

**Hartsfield-Jackson Atlanta International Airport**

**City of Atlanta**

**Department of Aviation**

**Planning Development Bureau**

# **Airport Facilities Landside/ Airside New Construction/ Design Modifications**

**Design Standards - Electrical**

## Electrical Design Standards

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## Electrical Design Standards

### 1.0 Purpose

#### A. Purpose of Design Standard – Electrical

The purpose of this document is to outline the minimum design standards and installation requirements for systems (electrical power, control, fire detection and others), which are installed to serve various spaces throughout the Central Passenger Terminal Complex (CPTC) and other DOA facilities to include Landside/Airside New Construction, Modifications, Concession and Tenant spaces at Hartsfield-Jackson Atlanta International Airport (H-JAIA or “Airport”).

### 2.0 Codes and Standards

#### A. Applicable Codes, Standards & Circulars

All design work shall be performed “In Accordance With” (IAW) generally accepted, professional principles and practices for electrical engineering and in compliance with all applicable Department of Aviation (DOA), Planning & Development (P&D) Facilities/Landside/Airside New Construction and Modification Standards included in this document. Compliance with the latest Federal, State and City of Atlanta Codes, Standards and Regulations along with the latest Advisory Circular (AC) for Airport Projects is required. The codes, standards and practices listed herein generally apply to airport projects. Other codes, standards or practices that are more specific will be referenced within a specific section (the list below is for reference and not all inclusive).

##### 1. Codes

- a. National Fire Protection Association (NFPA) 70 National Electrical Code
- b. NFPA 72 National Fire Alarm Code
- c. NFPA 101 Life Safety Code
- d. NFPA-110 Emergency and Standby Power Systems
- e. Standard Building Code
- f. NFPA 780 Standard for the installation of Lightning Protection System
- g. Georgia State Minimum Standard Electrical Code
- h. Occupational Safety and Health Administration (OSHA)

##### 2. Standards

- a. American National Standards Institute (ANSI)
- b. Institute of Electrical and Electronics Engineers (IEEE)
- c. Underwriters Laboratories (UL)
- d. Illuminating Engineering Society (IES) Lighting Handbook

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- e. National Electrical Manufacturers Association (NEMA)
  - f. Hartsfield Jackson Atlanta International Airport, City of Atlanta, Department of Aviation – Aviation Information systems, (AIS) Infrastructure Standards (latest revision)
  - g. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)
3. Circulars
- a. Federal Aviation Administration (FAA), Series - 150 Advisory Circular (AC) for Airport Projects (only AC numbers are indicated in this standard)

### 3.0 General Drawing Requirements

#### A. Facilities Electrical Drawings and Master Drawings (including systems)

**Table 1:** is a recommended list of “Drawing Types” required to illustrate the design scope and to be issued as acceptable DOA construction “As-Built” project deliverables.

Master drawing deliverables are designated below

Table 1 - Drawings			
Project Electrical/System As-Built Drawing Types	Scale	Master Deliverables	Deliverable Format
Legend	NTS		<b>Acceptable Electronic Formats for drawings:</b> AutoCAD (.dwg) Revit (.rvt) Adobe (.pdf) BIMS (contact DOA BIMs manager for specific details).  Early coordination with the DOA Project Manager is required to establish the acceptable drawing format for project
Electrical Site Plan	1 inch = 20 feet		
Lightning Protection and Counterpoise Composite Plan	1 inch = 20 feet		
Lightning Protection Details	NTS		
Grounding Site Plan	1 inch = 20 feet		
Grounding Riser diagram(s)	NTS		
Grounding Details	As required		
Primary Electrical System: One-line/Single-line and/or Riser Diagrams -Full and partial	NTS	<b>Master Drawing (3.B.2.d)</b>	
Power Electrical riser diagram (for multi-story buildings)	NTS	<b>Master Drawing (3.B.2.d)</b>	
Power Layout floor plans	¼ inch = 1.0 feet 1/8 inch=large spaces	<b>Master Drawing (3.B.2.d)</b>	
Power layout enlarged floor plans, specifically electrical vaults, electrical rooms, electrical closets	¼ inch = 1.0 feet All plans listed shall be drawn to scale	<b>Master Drawing (3.B.2.d)</b>	
Panelboard schedules and Directories	NTS	<b>Master Drawing (3.B.2.d)</b>	
Site Lighting Plans	1 inch = 20 feet		

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Site Lighting Photometrics Plans (when required)	1 inch = 40 feet		deliverables.  <b>Acceptable Hard Copy Formats for drawings:</b> Full and/or Half size drawings shall be printed to scale when requested.
Interior Lighting Plans	¼ inch = 1 feet 1/8 inch=large spaces		
Interior Lighting Photometric Plans (when required)	As required		
Lighting fixture schedule	NTS		
Special Systems layout Floor Plans (Fire Alarm,)	¼ inch = 1.0 feet 1/8 inch=large spaces		
Special Systems Details	As required		
Low Voltage Switchgear, Switchboard and Motor Control Center Elevation and Details	As required	<b>Master Drawing (3.B.2.d)</b>	
Miscellaneous Elementary and Wiring Diagrams (when required)	NTS		
Electrical Equipment List for (EPMS)	NTS	<b>Master Drawing (3.B.2.d)</b>	
Electrical Power Monitoring System (EPMS) user interactive graphic screen/input lists	NTS	<b>Master Drawing (3.B.2.d)</b>	
Electrical Power Monitoring System (EPMS) One- line and/or Riser Diagrams	NTS	<b>Master Drawing (3.B.2.d)</b>	
Power Duct Bank Plan and Profile (Civil Work Drawing)	1 inch = 50 feet horizontal		
Equipment Pad details for Switchgear, Switchboard, Transformer, Motor Control Center and floor mounted equipment	As required		
Electric Manhole Plan, Details and Sections	As required		

Note: electrical symbols and equipment placed on drawings shall match the layout plan drawing scale.

## B. Electrical and System Drawing Updates

1. The Design Service Providers (DSP) shall request and update the Department of Aviation's Facilities Master Electrical/System Drawings along with prepare and deliver stand-alone Final Project Electrical/System "As-Built" drawings whenever a project is performed at the Central Passenger Terminal Complex (CPTC) and a DOA property. Facilities Master Electrical/System Drawings (shown on Table 1), and the required stand-alone Final Project Electrical/ System "As-Built" drawings shall be developed and updated for each concourse/building located within the CPTC and DOA property as described within this design standard and IAW the contract project Scope of Work (SOW) documents. All document requested for check-out/check-in shall be through the PMWeb web-based Project Management software system, IAW P&D Policies and Procedure 02-002 "Document Control" (latest revision).

## 2. Definitions:

- a. **CPTC:** The area within the Hartsfield-Jackson Atlanta International Airport (HJAIA) referred to as the Central Passenger Terminal Complex (CPTC) to include all Concourse's and Terminal buildings.
- b. **Design Service Provider (DSP):** is a service organization contracted to provide electrical system design solutions and services starting at the design initiation phase and ending at a successful system turn over. The Design Service Provider is responsible for the project design as stipulated in the Design Contract and Task Orders.
- c. **Electrical Construction Drawings:** designated as working drawings issued before actual construction begins. Construction drawings are also known as Issued for Construction (IFC) drawings during the last phase of the design effort.
- d. **Facilities Master Electrical/System Drawings:** Facilities Master Electrical/Systems drawings are revised drawings which reflect ALL changes created by every project performed at the CPTC and a DOA property. Drawings considered "Master Drawings" to be incorporated into the Facilities Master Electrical/Systems are defined on Table 1. Drawings are DSP contract deliverables and independent of the Final Project Electrical/System "As-Built" drawings.
- e. **Final Project Electrical/System As-Built drawings:** Final project Electrical/System "As-built" drawings are independent of the Facilities Master Electrical/System Drawings and are project specific. The project "As-Built" drawings shall reflect all changes made during the construction process and provide an exact rendering of the finished project. Final project "As-Built" drawings are contract deliverable documents and shall be prepared and managed IAW, P&D Policies and Procedure 08-008 "Project As-Built Documentation" (latest revision). Drawings are DSP contract deliverables and independent of the Facilities Master Electrical/System Drawings.
- f. **Progress Electrical As-Built drawings:** progress electrical "As-built" drawings (also denoted as marked up-to-date or red-line drawings) are the revised sets of paper copy drawings on the Jobsite which provides an accurate record of all deviations between work as shown and work as installed during construction. All "As-Built" drawings shall be prepared and managed IAW, P&D Policies and Procedure 08-008 "Project As-Built Documentation" (latest revision).

### C. Drawing Request and Revision Process

1. Project Initialization:
  - a. Upon a project initialization, the DSP shall contact the DOA's Document Control Specialist (DCS) IAW, P&D Policies and Procedure 02-001 "Document Control" (latest revision) who is responsible for managing all project related documents during the project life cycle.
  - b. The DSP is responsible for identifying all Facilities Master Electrical/Special Systems drawings required for project and Master Drawing revisions during project initialization.
2. Facilities Drawing Request:
  - a. The DSP shall request from the DCS the Facilities Master Electrical/System Drawings pertinent to the design modification or new construction project.
  - b. The DCS shall forward the drawing request to the DOA Electrical Department Design Manager (or designee) for review and approval when required.
  - c. The revision number on the issued drawing shall be the current revision number or in general, revision X (such as revision 1).
3. Drawing Revisions
  - a. The DSP shall establish revision completion dates to issue the Final Project Electrical/System "As-Built" drawings, and the revised Facilities Master Electrical/System Drawing(s). The DSP shall contact the Electrical Engineering Department Design Manager (or designee) on the established completion dates for both and provide progress status updates.
  - b. Upon completion of a new construction or modification projects, the DSP shall revise the Progress Electrical "As-Built" drawings to reflect all changes made during construction which will become the official signed-off "Final Project Electrical/System "As-Built" drawing submittal.
  - c. Final Project Electrical/System "As-Built" Drawings shall be delivered to DOA through the PMWeb web-based Project Management software system IAW, P&D Policies and Procedure 02-001 "Document Control". The drawing(s) shall be in the software format identified on Table 1 with (1) one hard copy sealed and signed by a P.E. (Electrical) registered in Georgia. Drawings shall be stamped "As Built".
  - d. After completion and submittal of the Final project Electrical/System "As-Built" drawing deliverables the DSP shall request and check-out the Facilities Master

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Electrical/System Drawings to be revised IAW the details outlined in this design standard and as described in the contract project Scope of Work (SOW) document. The DOA Electrical Design Manager (or designee) shall follow up with the DSP during the check-out period (predetermined time) to assess if the procedural requirements are being adequately implemented. The requested check-out period shall include adequate time to perform a quality review of the updated Facilities Master Electrical/System Drawings prior to the revised documents being check-in to the document control system.

