operations and facilities teams at a project site to determine the criticality of the charging infrastructure and define the requirements for their resilience.

EV Charging stations and associated parking spaces shall be designed in accordance with latest ADA standards for accessibility.

Stations shall be protected from vehicular damage by the use of bollards or other means.

Stations shall be adequately illuminated as required by local codes. Lighting shall be arranged so as to avoid shadowing at system components and areas designated for future infrastructure.

5.0 Reference Materials

5.1 Technical and Code Standards

5.1.1 Building Codes

<<Under Development>>

5.2 Guidelines

5.2.1 Port Authority of NY & NJ

<<Under Development>>

5.2.2 Federal and State

<<Under Development>>

5.3 Regulatory Requirements

5.3.1 Federal and State

<<Under Development>>

5.4 Contract Documents

5.5 Contract Drawings

5.6 Net Cost

5.6.1 Definition/Procedure

<<Under Development>>

5.6.2 Sole Source

<<Under Development>>

5.6.3 Definition/Procedure

<<Under Development>>

5.7 CONTRACT SPECIFICATIONS

5.7.1 OBJ (2) (2)

Note: Look for Division 26, Division 27, Division 28 and Standard Specifications Index

5.7.2 CUSTOM SPECIFICATIONS

<<Under Development>>

6.0 REFERENCE LINKS

1. *[Online] https://www.panynj.gov/port-authority/en/business-opportunities/engineering-available-documents.html. 68.*
2. *[Online] https://www.panynj.gov/port-authority/en/business-opportunities/engineering-available-documents.html. 92.*

Appendix A

Acronym	Definition
A	Ampere
AC	Alternating Current
ADA	Americans with Disabilities Act
ADAAG	Americans with Disabilities Act Accessibility Guidelines
AFF	Above Finish Floor
ANSI	American National Standards Institute
ASHRAE	American Society of Heating, Refrigeration and Air-
ATS	Automatic Transfer Switch
AWG	American Wire Gauge
BIL	Basic Impulse Level
CB	Circuit Breaker
CCT	Correlated Color Temperature
CCTV	Closed Circuit Television
Co	Carbine Monoxide
CPE	Chlorinated Polyethylene
CPU	Central Processing Unit
CRI	Color Rendering Index
CT	Current Transformer
CTSS	Closed Transition Selector Switch
CU	Coefficient of Utilization
DACT	Digital Alarm Communicator Transmitter
DALI	Digital Addressable Lighting Interface
DC	Direct Current
EMT	Electrical Metallic Tubing
EO	Executive Order
EOL	Engineering OnLine
EPR	Ethylene-Propylene-Rubber
FAA	Federal Aviation Administration
FACP	Fire Alarm Control Panel
FM	Factory Mutual
FRE	Fiberglass Reinforced Epoxy
FSC	Flat Strap Cable
GFD	Ground Fault Detector

Acronym	Definition
GFPU	Ground Fault Pick-Up
HID	high intensity discharge
HLO	High Light Output
HO	High Output
HP	Horse Power
HPS	High-Pressure Sodium
HVAC	Heating, Ventilating, and Air Conditioning
Hz	Hertz
ICCP	Impressed Current Type CP
IEEE	Institute of Electrical and Electronics Engineers
IESNA	Illumining Engineering Society of North American
IMC	Intermediate Metal Conduit
INST	Instantaneous
KCmil	Thousand Circular Mil
KVA	Kilovolt-Ampere
KW	Kilowatt
LAHSO	Land and Hold Short Operations
LCD	Liquid Crystal Display
LDPE	Low-Density-Polyethylene
LED	Light-Emitting Diode
LEED	Leadership in Energy and Environmental Design
LLF	Light Loss Factor
LOTO	Lockout/Tagout
LTD	Long Time Delay
LTPU	Long Time Pick-Up
MCC	Motor Control Center
MER	Mechanical Equipment Room
MH	Metal Halide
MLPW	Mean Lumens Per Watt
MSS	Mode Selector Switch
MVA	Megavolt-Ampere
NACB	Notification Appliance Circuit Booster
NACE	National Association of Corrosion Engineers

Acronym	Definition
NAVAID	Navigation/al Aid
NEC	National Electric Code
NEMA	National Electrical Manufacturers Association
NESC	National Electrical Safety Code
NFPA	National Fire Protection Association
NJDEP	New Jersey Department of Environmental Protection
NLO	Normal Light Output
NYCBC	New York City Building Code
NYCT	New York City Transit
NYS ECCC	New York State, Energy Conservation Construction Code
NYSDEC	New York State Department of Environmental Conservation
PA	Port Authority
PS	Pulse Start
PT	Potential Transformer
PVC	Polyvinyl Chloride
RA	Remote Annunciator
RGB	Red-Green-Blue
RGS	Rigid Galvanized Steel
RLO	Reduced Light Output
RP	Recommended Practice
SCADA	Supervisory Control and Data Acquisition
SMGCS	Surface Movement Guidance Control System
SP	Standard Practice
STD	Short Time Delay
STPU	Short Time Pick-Up
TCLP	Toxicity Characteristic Leaching Procedure
THD	Total Harmonic Distortion
THWN	Thermoplastic High Water-Resistant Nylon Coated
TVSS	Transient Voltage Surge Suppressor
UL	Underwriters Laboratories, Inc.
UPS	Uninterruptible Power Supply
UST	Underground Storage Tank
VAC	Volts Alternating Current

Acronym	Definition
VCE	Vertical Circulation Elements
VFD	Variable Frequency Drive
VISAID	Visual Aid
VRLA	Value Rated Lead Acid
XHHW	XLP High Heat-Resistant Water-Resistant

7.0 DOCUMENT CHANGE CONTROL

	Date	Version	Author	Description
1	08/29/2018	Version 2018 v2.0	Z. Whiteman	EAD updated document content
2	05/02/2019	Version 2019 v1.0	Z. Whiteman	EAD updated document content
3	03/31/2022	Version 2022 v1.0	B. Kuriakose; A. Agnello	Update document content