- e. The Final Project Electrical/System “As Built” Drawings and revised Facilities Master Electrical/System Drawings shall include the following information in the revision blocks:
    - i. New revision number, generally Revision number enclosed in a triangle (revision number shall increase with each submittal),
    - ii. Revision date,
    - iii. Engineer’s initials,
    - iv. A brief description of the revision such as project name and WSB number,
    - v. Sealed and signed by a P.E. (Electrical) registered in Georgia.
4. Facilities “As Built” and Master Electrical Drawings Deliverables
- a. The required Final Project Electrical/System “As Built” and Facilities Master Electrical/System drawing deliverables identified on Table 1 shall be officially transmitted to the DOA through the PMWeb web-based Project Management software system IAW, P&D Policies and Procedure 02-001 “Document Control. The project “As-Built” Drawings shall be comprised at a minimum all Electrical/System Drawings included in the issued for construction set along with the Facilities Master Electrical/System Drawings identified in Table 1.

## 4.0 Design Requirements

### A. General Design Requirements

1. Keep abbreviations to a minimum.
2. Use only standard technical abbreviations from the American National Standards Institute (ANSI) and the Institute of Electrical and Electronics Engineers (IEEE) on all drawings.
3. When "In Accordance With" (IAW) is annotated, it is referring to an agreement or conformity with an authority, code, standards, rules, procedures, etc.
4. All Electrical Components, Devices, and Accessories used as the basis of design shall be Underwriters Laboratories (UL) Listed as defined in NFPA 70, NEC, Article 100. The contract specifications shall identify the UL listed requirements for all electrical components, devices, and accessories.

### B. Administrative Design Requirements

1. The DSP shall resolve code conflicts found during design and construction. The more stringent applicable portion of conflicting codes shall be used unless a written waiver letter with concise details and supporting evidence is submitted to the DOA Assistant Director (or designee) through the PMWeb web-based Project Management software system IAW, P&D Policies and Procedure 02-001 "Document Control" (approval shall be granted prior to performing any work).
2. The DSP shall provide details on the design contract documents to include raceways, wires, cables, equipment, controls, grounding, wiring diagrams and other details required to make complete electrical, control and all ancillary systems operational.
3. Design drawings are generally diagrammatic and are not intended to show exact locations of all raceways runs, outlet boxes, junction boxes, pull boxes, etc. In general, exact locations shall be determined and coordinated in the field which shall be illustrated on the "As-Built" construction documents. The locations of equipment, appliances, fixtures, raceways (conduit, cable tray, busduct, junction boxes, wireways, outlets boxes, and similar devices) shown on the drawings are approximately located to obtain accurate cost estimates unless "to-scale" placement is specifically required by the design to illustrate and avoid constructability design conflicts with the following exception:  
Exception: All electrical rooms, electrical closets and major equipment placed within these electrical rooms such as switchgear, switchboards, distribution panelboards, panelboards, etc. shall be drawn "to scale".

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4. Where circuits are shown as "homeruns" on drawings, place notes on contract documents indicating that all necessary fittings, supports, and boxes shall be provided to make complete raceway installations IAW code requirements.
5. The DSP shall show circuit layouts on drawings; however, layouts are not required to show all fittings, or all installation details. Details illustrating connections to equipment shall be shown as required, and IAW the accepted shop and manufacturer's design drawings.

### C. Landside Technical Design Requirements

1. Raceway
  - a. This Design Standard considers a Raceway System to consist primarily of cable tray, conduit and necessary hardware used to support cable runs between electrical equipment and physical protection to the cables. IEEE 422 is considered a valid reference when designing/installing a similar raceway system as described in this standard.
  - b. Electrical metallic tubing (EMT) may generally be used for dry accessible concealed installations; however, Rigid metal conduit (type RMC) shall be used in most cases for exposed installations with the following exception:

Exception: When raceway is not subject to any physical or mechanical damage EMT can be used for exposed installations. When specified, EMT shall be used with compression fittings (coupling) and installed in accordance with the NEC.
  - c. EMT couplings with set screws are not allowed.
  - d. EMT shall be installed with appropriate fittings if used as an equipment grounding conductor IAW NEC and IEEE 422.
  - e. Surface nonmetallic raceways shall not be permitted.
  - f. Only cast metal boxes shall be used for exposed installation.
  - g. Minimum conduit size to route electrical cables shall be  $\frac{3}{4}$ ". This criterion applies to all HJAIA CPTC and DOA facilities. See FAA circulars for airside requirements.
  - h. Signal cables may be installed in cable tray; however, J-hooks, D-rings and Bridal Rings are not allowed.
  - i. Each three-phase circuit shall be run in a separate Raceway unless otherwise shown on the contract drawings.

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- j. When PVC is specified, the schedule type shall be provided.
  - k. Supporting raceways from cable trays/supports, wireways/ supports, and from another raceway including supports is not allowed.
  - l. Underground Raceway: All underground, direct buried, encased conduits, duct banks and other underground raceways installed at HJAIA CPTC and DOA facilities to include abandoned conduits capped in place, shall be equipped with “Electronic Utility Markers”. The DSP shall recommend to DOA the type of “Electronic Utility Markers” which will offer the best accuracy for locating underground utilities, complies with local codes/standards, industry color codes and are UL certified. Prior DOA approval is required before installation.
2. Wiring & Cables
- a. Conductor/Wiring: All wire and cables shall be Underwriter’s Laboratories (UL) listed and shall meet all national, state, and local code requirements for their application. Insulated wire and cables shall conform to the minimum requirements of the Insulated Cable Engineer Association (ICEA) Standards. Conductivity shall be IAW the standardization rules of the Institute of Electrical and Electronics Engineers, Inc. (IEEE).
  - b. Cable Definitions
    - i. **Power:** cables are used to send energy from its source to downstream equipment.
    - ii. **Control and Instrumentation:** cable terminology may be used interchangeably to refer to the same cable. However, control and instrumentation cables have related functions and are used for sending signals that control equipment, as well as for measurement.
    - iii. **Signal:** include coaxial cables, twisted pair cables, and fiber optic cables which are used to transmit data.
  - c. All power, control, instrumentation and signal cables to include the following systems at a minimum: Power Systems, Fire Alarm (FA), Heating, Ventilation, Air Conditioning (HVAC), Lighting, Communication, Video Surveillance Cameras (CCTV), Access Control, Information Technology (IT), phone (data or voice) shall be routed in NEC raceways. Coordination with the project design specifications is required.
  - d. Branch circuit power cables (conductors) shall be minimum #12 American Wire Gauge (AWG) and shall be copper, type THHN/THWN unless otherwise noted on design documents and approved by DOA electrical.

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- e. Control and instrumentation cables (signal wiring) for all systems identified shall be minimum #14 American Wire Gauge (AWG) unless otherwise noted on design documents and approved by DOA.
- f. Communications Installation: Fiber Optic cabling, copper data cabling, communications conduit, pathways, grounding/bonding, firestopping, testing, and all associated task involved in communications installation, shall be designed and specified IAW Aviation Information Systems (AIS) infrastructure Standards and Telecommunications Industry Association (TIA) Standards (latest version).
- g. Metal Clad (MC) cable shall only be used for final connections to light fixtures from ceiling junction boxes (less than 72 inches) or inside existing walls where concealed. MC cable is not allowed for feeder and branch circuits.
- h. Feeders and service wiring shall be copper.
- i. Aluminum feeders shall only be allowed for 400 Hz feeders/ branch circuits.
- j. No abandoned cable or raceway due to demolition shall be allowed. Remove all the wiring, conduit, and other associated raceways back to the source. Requirements apply to interior and exterior building installations.
- k. Where existing switchgear, switchboards, panelboards and other electrical components are being replaced, the associated feeders shall also be replaced.
- l. No reduced sized neutrals will be allowed. Each single pole overcurrent device shall have its own separate neutral conductor.
- m. Neutral conductor sizes shall not be less than the respective feeder or phase conductor sizes.
- n. Multi-wire branch circuits are not allowed.
- o. Include equipment grounding conductors sized per NEC with all power and control circuits over 50 volts.
- p. Install computer-related circuits and receptacles separate from motor load circuits. If required by the manufacturer to minimize noise, provide a separate grounding conductor back to the branch circuit breaker for each circuit, consistent with NEC grounding criteria. Provide an isolated ground receptacle as needed.
- q. All underground wirings shall be protected by conduit and concrete encasement for areas with heavy vehicle traffic such as roadways, parking lots, etc.. The minimum burial depth cover shall be IAW NEC (latest version).

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- r. Wiring in light pole handholes: Provide at least 18" of slack at handholes or as otherwise defined in specifications. The type of cable splicing used shall be detailed in the project specifications and shall comply with the NEC and industry standards. See section titled "Splices" for additional details.
3. Voltage Drop Assessments
    - a. The DSP shall perform voltage drop calculation (s) IAW Section 8.G and increase the conductor and conduit sizes as required. This increase shall compensate for any voltage drop concerns which will reduce the operating efficiency of motors, lights or other electrical equipment. If during construction a cable voltage drop concern is identified due to unforeseen circumstances, the electrical DSP shall re-analyze to determine a new cable size and provide results to the contractor for installation.
    - b. Mid to large projects: If a substantial quantity of cables is specified, the electrical DSP shall provide a "Voltage Drop Table" and place details on the contract drawings. This table shall specify the conductor's maximum allowable length and amperage to ensure that the electrical components can operate efficiently.
    - c. Small projects: the DSP may provide voltage drop notes on drawings to identify acceptable cable sizes.
  4. Splices
    - a. If it is determined by the DSP construction team that a cable splice may be required or a cable replacement is more practical, this occurrence shall be brought to the attention of the DOA Design Manager (or designee) for all normal and emergency branch circuits. Splices in handholes near spouts or other water sources shall be waterproof and approval is required prior to any work being performed.
    - b. Cables for life safety branch circuits shall not be splices, cable replacement is required.
  5. Circuiting
    - a. A shared neutral wire is not allowed.
    - b. Branch circuit design for general use power receptacle outlets shall be limited as identified in section 6.B.8.
    - c. Only "Life Safety" (S) circuits shall be connected to the emergency power system.
    - d. Emergency Feeder Circuit Wiring: Wiring for emergency systems shall meet the requirements of NEC 700.10 (D).

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- e. Maintain a minimum of four spare circuit breakers and/or spaces in existing panel boards when practical. Provide new panel boards to accommodate the circuit excess.
  - f. Main circuit breakers shall be sized 25% above connected load as a minimum.
  - g. Provide and install dedicated electrical circuits fed from local panels (when required) to power loads for general office spaces, data centers, communications complexes that use electrically sensitive equipment (computers), data processing equipment and other similar devices.
  - h. Dedicated panel boards should be fed from separate feeders to the service entrance if possible.
  - i. For small loads explore the possibility of using existing circuits vs. proposing new circuits.
  - j. Circuit Loading and Metering: The following requirements shall apply to all electrical designs to include HJAIA Capitol, DOA facilities, Concessions and Tenant projects. The requirements for electrical load calculations for Criteria 1 and 2 shown below are described in section 8.C titled "Load Calculations". The metering requirements are identified in Criteria 2 below.
    - i. Criteria 1: for minor load additions provide a load calculation with conclusions and any recommendations shown on a contract drawing panelboard schedule or in a stand-alone load calculation.
    - ii. Criteria 2: If Criteria 1 is not practical due to the complexity of projects, then a) obtain metered load measurement data which validates the maximum demand load for a 1-year period for input into a load calculation. If data is not available, then b) obtain services from a certified electrical contractor to place meters on equipment in question and record existing load data over a 30-day period. Either scenario a) or b) can be used when adding loads to the existing switchboards and panelboards. Once load data measurements are successfully captured and analyzed the output shall then be used as the design basis input for a formal load calculation.
    - iii. The load analysis for Criteria 1 and Criteria 2 shall be performed IAW the latest edition of the NEC, article 220.87 which is a requirement for the City of Atlanta permitting department.
6. Exclusions
- a. No welding or cutting of structural steel for electrical systems is allowed unless it is

specifically approved by DOA structural engineering in writing.

- b. No saw cutting of flooring to install raceway (conduits) used to route cables is allowed for new circuits.

## 7. Miscellaneous Requirements

- a. Conduit Color Coding: All electrical conduits shall be identified by color-coding. Apply color-coded identification on electrical conduit in a neat and workmanlike manner and as specified in the project specifications.
- b. Conduit Labeling requirements: include requirement for the contractor to provide and install labeling for all new conduits that are connected to switchgears, switchboards, motor control centers, panelboards, junction boxes and wireways, located inside each electrical room.
  - i. Labels shall be (1) inch wide, Self-Adhesive, vinyl, laminating, (waterproof when required), fade resistant black letters, "normal" font size 36 on yellow continuous tape.
  - ii. Apply bands 50 feet on center along the raceway system and at each side of walls or floors, and at branches from mains.
  - iii. Instructions shall be provided to the contractor that before applying any identification products to the raceway systems, components shall be cleaned of any foreign substances that could prevent permanent bonding. Attachment methods and material recommended by the manufacturer shall be followed.
  - iv. Labeling shall include power source (name of switchgear, switchboard, distribution panelboard or panelboard), voltage level, circuit number and load serving.
  - v. The contractor shall provide label samples to DSP and construction manager for approval prior to installation.
- c. Equipment Mounting Detail requirements:

Prepare elevations and details to show the mounting method for all equipment such as large transformers, large junction boxes and large control cabinets. Any large equipment (example: transformer) when allowed by the NEC to be suspended from a ceiling structure, shall have an approved installation detail signed by a registered Professional Engineer (structural). Structural Mounting details are not necessary for small simple wall mounted devices, however details for the mounting height above the finished floor or above finished grade is required.

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## d. Floor mounted equipment to include electrical emergency generators:

All floor mounted equipment shall be placed on housekeeping pads with details shown on the electrical layout plan drawings. Provide reinforced concrete pads for floor mounted electrical equipment or unless otherwise noted (for electrical equipment installed in the Airfield Lighting Vaults see AC 150/5340-30J). The DOA recommendation: housekeeping pads shall be nominally four (4) inches high and shall exceed the dimensions of equipment being set on them, including future sections, by six (6) inches on all sides, except when equipment is flush against a wall, then the side or sides against the wall shall be flush with the equipment. Concrete pads shall also be provided and installed for all electrical emergency generators. The DSP structural engineer shall be responsible for all housekeeping and generator pad structural calculations, elements and details.

## e. Surface mounted equipment:

Surface-mounted fixtures, outlets, cabinets, panels, etc. shall have a factory-applied finish or shall be painted as accepted by the DSP. The mounting and anchorage for surface mounted equipment to building structural elements shall be specified in project specifications and approved by the DSP structural engineer.

## f. Surface mounted raceway:

Raceways and fittings, where allowed to be installed surface mounted, shall be painted to match the finish on which it was installed. Paint and details for raceway and conduit supports shall be IAW specific project specifications.

## g. Fire Barriers:

Indicate all fire barrier penetrations on electrical plan drawing; specification shall show how the wall/barrier will be labeled.

## h. Fire Stops and penetrations:

Specify fire stopping rated sealant for electrical penetrations in fire-resistance rated walls, partitions, floors, and ceilings to maintain the fire-resistance rating. Specifically, seal all conduit penetrations at fire-rated partitions. Coordinate all conduit penetrations with architectural and structural drawings, field conditions and other trades. Provide sealing fitting to prohibit condensation and passage of gases or vapors and coordinate with the project architect and or consult with the method of sealing and sealant type.

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## i. Sleeves and Forms:

Provide sleeves for Raceways penetrating floors, walls, partitions, etc. Locate necessary slots for electrical work and form before concrete is poured. Provide boxed out forms for raceway penetrations only were allowed by the Architect. Fill opening after raceway installation, with equivalent material. DSP Structural engineer shall be responsible for all design details.

## j. Leadership in Energy and Environmental Design (LEED) Efficiency:

Electrical equipment specified must meet energy efficiency requirements to align with LEED certification.

## k. Modifications:

Electrical equipment being added to an existing electrical system requires a circuit load calculation or metering to determine the suitability of any equipment's ability to accommodate new loads and perform as intended. See sections titled "Circuit Loading and Metering" and "Load Calculations" for requirements. In addition the DSP shall analyze the Form, Fit, and Function (FFF) for all new proposed electrical equipment to ascertain the integration with existing infrastructure. FFF refers to the identification and description as follows: Form: the shape, size, dimensions, weight, and other physical parameters that uniquely characterize an item; Fit: the ability of an item to physically interface or interconnect with or become an integral part of another item and Function: the action or actions that an item is designed to perform.

## l. Field verification:

Site walkdown's of facilities and equipment shall be performed prior to any additions or modifications to verify and validate existing field conditions.

## m. Electrical Rooms and Electrical Closets:

- i. Provide notes on electrical drawings to instruct the contractor to efficiently use wall and floor space in electrical rooms when installing new electrical equipment to maintain and reserve space for future electrical work.
- ii. See section "Building Grounding System Design" for electrical room grounding.
- iii. See section "Power Receptacles System Design" for requirements in or around electrical rooms and electrical closets.
- iv. Electrical rooms (wall and ceilings) shall be two-hour rated. The DSP shall coordinate with the "Architectural" and "Structural" drawings for validation.

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- v. Smoke detectors shall be provided and installed in HJAIA electrical rooms, closets if space is not provided with sprinkler protection as defined by the Georgia State Minimum Standard Building Code.
- vi. Information Technology (IT) Telecommunication system equipment to include cabling shall not be installed in any HJAIA - CPTC and DOA property electrical rooms, except if electrical equipment is served. Electrical rooms shall not be used as an IT telecommunication room.
- vii. Exit and exit access doors serving electrical rooms and working spaces shall swing in the direction of egress travel and shall be equipped with panic hardware or fire exit hardware where such rooms or working spaces contain one or more of the following: equipment operating at more than 600 volts, nominal.
- viii. Electrical rooms in the CPTC shall be fitted with CyberKeys in coordination with AATC requirements.

n. MDF and IDF rooms:

The details for the HJAIA – CPTC, Main Distribution Frame (MDF) and Intermediate Distribution Frame (IDF) rooms are designed IAW, “AIS Infrastructure Standards” latest version. This standard also applies to the HJAIA - DOA external facility building telecommunication rooms. A review of this standard during all phases of design is required to ensure compliance.

8. Generators

- a. The DSP shall install permanent diesel generators when required to meet the requirements of NFPA 110, “Emergency and Standby Power Systems”, NEC Articles 700 “Emergency Systems”, 701 “Legally Required Standby Systems” or 702 “Optional Standby Systems.”
- b. Diesel generators installed shall meet EPA Tier 2 NOx emission Levels unless otherwise exempt. See DOA “Sustainability Standards” for additional EPA requirements.
- c. All generators shall be installed on a generator pad. See section 4.C.7.d titled “Floor mounted equipment to include electrical emergency generators”.
- d. See section 4.D.1.o for Airfield- “Emergency Generator” requirements.

#### D. Airfield Technical Design Requirements

1. The following sections include design standards for systems and items specific to the airfield, but Airfield Lighting Systems designs are not limited to the design standards listed in this section. There are other sections contained within this Electrical Design Standard that will provide design standards for items that are common to both Airfield Lighting Systems Design and other facility designs. Where duplicate design standard sections common to both Airfield Lighting Systems and other facilities are covered within this design standard, the Advisory Circulars listed in this section shall govern airfield related items.

- a. Airfield lighting vaults:

Are designed to include equipment that complies with the appropriate Advisory Circulars for that equipment. Equipment designed to be installed shall also comply with AC 150/5345-53D "Airport Lighting Equipment Certification Program" (or latest revision). The configuration for electrical power feeding the Airfield Lighting Vault Facility shall be designed to meet the standards of a Continuous Power Facility as defined in AC 150/5340-30J section 13.2.1 "Continuous Load" (or latest revision). The electrical power configuration for the existing North and South Airfield Lighting Vaults and structures were sized for both equipment needs at the time of design, and potential future developments based on information provided by HJAIA Planning & Development Department.

- b. Airfield Lighting Vault design details:

The building shall be climate controlled and shall have a separately climate-controlled computer room exclusively for the ALCMS equipment. This room must have a window between the equipment area and the computer room. The vault shall have a workroom and a uni-sex restroom facility. Housekeeping pads were not previously provided for existing vault equipment locations, however, validation with the latest AC 150/5340-30J and others ACs shall take place to ensure compliance for current or future designs. The Vault shall have 10' X 10' roll up doors with electric operators. The roll up doors shall be aligned with inside movement areas which will allow for easy equipment installation and manipulation. The Vault shall have a paved parking area and an apron around the entire building. The Vault building shall have photocell-controlled area lighting. The Vault must have access and turn-around capability for large vehicles. See AC 150/5340-30J, section 12.13 "Vault" and AC 150/5370-10H for specific Vault requirements.

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## c. Airfield Lighting Vault Equipment:

All switchboards, panel boards and all other electrical equipment, except Airport lighting equipment items requiring FAA Approved, shall have UL approvals. See AC 150/5345-53D "Airport Lighting Equipment Certification Program" (or latest revision).

## d. Conduit/Wiring:

Wiring for airfield lighting shall be in polyvinyl chloride (PVC) conduit schedule 80 or as described in AC 150/5370-10H (or latest revision). The circuit conductors for lighting shall be L-824 Type C Underground Electrical Cable for Airport Lighting Circuits. Lighting circuits for taxiway lighting shall be 8 AWG and 6 AWG for runway lighting. Cable size is not dependent on whether it is a runway or taxiway circuit but is based on the size Constant Current Regulator that is energizing the circuit. L-824C cables (6# AWG) are used for 50KW CCRs. See AC 150/5345-7F (or latest revision) for airport lighting circuit requirements to include L-824.

## e. Exposed Conduits:

All exposed conduits shall be galvanized rigid. Flexible connections shall be of the "Sealtite" type flex. All surface mounted boxes shall be cast metal. All conduits and other steel shapes shall be properly cleaned, treated, primed and painted. All wall mounted devices and equipment shall be mounted on steel supports attached to the walls. See 150/5370-10H (or latest revision) for additional requirements.

## f. Under Floor Conduits:

All under floor conduits shall be 1" minimum size PVC conduit. At every location where the under-floor conduit turns up to the surface, for extension, a rigid steel conduit coupling shall be installed with the top end flush with the finished floor. All wiring for control, monitoring, FAA RVR and CCR output circuits shall be installed in under-floor conduit. Spare 4" under floor conduits shall be installed from the quarter-points of each wall, or wall section, to the Break-out Boxes. See 150/5370-10H (or latest revision) for additional requirements.

## g. Constant Current Regulators (CCRs):

Primary power distribution to the 2400-volt primary CCRs shall be by a totally enclosed and properly ventilated overhead 4160 Volt bus system. CCR Primary connections to the 4160 Volt bus shall be fully enclosed, hook-stick installable and operable fuses of the proper size for each CCR. All Constant Current Regulators (CCRs) above 15 KW shall have a 2400 Volt primary and all 15 KW CCRs or below

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shall have a 480-volt single-phase primary. Where possible all regulators will be either 15 KW or 30 KW with a 6.6-amp output to match existing equipment and utilize internal control equipment that is interchangeable with existing similar components. See AC 150/5345-10H (or latest revision) for specification details.

h. Regulator Junction Box/meters:

All CCRs shall have cabinet front mounted digital input voltage, output amp and lapsed time meters. All regulators shall have a 10" X 18" X 8" deep junction box, with thumbscrew closed hinged cover, attachment installed in the field circuit conduit, for the installation of FAA L-823 connector kits specified in AC 150/5345-26E (or latest revision).

i. Runway lighting circuit:

Existing CCRs shall have a second 10" X 18" X 12" deep junction box attached and connected to provide for the installation of FAA RVR monitoring equipment. All Constant Current Regulators at HJAIA are manufactured by MANAIRCO (justification letter dated 02/05/2003) and have 5 intensity step settings. All CCRS shall have taps to allow 30KW CCRs to be taped down to a minimum of 15KW; 15 KW CCRs shall have taps to allow CCRs to be tapped down to a minimum of 7.5 KW. The DSP shall review "As-Built" drawings and perform a field survey prior to performing any new airfield modifications.

j. Break-Out Boxes:

Existing airfield lighting vaults currently have field circuits passing through a wall mounted "Break-Out Box" which was properly sized to allow alignment, support, identification, manipulation and splicing of each conductor with an FAA L-823 connector kit specified in AC 150/5345-26E (or latest revision). Existing duct banks consisting of 4" PVC duct, number as specified on drawings are installed from Break-Out Boxes to a manhole located on the outside of the existing airfield lighting Vault building. Duct banks are extended to the field locations as required to connect into airfield circuitry locations or the existing manhole/duct bank system. The DSP shall review "As-Built" drawings and perform a field survey prior to performing any new airfield modifications.

k. Duct bank:

Existing duct banks consisting of 4" PVC duct, number as specified, are installed from the computer room to a manhole located on the outside of the airfield lighting

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Vault buildings. Duct banks are extended to the field locations as required and connected into existing control and communications manhole / duct bank systems. The DSP shall review "As-Built" drawings and perform a field survey prior to performing any new airfield modifications. and compliance with AC 150/5370-10H (or latest revision) is required for Duct Bank specification details.

l. Electrical Manhole:

Electrical manholes shall be equipped with spring assist, aircraft rated manhole covers. The cover shall be clearly identified as ELECTRICAL, COMMUNICATION or FAA with proper designation being cast into the cover. See AC 150/5370-10H (or latest revision) for manhole details.

m. Grounding:

All CCRs and other equipment shall be connected to a properly sized building ground loop using ground lugs bolted to pre-drilled and threaded ground brackets which are installed flush with the finished floor. Ground brackets must be installed at each location identified for future equipment installation. 1/4" X 2" Ground bus shall be mounted along to the Vault walls to provide for grounding of future equipment. See FAA-STD-019F (or latest revision) for grounding requirements and details.

n. Lightning Arrestors:

All fields lighting circuitry shall have properly sized lightning arrestors connected to the circuit conductors immediately prior to the "Break-Out Boxes". See AC 150/5345-10H (or latest revision) for lightning arrestor details.

o. Emergency Generator:

A minimum of one emergency generator, meeting the requirements of AC 150/5340-17B Section 4.a.1, for a Continuous Power Facility, must be furnished. The generator must be properly sized to energize the entire connected load of the Vault. Additional capacity shall be provided to allow additional future loads to be added as needed. Each generator must be provided with a minimum of a 5000-gallon fuel tank. See AC 150/5340-30J and AC 150/5340-30H (or latest revision) for fuel storage tanks and any FAA generator details

p. Standby Generators:

The design for standby power system shall provide automatic changeover from commercial power to the engine generator within 15 seconds of loss of commercial power. The design must comply with the requirements for a "Configuration A" power

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system as described in AC 150/5340-30J, section 9.4.1.2.1 "Configuration A" which provides for ATCT activation of the generator(s) during low visibility conditions. Provide for a one second power transfer from generator to utility if the generator should fail during low visibility operations. The generator shall be sized to power the entire airfield lighting vault with all existing connected loads. Refer to AC 150/5340-30J, section 9.12 for engine generator performance requirements.

q. Airfield Signage:

The signage guidance system provides the ability to easily determine the designation or name of the taxiway in which the aircraft is located, identify routes, indicate mandatory holding positions and identify boundaries. Signs are placed strategically to deter confusion among aircraft and to lessen the probability of accidents. General signage conventions, signage size and signage location requirements shall comply with FAA Circular AC 150/5340-18H D (or latest revision).

r. Monitoring Systems:

CCRs and all other controlled equipment must be equipped with or modified to accept Distributed Control and Monitoring Units (DCMU) that will be totally compatible with the existing Siemens Control and Monitoring System (ALCMS). Each field circuit or sub-circuit shall be equipped with individual circuit megging (IRMS) equipment and DCMU compatible with the existing ALCMS. Refer to FAA Circular AC 150/5340-30J, Chapter 13 and Appendix F (or latest revision). Compliance to AC 150/5345-53D (or latest revision) is also applicable.

s. Security:

The vault must be furnished with security entry control and CCTV monitoring capability. DSP shall coordinate with HJAIA - AIS and Security departments for any design modifications.

t. Miscellaneous Utilities:

The Vault must be furnished with potable water, sewer, and a minimum of 4 telephone lines. The DSP shall coordinate with HJAIA -AIS department for any modification requirements.

## 5.0 Lighting Systems Design

### A. Interior Lighting Systems Design

1. Design Philosophy: Provide adequate, comfortable, and reliable indoor illumination levels appropriate for the tasks to be performed by using the most common unit of measure for quantifying light levels as follows:
  - a. DOA's design lighting levels measured in footcandles (fc) shall conform to the latest recommended average maintained footcandle levels established by the Illuminating Engineering Society (IES) Lighting Handbook published standards (latest revision) unless otherwise indicated.
2. Minimum to Maximum (brightness) ratio: The lighting minimum to maximum ratio, or uniformity ratio, is the ratio of the maximum illumination level to the minimum illumination level in a space. The uniformity ratio is a measure of how evenly the lighting is distributed throughout a space as perceived by our customers at HJAIA and DOA facilities.
  - a. Lighting designs shall be modified accordingly when dark spots (low uniformity ratios which are NOT allowed by DOA) are identified with a photometric analysis.
  - b. On occasion the electrical DOA Assistant Director (or designee) may request placement of additional lighting fixtures due to airport knowledge which is not readily accessible to the DSP. DOA recognizes that additional lighting fixtures may contribute to footcandle levels exceeding the IES recommendations, however, compliance is required unless an alternative lighting design solution is proposed to meet DOA concerns. If there are compelling circumstances which prevent meeting the requirements a consultation with the DOA electrical Assistant Director Electrical (or designee) is required. The DSP shall demonstrate that the alternate solution is adequate with a new photometric calculation design.
3. All interior lighting shall be Light Emitting Diode (LED) luminaires to save energy, reduce maintenance cost and to align with LEED certification requirements.
4. Lamp Color: Different color temperatures create different lighting effects and ambiance. Coordination with the DOA Architect shall take place during design to determine the ideal recommended lamp color temperature for the various interior spaces.
5. Small Rooms: If the lighted area contains small rooms enclosed by fixed partitions and/or is occupied by fixed structures or equipment, follow a nonsymmetrical pattern according to the IES Lighting Handbook, using the recommended practice for office lighting.
6. Large Bay Area: If the lighted area is a large bay and a suggested layout is not present in

the Electrical Design Criteria, use a modular system so a bay or sectional area can be cut into equal sections without disturbing the fixture pattern.

7. Use natural or day lighting as much as possible, both for energy management and for architectural aesthetics.
8. Provide photo sensitive lighting controls to extinguish selected fixtures or lamps in response to daylight contributions to space.
9. Utilize task lighting in workstations and consider day lighting from windows and skylights when determining lighting levels for the space.
10. Employ energy management tools such as occupancy sensors, time of day controls or other appropriate means. Energy management should be considered for all spaces. When a Lighting Control Management system is designed with zones, relays and other miscellaneous components provide a detail legend to describe the unique lighting circuit naming methodology and a lighting control wiring diagram for complex systems when required.
11. Lighting fixture maintenance and repair is an important design consideration and can supersede architectural considerations when life cycle cost is considered.
12. Do not locate light fixtures where they cannot be safely reached by ladders.
13. Coordinate fixture locations with other disciplines to ensure that equipment or other work will not occupy space below the fixture mounting planes.
14. Coordinate with other disciplines in the reflected ceiling plans to avoid equipment interference.
15. Air handling type light fixtures listed for installation in plenum (environmental air) space may be utilized in coordination with the mechanical design.
16. Proactively determine the programmatic use of the space, and do not locate fixtures where later installation of programmatic equipment will block fixture access. If this cannot be avoided or fully anticipated during the design phase, provide alternative access such as catwalks.
17. In areas subject to vibration (for example, equipment rooms and rooms near large motors), evaluate the need for a suitable adhesive for all nuts and screwed fittings involved in the fixture mounting. Proper seismic bracing shall be supplied for all fixture types.
18. In general battery packs for emergency egress lighting are not allowed. Where generator power is available, unswitched fixtures shall be utilized for emergency lighting and may

also be designated as 'night lights. Keyed switches are not allowed. The requirements of the NFPA Life Safety Code states "Emergency generators used to provide power to emergency lighting systems shall be installed, tested, and maintained in accordance with NFPA 110, Emergency and Standby Power Systems". Compliance is required.

19. Where generator power is unavailable, provide a UPS for emergency egress lighting.
20. Provide interior photometric lighting calculations (normal and emergency) as described in the "Design Calculation" section of this Design Standard -Electrical.

#### **B. Exterior Parking Lot Lighting System Designs to include Electric Vehicle Areas**

1. In general, all exterior building wall and pole mounted light fixtures shall be switched by photocell with an override switch accessible to qualified maintenance personnel.
2. Emergency Generators, automatic transfer switches and all required components necessary for a complete and operational emergency lighting system shall be provided for parking decks and parking lots. See section "Engine Generator" for details.
3. Parking lot lighting shall be LED luminaires which can efficiently direct light to where it is needed on the parking lot surface when required.
4. Parking lot lighting shall satisfy visibility requirements while providing a sense of safety and security, comfort and aesthetic appeal. Coordination with the DOA Architects is required with the fixture selection.
5. Parking lot light pole locations shall be shown on the site plan drawings with light pole details shown on associated drawings. Details such as round vs. square vs. tapered light pole, pole height, material of pole (DOA preference is Aluminum) and light fixture mounting details shall be specified. Light pole bases shall be shown on design drawings with the DSP structural discipline providing technical pole base requirements and details.
6. Each light pole shown on a site lighting plan shall be assigned a unique pole identification number.
7. Electric vehicle (EV) charging stations: Adequate footcandle levels for Electric vehicle (EV) charging stations shall be provided as recommended by the Illuminating Engineering Society (IES) to ensure safety and visibility. Based on industry data, the recommended lighting levels for outdoor parking areas, which can be applied to EV charging stations, are: 5-10 foot-candles for general parking areas, 10-20 foot-candles for areas with higher activity or where enhanced security is needed. Footcandle levels shall also consider any Americans with Disabilities Act (ADA) requirements.

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8. Exterior Lamp Color: Different color temperatures create different lighting effects. Based on published industry data, DOA determined that the ideal recommended color temperature for parking lots, parking deck, and exterior lighting is 4,000 Kelvins (K) which is a natural white color with a low color rendering index (CRI) and good for visibility. Confirmation with the DOA Architect during the exterior lighting system designs is required.
9. Provide the following illumination levels in areas shown below, measured at grade with all fixtures at full brightness, zero sky contribution, 15% variance permissible:

Design Footcandle Levels (fc):

- a. 10 fc at building entrances, with 5 fc for night emergency egress.
- b. 5 fc at gates and perimeter fences where security assessment is an issue; maintain 3:1 ratio between maxima and minima.
- c. 10 fc in parking lots, maintain 3:1 ratio, with 5 fc for emergency lighting.
- d. 2 fc along illuminated HJAIA roadways. Coordination with other stakeholders may be required for non HJAIA roadways.
- e. The illuminance for Roadway Tunnel lighting shall IAW the IES requirements. However, coordination with other stakeholders may be required for non HJAIA roadway tunnels.
- f. 5 fc at major street intersections.
- g. Dark spots are NOT allowed. Modify lighting designs accordingly to ensure compliance.
- h. Provide exterior photometric lighting calculations (normal and emergency) as described in the "Design Calculations" section of this Design Standard.

**C. Parking Deck Lighting System Design**

1. Parking deck lighting shall satisfy visibility requirements while providing a sense of safety and security, comfort and aesthetic appeal. Coordination with the DOA Architects is required with the fixture selection.
2. Parking deck light levels shall conform to the latest recommended average maintained footcandle levels established by the Illuminating Engineering Society (IES) Lighting Handbook published standards.
  - a. Dark spots are NOT allowed. Lighting designs shall be modified accordingly to ensure compliance.

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- b. Adequate lighting levels shall be provided for parking deck's basic areas, ramps (Day/Night), entrance (Day/Night), stairwells, and roofs.
3. Designs shall consider all factors to ensure the drivers and pedestrians' safety while providing consideration of columns and other obstacles.
4. All parking deck lighting shall be LED luminaires to save energy, reduce maintenance costs and to align with LEED certification requirements.
5. Light fixture selections shall consider installation, maintenance, energy consumption, efficacy and lifespan.
6. See section 5.B.7 for Electric vehicle (EV) charging stations and 5.B.8 for exterior lamp color requirements.
7. Do not locate light fixtures where they cannot be safely reached by ladders for maintenance.
8. Provide parking deck photometric lighting calculations (normal and emergency) as described in the "Design Calculation" section of this Design Standard. Also provide photometrics lighting calculations specifically for the Electric vehicle (EV) charging station areas to include considerations to meet any ADA requirements.

**D. Airfield Lighting Systems (150/5340-30J or latest revision)**

1. Specific Details: The following sections include details specific to the HJAIA, Airfield Lighting Systems designs. AC 150/5340-30J (or latest revision) shall govern all airfield related designs and shall take precedent over this electrical design standard unless otherwise noted or if any conflicts are identified. Other sections of this Electrical Design Standard are applicable to the airfield designs so the DSP shall perform a review to determine applicability and a field walkdown shall take place to determine all existing systems.
2. Edge Lights: Edge lights are employed to outline usable operational areas of the airport during periods of darkness and low visibility weather conditions. The FAA approves airports for certain types of aircraft traffic. Based on an airport's approved FAA rating, AC 150/5340-30J (or latest revision) is used to determine whether lights shall have low, medium or high intensity light levels. Hartsfield-Jackson Atlanta International Airport (HJAIA) uses high intensity elevated L-862T runway edge lights with L-850C semi-flush lights in paved exits and LED L-852T semi-flush taxiway edge lights. See AC 150/5340-30J (or latest revision), Chapter 2 for specific light spacing based on the pavement geometry and to confirm the latest lighting types. This includes required spacing on curved taxiway sections and taxiway radii.

### 3. Runway and Taxiway Centerline and Touchdown Lighting Systems

- a. General: Runway centerline and touchdown zone lighting systems are designed to facilitate landings, rollouts, and takeoffs. The touchdown zone lights are primarily a landing aid while the centerline lights are used for both landing and takeoff operations. See AC 150/5340-30J, Chapter 3 for specific information regarding runway centerline, touchdown zone lights and spacing criteria.
- b. Runway Centerline lights: The line of lights is offset at a maximum of 2'-6" to either the right or left side of the runway centerline and should be to the opposite side of the centerline marking from the major taxiway turnoffs. Centerline lights must be installed with a 1" maximum deviation from perfect alignment and with a + 0" – 1/16" maximum deviation from finished pavement grade. HJAIA utilizes a 2'-6" spacing from the joint line to the center of the light fixture or light base. See AC 150/5340-30J for Runway Centerline light details.
- c. Taxiway Centerline lights are installed on taxiways at H-JAIA. Taxiway centerlines lead off lights for runway exit taxiways emit alternating green and yellow lights to the first light past the runway holding position. In general, lead-off lights on high-speed exits are unidirectional. All taxiway centerline lights shall be equipped with LED lamps. See AC 150/5340-30J, Chapter 3, to obtain specific spacing criteria.
- d. touchdown zone lights are used to show where aircraft wheels should touch ground to ensure a safe landing. They emit a white light. The lights consist of 2 rows of transverse light bars located symmetrically about the runway centerline. Each light bar consists of 3 unidirectional lights facing the landing threshold. The rows of light bars extend to 3,000 ft. or half the runway length for runways less than 6,000 ft. from the threshold, with the first light bars located 100 ft. from the threshold. See AC 150/5340-30J Chapter 3 for more specific information regarding runway touchdown zone lights.

### 4. Miscellaneous Lighting Visual Aids

- a. Beacons serve as indicators to locate lighted airports. The type of beacon used is dependent upon its function. They can be used at airports that have a high or medium intensity lighting system or when it is necessary to warn airmen of an obstruction which presents a hazard to air commerce during periods of darkness or limited visibility. See AC 150/5340-30J, Chapter 6 for guidelines to determine which beacon would best serve HJAIA and the mounting method for the beacons.

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**5. Airfield Lighting Control System:**

The existing airfield lighting control system at H-JAIA is/was a Siemens Airfield Solutions system, however, confirmation is required to determine if system is currently installed. All future controlled equipment, either in the lighting vault or individual fixture control and monitoring devices must be designed with equipment that is compatible with this system, or the current system installed. The system uses a Distributed Control and Monitor Unit connected to each piece of controlled equipment and an integrated circuit megging unit for each circuit. All individual fixture control and monitoring equipment must be designed using power line carrier equipment that is compatible with the Siemens ALCMS. See AC 150/5340-30J, Chapter 13, Appendix F and other sections for details.

**6.0 Power Receptacle System Design****A. Definition**

The term outlet refers to the actual box where receptacles are present, receptacles are opening in the box which you plug your device into.

**B. Location / Minimum Requirements**

Locate receptacle symbols on power plan layout drawings. The minimum requirements for the receptacle system design shall include the following:

1. In general, flush mount receptacles shall be installed in all areas.
2. Surface mounted receptacles are allowed in spaces such as warehouses, equipment chases and electrical/mechanical rooms.
3. Provide dedicated receptacles for janitorial equipment in hallways and aisles maximum 50 feet apart; mount at 36 inches above the finished floor, and segregate from other receptacles.
4. Mounting heights for general duplex receptacles shall be mounted at 48" AFF unless noted otherwise.
5. Provide general-purpose receptacles in electrical and mechanical rooms; receptacles shall be Ground Fault Circuit Interrupter (GFCI) type. See reference 2.A.1.g, section 210.63 (B) for additional receptacle location requirements.
6. Only where specified on design drawings provide duplex receptacle, 20 AMP, 120V with USB-A and USB-C charging ports.

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7. Avoid back-to-back receptacle installations.
8. Branch circuit design for general use power outlets shall be limited to no more than six receptacles per circuit.
9. Provide general-purpose receptacles adjacent to each exterior door; receptacles shall be weatherproof and GFCI type.
10. Provide rooftop maintenance outlets per NEC, outlets shall be weatherproof and GFCI protected.
11. Do not wire GFCI's and non GFCI's in the same circuit.

**C. Electric Vehicle Supply Equipment (EVSE) Charging Stations**

1. A charging station, also known as a charge point, or EVSE, is a power supply device that supplies electrical power for recharging plug-in electric vehicles. When specified, typical units require a dedicated 40-Amp circuit to comply with the NEC requirements in Article NEC 625. A design-based vendor is required to determine the actual electrical requirements.
2. EVSE charging stations shall be installed at Parking Decks, Parking lots, and at various DOA facilities located throughout HJAIA when specified under the DOA project scope document.
3. Level 2 chargers shall be specified when required.
4. If multiple electric vehicle supply equipment (EVSE) units are connected to the same circuit, an EV charging load management systems shall be specified which allows the control of how much electricity each charging station can use.
5. The DSP shall review the City of Atlanta, ordinance 25-O-1011 for the comprehensive Electric Vehicle Charging Readiness Policy requirements to determine applicability.

**7.0 Low Voltage Power Systems Design (<600 volts)****A. General Power Requirements:** Applicable to low voltage power system electrical components (systems less than 600 volts).

1. Single Line Diagram Drawing details
  - a. Single line drawings shall be provided for all HJAIA CPTC, DOA facilities, Capital, Concessions and Tenant projects. A riser diagram can be submitted to illustrate

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designs; however, riser diagrams shall not be substituted for single lines diagrams. Riser diagrams AND single line diagrams shall be provided for multiple story buildings.

- b. Electrical data such as voltage, amperage, phase, cable, conduits and breaker sizes, AIC ratings, metering (see section "Electric Power Monitoring System" (EPMS)), interconnection to utilities, downstream devices and ALL other pertinent electrical details to make a complete electrical distribution system shall be illustrated on the single line diagrams.
- c. Single line diagrams shall be provided for each switchgear, switchboard, distribution panelboard and motor control center with partial single line diagrams provided for each switchboard showing downstream panelboards
- d. Single Line diagram drawing(s) representing the entire electrical distribution system infrastructure or sections of the affected electrical system shall be developed for each project scope of a HJAIA CPTC, DOA Capital, Concessions and Tenant project. Details can be added to existing As-Built single-line diagram drawings as required.
- e. Symbols used on single line diagram drawings shall be consistent with DOA CADD and ANSI standards.
- f. Single line drawing detail illustrations shall start at the top of drawing with the highest voltage levels at the utility transformer and generator with the incoming source of the power at the building transformers(s). Then show all pertinent electrical equipment downstream to the panel board level including cables. Details such as switchboard/switchgear, transformers, panel boards, motor control centers, generators, automatic transfer switches, uninterruptible power supplies, inverter systems, motors, starters, main disconnect switches, etc. shall be included to show a complete system.
- g. Transformers: note the kVA size, primary and secondary voltages, available fault current (at the transformer terminals) and phasing (building service entrance only).
- h. Switchgears, Switchboards, and Distribution Panelboard equipment shall be shown in the "expanded" form. Drawings shall detail main breaker, tie breaker, feeder breakers, spare breakers, CT's, PTs, and meter(s). Annotate switchboard rated amperage, voltage, short circuit capability to include frame and trip sizes of all breakers in the gear and distribution panelboard.
- i. Starters: show starter/breaker/fuse and NEMA ratings for all starters.

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- j. Generators and Transfer switches when required: details shall include generators, automatic transfer switches and their respective single line diagrams. Note the service entrance, feeder wire and conduit sizes.
  - k. Provide short circuit information for Kilo Ampere Interrupting Capacity (KAIC) on single lines for all buses.
  - l. Circuit Breakers or fuses rated 1200 Amps or more must have a documented means of Arc Energy Reduction in accordance with NEC Section 240.67 and 240.87.
2. Electric Power Monitoring System (EPMS)
- a. The DOA utilizes an Electrical Power Monitoring System (EPMS) consisting of power digital smart meters, data connections, converters, gateways, hubs, cables, software and programming, interactive graphic displays, circuit breakers, receptacles and other accessories as required by the manufacturer to make a complete/operational system.
  - b. The DSP shall include an EPMS scope of work to include EPMS single line diagram or riser diagram drawing (s) with notes, interactive graphic screen updates (with new or revised floor plans showing EPMS meter locations and graphic screen single line diagrams), software and programming details for the EPMS metering equipment to integrate and communicate with the existing EPMS system. The installation of software along with programming of the EPMS monitoring equipment and interactive graphic screens (new or updates) shall be provided by the AATC's preferred contractor and in conjunction with the EPMS contract service provider. The EPMS component naming methodology shall be consistent throughout the HJAIA CPTC and match construction documents.
  - c. When metering for switchgear, switchboards, motor control centers, distribution panelboards and panelboards is specified, provide instruction indicating that meter(s) shall be integral to the equipment, supplied and installed by the original equipment manufacturer at the factory.
  - d. Digital smart meters shall be provided to monitor the mains of switchgear, switchboards, motor control centers, distribution panelboards and panelboards. The digital smart meters shall be capable of aggregation to provide building-level usage representing total building energy consumption.
  - e. Load Separation: The DSP shall include the separation of electrical circuits for electrical monitoring in their power system design. The system(s) shall be designed so that measurement devices can monitor the electrical energy usage of the following load types: lighting (interior and exterior), HVAC, boarding bridges, and receptacle

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loads. All load types shall be separately metered as required by ASHRAE 90.1-2013/2016 and LEED requirements.

- f. Separate metering: For new construction, lighting, HVAC (heating, cooling), boarding bridges, elevators, and escalators shall be metered separately which may require additional panelboards. The DOA electrical Assistant Director shall be notified as early as practical if additional panelboards are required.
- g. Concessions/Tenants: Concessions must draw power through a digital smart energy meter. Each distribution section of new concession switchboards shall be equipped with (10) sub-meters for individual concessions feeder breaker monitoring. Sub-meters shall be factory pre-wired to main meter. Coordinate with AATC for concession revenue meter requirements (EPMS metering not required for internal concession spaces). *Tenant* space power consumption is covered under separate lease agreements with AATC.
- h. Cyber Security: The vendor of the EPMS software shall have a cybersecurity evaluation program which is certified under UL 2900. Verification shall be provided by the DSP under the shop drawing review process.
- i. Specifications - for small projects EPMS specification requirements can be included on the EPMS drawings.
- j. Specifications - for large projects a Division 260913, Specification section titled "Electrical Power Monitoring System (EPMS)" shall be included as a standalone electrical specification section deliverable.
- k. Digital Smart Meter Levels - Provide embedded main digital smart metering with display on new switchgear, switchboards, motor control centers and panelboards as follows: (Feeder metering is not required)
  - i. Highest Level: Switchgear main metering shall be the highest-level product of the manufacturer.
  - ii. Midrange Level: Switchboards meters shall be of the next highest-level product type of the manufacturer.
  - iii. Lowest Level: Panelboard meter shall be of the basic lowest level product type required for wattage, voltage and current.
- l. Data Storage: meters shall be able to store data for a minimum of 1 year and shall be capable of sending data to a server for use in a power monitoring software application.

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3. Low Voltage Switchgear (SG)/Switchboards (SB)
  - a. All new SGs and SBs shall be purchased with new Digital Smart Meters as described in section titled "Electric Power Monitoring System (EPMS)".
  - b. All new and existing SGs and SBs shall be located on power plan drawings.
  - c. Detail feeder and branch circuit wiring sizes shall be shown on single -line diagram.
  - d. For all SG and SB provide load information, voltage, phase, Kilo Ampere Interrupting Capacity (KAIC) ratings, mains ratings, load summary, demand load summary, circuit breaker sizes, spare sizes and space information in panel schedules.
  - e. Provide elevation front view drawings for each SG and SB showing all circuit breaker locations in each section with compartment / cubicle assigned with a unique identification number.
  - f. Provide any additional details on constructions drawings as necessary to make a complete and operational system.
  - g. Locate SGs and SBs indoors where possible, avoid outdoor locations.
  - h. Locate SGs and SBs in dedicated electrical rooms accessible only to qualified personnel.
  - i. For service entrance equipment, provide rear access when possible.
  - j. SG's/SB's shall be equipped with:
    - i. Copper main bus; 100 percent capacity full length.
    - ii. Copper neutral bus, if required; 100 percent capacity full length.
    - iii. Copper ground bus; full length.
  - k. Main and feeder circuit breakers shall be arranged for compression connectors.
  - l. All circuit breakers for SGs/SBs shall be constructed according to NEMA standards and shall have provisions for lockout/tag out.
  - m. All circuit breakers shall include electronic interchangeable trip with adjustable LTPU, LTD, STPU, STD and INST functions. When required, provide integral GFPU and GFD functions.
  - n. The design for SGs/SBs shall include:
    - i. a minimum of 20 percent spare capacity with the connected load not exceeding 80% of main circuit breaker rating.

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- ii. at a minimum 1-spare circuit breaker of each frame size (excluding main) used.
  - iii. future bus extensions and dedicated space for at least one future section.
  - o. Provide integral TVSS to meet requirements of NFPA 780, when required.
  - p. Where draw out circuit breakers are specified, provide manufacturer's overhead lifting device suitable for all circuit breaker sizes and locations.
  - q. Provide manufacturer's test kit for all circuit breaker types and functions used.
  - r. All circuit breakers larger than 200 amps shall be tested.
  - s. Main circuit breakers are to be sized according to the appropriate NEC section for any location. If a larger breaker is installed, then the appropriate trip plug must be installed. It is not permitted for the trip settings to be dialed down to meet the intent of this article.
  - t. Provide main lugs only when the switchboard is in the same room with their feeder breaker, otherwise, provide main circuit breaker.
  - u. Switchboards shall be provided with a main circuit breaker.
  - v. Switchboard and Distribution Panelboard (DP) requirements for Concession and *Tenant* spaces are as follows:
    - i. The power feed for the Concession spaces must originate at a switchboard dedicated to concessions. If there is no space or spare available in the Concession switchboards DOA shall be consulted so that a suitable alternative switchboard can be designated by the DOA.
    - ii. For large Concession spaces where the main disconnect size is 400 amps or above ground fault protection may be required at the discretion of the DOA.
    - iii. Verification of the actual load on the existing switchboard is the responsibility of Concession's DSP. Current load readings of the switchboard are required so that new loads can be added to the switchboard safely. See section titled "Circuit Load and Metering" and "Load Calculations".
    - iv. Power for the *Tenant* spaces shall originate at a CPTC house SB or DP with spare capacity to add load and not be dedicated to Concession spaces.
4. Motor Control Centers (MC)
- a. MCs shall be purchased with new Digital Smart Meters as described in section titled "Electric Metering and Power Monitoring System (EPMS)"

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- b. MCs which consist of multiple enclosed sections with motor starters, fuses or circuit breakers and power disconnects shall be shown on the power plan layout drawings.
- c. MC details shown on one-line diagram shall include all loads, circuit numbering and spaces. KAIC ratings of all components shall be shown to match the electrical system.
- d. Provide elevation (front views) showing all starter locations and circuit (compartment) number in a logical industry sequence.
- e. Provide additional details such as schedules or other information on drawings as necessary for construction.
- f. Locate indoors where possible; avoid outdoor locations.
- g. Locate MCs in dedicated electrical rooms accessible only to qualified personnel.
- h. Use front accessible where possible.
- i. Use copper main bus; 100 percent full length capacity, minimum 600A.
- j. Use copper neutral bus, if required; 100 percent capacity full length.
- k. Use copper ground bus, full length.
- l. Wire MCs for NEMA Class I, Type B.
- m. Circuit protectors, contactors, overload blocks and all accessories shall be NEMA construction.
- n. Motor starters shall include overload reset button, red and green, LED type pilot lights- red for "run" mode and green for "stop".
- o. Provide (HAND-OFF-AUTO (HOA) in cover; minimum 2-normally open (N/O) and 2-normally closed (N/C) auxiliary contacts and individual control power transformer (CPT) if above 150V to ground. Provide fuses for transformers over current protection.
- p. CPT, if required, shall be sized for 100 VA spare capacity and include 2 primary and 1-secondary fuses for 120V control.
- q. Do not mount panelboards or associated transformers in MCs. In addition, transformers must not be installed above the ceilings.
- r. Do not mount variable frequency drives (VFD) in MCs; VFD's shall be individually mounted at controlled motor.
- s. Provide future bus extensions and dedicated space for at least one future vertical section.

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- t. Provide minimum 20 percent spare capacity.
- u. Provide 10 percent spare cubicles for each size provided.

## 5. Panelboards

- a. All new Panelboards shall be purchased with new Digital Smart Meters as described in section titled "Electric Power Monitoring System (EPMS)".
- b. Locate new and existing panelboards identified for a project on power layout and or enlarged layout floor plan drawings.
- c. Provide completed panelboard schedules on drawings. Schedules shall show voltages to match voltages on single line diagram. Each circuit on the panel schedule shall be described to reflect the function and location of each load (for example, lighting room xx apron level). Each circuit shall show a connected and demand or estimated load in KVA whether the circuit is new or existing.
- d. Locate indoors where possible, avoid rooftop locations.
- e. Locate in dedicated electrical rooms and where possible avoid user or passengers' spaces. Column type panelboard is not allowed unless approved by DOA electrical Assistant Director or designee.
- f. Flush-mounted in areas such as user hallways and office spaces. When flush-mounted, provide spare conduits, skirting or other provisions to facilitate future modifications.
- g. Surface-mount in all other areas including user storage, warehouses, equipment chases and electrical or mechanical rooms.
- h. Avoid sub feed or dual-feed lugs. Connecting more than one wire on or under a single lug or connection point in the industry is referred to as double lugging. This is only allowed if that terminal, lug or connection is specifically rated for more than one wire per NEC 110.14.
- i. All buses for panelboards shall be copper.
- j. Avoid individually mounted sub feed circuit breakers.
- k. Main circuit breakers are to be sized according to the appropriate NEC section for any location. If a larger breaker is installed, then the appropriate trip plug must be installed as well. It is not permitted for the trip settings to be dialed down to meet the intent of this Section.
- l. Provide Transient Voltage Surge Suppression (TVSS) for all panel boards serving

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electronic loads.

- m. Provide 200% panelboard feeder neutrals and 200% neutral bus when required per harmonic analysis and for all electronic loads to include IT equipment. The 200% panelboard feeder neutrals shall be located on the appropriate feeder schedule.
  - n. Provide main lugs only when the panelboard is located in the same room with their feeder breaker otherwise, provide main circuit breaker.
  - o. Connected loads shall not exceed 80% of main circuit breaker rating.
  - p. Series rated circuit breakers are not acceptable.
  - q. Panelboards shall be provided with a main circuit breaker designated with the required KAIC ratings to match the electrical system.
6. Low Voltage Dry Type Transformers (TR)
- a. Low voltage dry type TRs shall be shown on the power plan layout drawings.
  - b. Project design specifications shall include requirements for the transformers to factory assembled, metal enclosed and provided complete with mounting brackets (as required) to make a complete operational system.
  - c. Provide elevation and/or mounting details as required for construction.
  - d. Energy efficient type: Shall meet NEMA TP-1.
  - e. Taps: Voltages shall be compatible with the application. Taps shall be provided two at plus 2-1/2 percent increments and two minus 2-1/2 percent increments from rated voltage
  - f. Windings: TRs shall be provided with copper windings; aluminum is not acceptable.
  - g. Rating: The sizing of step down or step up dry type TRs shall take into consideration the current or expected normal and harmonic loading. The decision to use "K" transformers will be based on harmonic analyses of the connected and forecast load and be in compliance with IEEE- 110 and defined by UL as K-factor.
  - h. Mounting: TRs shall be mounted where accessible. No units may be mounted behind partitions, above ceilings, etc. If transformer is floor mounted see section 4, titled "Floor Mounted Equipment" for details. See section C.7.c for additional transformant mounting details.
  - i. Dry type TRs shall be U.L. listed and certified to meet NEMA Standards.
  - j. Grounding and bonding for TRs shall be per NEC requirements.

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## 7. Motors

- a. Motors shall be shown on the power plan layout drawings.
- b. Motors that are controlled by across the line motor starters (contactor, motor circuit protector and overload relay) and are 25 HP or larger shall include power factor correction capacitors at the motor starter to achieve 95 percent power factor.
- c. VFD controlled motors are excluded from the power factor correction requirement. Utilize VFD's with minimal harmonic distortion.
- d. To ensure a minimum standard of quality, identify devices, fittings, fixtures, and equipment on equipment list drawings with their electrical sizes, ratings, manufacture and catalog number. This is not necessary for items such as panel boards where complete specifications are written.
- e. Identify motor starters with sizes on the motor control schedule.
- f. Identify all equipment by using standard symbols and equipment schedules. In addition to the items already mentioned, the schedule should include information to help the contractor obtain the equipment and materials intended by the design.
- g. Specify nameplates on all control items used on the job. Specify each nameplate either on the motor schedule or on the equipment list. Each nameplate identifies the system and the function of that device to the system.
- h. Motors shall comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements.
- i. Code Letter Designation: Motors 15 HP and larger: NEMA starting Code F or Code G, Motors Smaller than 15 HP: Manufacturer's standard starting characteristic. See project specifications for specific common motor requirements.
- j. When required, provide motor thermal overload (TOL) relays IAW NEC requirements which serves as a crucial protective device in electrical systems used primarily to safeguard motors from overheating.

## 8. Variable Frequency Drives (VFD)

- a. VFD's shall be shown on the power plan layout drawings, indoors where possible; avoid outdoor locations. Locations shall match the mechanical drawings therefore coordination is required.
- b. Typically, VFD's will only be installed when requested by the Mechanical Engineer.

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Coordination with the mechanical project specifications is required for requirements.

- c. Contrary to previous requirements, a manual bypass circuit is not typically required on a VFD. A bypass circuit should only be specified after discussing the requirements with the Mechanical Engineer.
- d. Do not install VFD's closer than five feet to an FID cabinet.
- e. VFD's should be located as near as practical to the motor it controls.
- f. The VFD should never be located more than 50 feet from the controlled motor.
- g. A disconnect switch with an auxiliary contactor shall be provided near the motor.

## 9. Busway Systems

- a. Type: The DOA preferred Busway shall be the "**Integral**" ground busway system where all or part of the housing are designed-built-in (not an add on) for grounding.
- b. Busway shall be copper with 100% neutral bus minimum. Other electrical characteristics such as voltage and phase, shall be specified on single line drawings.
- c. The Busway shall be totally enclosed in a non-ventilated aluminum housing and single-bolt joints.
- d. Use IP54 or greater for indoor installations and NEMA 3R for outdoor installations. Busway shall also comply with UL 857.
- e. The Busway shall be protected against overcurrent in accordance with the allowable current rating of the busway.
- f. Where busway is used as a feeder, the voltage drop should not exceed 3 percent.
- g. All busways shall be grounded as described in section titled "Building Grounding System Designs"
- h. Provide expansion fittings for all busways at building expansion joints.
- i. The entire busway run shall be shown on power plan layout drawings. Busway shall also be shown and designated on the single line diagrams
- j. Where busway penetrates walls and floors, seal all penetrations with the appropriate fire stopping material to maintain fire rating of walls and floors.
- k. Existing legacy Busway at the CPTC is "Siemens". If existing sections of busway are to be replaced, the replacement should be "Siemens", like-for-like. If a different manufacturer is selected due to busway being obsolete a busway "TAP" box may be required which is not the preferred method for DOA,

## B. Lightning Protection System Designs

1. The Lightning protection systems shall conform to UL 96A and NFPA 780 requirements.
2. A Master Label Lightning Protection system (UL certified) is required for all new roof and/or modified roof renovations/extensions associated with DOA facilities located at HJAIA. In addition, all new and existing Lightning Protection Systems shall have a Master Label UL Certification and or a UL "Letter of Findings". The scope of work associated with the "Letter of Findings" requires DOA electrical approval.
3. The DSP shall place notes on contract drawings and specifications stating that a new Master Label UL Certification is required for any new roof structures.
4. A Master Label UL re-Certification or a "Letter of Findings" is required when any new lightning protection components are tied to an existing lightning protection system or when the existing lightning protection system is modified.
5. A UL Master Label and or a "Letter of Findings" is also required for structures with expired Master Label UL Certification or with structures having an undetermined certification.
6. The DSP shall submit a Master Label UL Certification or a UL "Letter of Findings" as a project deliverable.
7. The DSP shall show a lightning protection system with details on Lightning Protection and Counterpoise Composite Plan drawings. Details such as loop conductor, air terminals, down conductors, bonding, penetration sleeves and all other components required to make a complete and operational Lightning Protection System shall be identified.
8. The Lightning protection drawings shall be sealed and signed by a P.E. (Electrical) registered in Georgia and submitted to the DOA for review.
9. The lightning protection system shall be connected to the building counterpoise system.
10. The DSP shall develop a performance specification for a certified Lightning Protection system which complements the submitted lightning protection drawings.

### C. Building Grounding System Designs

1. The Grounding system shall conform to IEEE 142-2007 "Grounding of Industrial and Commercial Power Systems", National Fire Protection Association (NFPA) and NEC Article 250 for all grounding requirements. IEEE 142, section 4.1.3 states "Resistances in the 1 ohm to 5-ohm range are required". DOA requires that the resistance to ground for individual equipment and systems shall not exceed 5 ohms. See AIS Infrastructure Standards (latest edition) for specific and independent telecommunication grounding and bonding system requirements).
2. The Grounding system shall be designed and illustrated on a stand-alone grounding layout plan drawing.
3. Associated grounding details shall be placed on electrical drawings.
4. A grounding one-line or /riser diagram shall be developed for each project.
5. Grounding drawing shall show interconnection of the following:
  - a. All metal systems of the building such as:
    - i. Interior and exterior water system.
    - ii. Metal ductwork.
    - iii. Building steel and HVAC roof top units (if applicable).
    - iv. Lightning protection system.
    - v. Made electrodes, etc.
    - vi. Building foundation rebar.
    - vii. Metal roof drains.
    - viii. Antennas and Apron light poles.
  - b. All busways shall be grounded in accordance with the NEC. See section titled "Busway Systems" for additional details.
  - c. Drawings shall indicate where bonding is required in the electrical system (that is, neutral or ground bushing on transformers).
  - d. Drawings shall indicate where any new electrode system (s) connects into the rest of the grounding system when applicable.
  - e. Drawings shall identify any special requirements for the building grounding system specifically for static or signal grounds.
  - f. The size of all required grounding conductors (grounding electrode conductor,

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equipment grounding conductors, main bounding jumpers, etc.).

6. The design shall consider the NEC as a minimum requirement and other factors need to be considered when designing the system, signal grounds, and lengths of grounding conductors to ground.
7. All ground connections to ground rods, buses, panels, etc., shall be made with pressure type solderless lugs and ground clamps.
8. Soldered or bolt and washer type connections are not acceptable, exothermic welds are the DOA's preferred method of connection to a ground rod.
9. The grounding design must also be based on a soil's resistivity test and ground resistivity calculations. Below grade connections should be exothermically welded.
10. A wall mounted copper ground bar shall be provided in each electrical room housing medium voltage switchgear or substations. It should be interconnected with the ground electrode and ground bus in the switchgear or switchboard
11. Tests: After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements. Measure ground resistance no fewer than two full days after the last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance. Perform tests by fall-of-potential method according to IEEE 81.
12. If resistance to ground exceeds acceptance criteria of IEEE, the Grounding system will be considered defective and corrective actions shall be performed to reduce the ground resistance and bringing into compliance. The electrical DOA Assistant Director (or designee) shall be notified of any deficiencies; however, the grounding system will not be accepted until the 5 ohms acceptance criteria is met.

## 8.0 Design Calculations

### A. Calculation requirements

1. All electrical calculations to include any recommendations shall be sealed and signed by a P.E. (Electrical) registered in Georgia. The original stamped signed copy of the calculations shall be provided to DOA as part of the design submittal.
2. Present all electrical calculations using the guidelines provided in this section. Provide two 8-1/2- by 11-inch, 3-hole-bound reports that contain all electrical calculations, time coordination curves, and protective device settings.
3. Provide one-line diagrams (hard copy) and electronic files with all calculations. At the end of the project, update both reports and electronic files in the same manner as other As-Built drawings.
4. The DSP shall submit calculations to DOA using PMWeb which is a web-based Project Management software tool IAW, P&D Policies and Procedure 02-001 "Document Control".
5. The SKM System Analysis software tool (latest version) identified in this section, shall be used for all mid-to-large CPTC projects. For smaller non-CPTC projects, the DSP shall notify the DOA Assistant Director (or designee) of the analysis software tool being used and obtain approval.

### B. Short Circuit, Circuit Breaker Coordination Study

1. The DSP shall prepare a complete set of short-circuit, circuit breaker coordination study calculations. The DSP may elect to sub-contract this work but must inform DOA in writing. The DSP shall submit the sub-consultant's experience and qualifications to the DOA electrical Assistant Director (or designee) for approval and shall be responsible for any sub-contracted work to include technical and quality assurance reviews.
2. When both normal and standby primary feeders serve a facility, provide calculations for both. The calculation shall be performed utilizing the latest SKM System Analysis software tool.
3. Calculations shall consider both three-phase and single-phase to ground fault current on secondary systems. State the base MVA/kVA on the calculations.
4. Prepare protective device coordination graphs which demonstrate coordination of devices for interrupting faults. Prepare these graphs for all new or modified primary

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- and secondary systems. Coordination curves shall be prepared along with the single line diagram indicating which devices are under review.
5. Provide a flag on all coordination curves indicating the available short circuit current at each device. Curve plots from the software shall be used.
  6. The Electrical System shall be fully coordinated unless directed otherwise by the DOA Engineering Director. Coordination study shall be from the utility transformer to the main circuit breaker in the smallest panel.
  7. Indicate in the coordination sheet, short circuits (with flags), breaker type, settings and scales.
  8. Calculations shall include ATS in closed-transition mode unless directed otherwise by DOA Engineering. See Engine Generator/Transfer Switch Sizing Calculations for additional guidance.
  9. Present the manufacturer's catalog data for each protective device to show they have adequate fault current interrupting capacity for the available short circuit current
  10. The Short Circuit, Circuit Breaker Coordination calculation report shall include the following:
    - a. Summary
    - b. Assumptions (verified or unverified),
    - c. Available short-circuit current letter from utility company,
    - d. Tabulation of results of all scenarios,
    - e. Print out of all inputs from SKM System Analysis software,
    - f. Print out of all results from SKM System Analysis software,
    - g. Single Line Diagram from SKM System Analysis software, and
    - h. Single Line Diagram with available short-circuit current value on each bus.
  11. One final hardcopy report shall be provided to the DOA in a 3" binder(s) and in an electronic SKM System Analysis file format. The DSP shall submit files to DOA using PMWeb IAW, P&D Policies and Procedure 02-001 "Document Control".
  12. See AC 150/5340-30J, section 13. "Short Circuit Analysis for airport airside projects.

### C. Load Calculations

1. The DSP shall prepare and submit electrical normal load calculations early in the engineering process (schematic - design phases) to provide reasonable assurance that existing electrical equipment such as switchgear, switchboards (including main-tie-main configurations), panelboards and other equipment are adequately sized (with margin) to accommodate new load additions or if equipment concerns are preventing a code compliant design. The DSP shall analyze the Emergency Generator loads in parallel with the normal power loads.
2. The DSP shall follow steps outlined in section titled "Circuit Load calculation or Metering" for obtaining output load data used as input in the design basis load calculation(s).
3. The load calculation(s) shall provide an estimation of all newly added electrical loads along with existing for the system under review.
4. The units of electrical loads shall be kilovolt-amperes (kVA). The units of kilowatts (kW) shall be converted to kVA using a power factor (PF).
5. If an existing Panelboard illustrated on a contract drawing is used as the design basis for a load calculation the following is required:
  - a. The load calculation shall indicate load classifications (type such as lighting, heating, motor, HVAC, receptacles, miscellaneous equip, etc..), connected loads, demand factors and estimated demands.
  - b. The Panelboard "Totals" shall be identified for connected loads, estimated demands, existing connected current loads (A), estimated demand loads (A).
  - c. All verified or unverified assumptions shall be identified.
6. The electrical load calculation results shall demonstrate that the existing equipment is sufficient to meet new added load demands (Pass) or is inadequate (Fail) with recommended corrective actions. A discussion with the DOA Assistant director (or designee) is required if code compliant issues are identified and resolutions are necessary to continue.

#### **D. Emergency Generator/Transfer Switch Sizing Calculations**

1. For HJAIA CPTC: The HJAIA Resiliency Emergency Power program provided and installed emergency power generators for each individual concourse and main terminal at the CPTC which were sized to accommodate their individual concourse loads upon loss of normal power (resilient 100% back-up emergency power). When loads are added to the normal power source, the DSP shall analyze the associated generator load block (emergency generators) capacity and determine if the existing emergency generators are adequately sized to provide a resilient emergency power source. Load shedding to remain resilient is prohibited. Coordination with the DOA electrical Design Manager may be required to obtain the latest Peak demand load data from the utility.
2. When loads are added/removed the emergency generator's capacity/margin shall be revised and documented in the analysis.
3. For all HJAIA CPTC and DOA facilities, the emergency generator sizing calculations shall show the "sequence of operation" for the various loads that are served from the generator. Consideration that the voltage dip shall not exceed 35% for general loads and motors and 20% for critical and electronic loads.
4. For HJAIA DOA facilities with generators, as new loads are added to an existing generator the analysis shall illustrate the generator's ability to handle new and existing loads along with identifying the reserve capacity remaining for the generator size.
5. All loads used for this analysis shall be from a verifiable source with all verified or unverified assumptions identified and documented.
6. Automatic Transfer Switch (ATS) sizes fed from the generator shall match the generator size.
7. ATS's shall be closed transition as required by Georgia Power or unless otherwise directed by the DOA electrical engineering department. Noted exceptions: ATS's shall be open - transition for parking decks, parking lots, guard booths and escalator designs if required.

#### **E. Arc Flash Calculations**

1. Arc Flash calculations shall be in accordance with NFPA 70E and IEEE STD-1584. Provide complete electronic calculation in its original format (i.e. SKM System Analysis files).

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2. For arc flash, provide calculations for each piece of electrical equipment and provide 3 samples of the arc flash warning signs to DOA for approval.
3. Based on the calculation output, Arc-flash warning signs shall be placed on electrical equipment in locations where arc-flash hazards exist IAW requirements of OSHA and NFPA 70E.
4. One final Arc Flash hardcopy report shall be provided to the DOA in a 3" binder(s) and in an electronic SKM System Analysis file format via. the PMWeb system, IAW P&D Policies and Procedure 02-001 "Document Control" (latest revision). For smaller non-CPTC projects, the DSP shall notify the DOA Assistant Director (or designee) of the software being used.
5. See AC 150-5370-10H for airport airside project arc flash requirements.

**F. Harmonic Calculations**

1. Electronic loads are generally nonlinear, and results in the generation of harmonic currents. These currents circulate within the AC distribution system, which supplies power to electronic loads. For each HJAIA - DOA facility, prepare a harmonic study calculations when significant harmonic (nonlinear) load is added to the distribution or building power system.
2. A harmonic study will also be required when the new load exceeds the recommended voltage or current distortion levels as allowed per by IEEE 519-2022, "Recommended Practices and Requirements for Harmonic Control in Electric Power Systems."
3. The results of the harmonic study will dictate when additional harmonic correction measures are required. Provide base line harmonic measures prior to adding new equipment that may introduce harmonics. Ensure that harmonics introduced due to the new equipment will not exceed the base line values.
4. One final Harmonic Analysis Calculation hardcopy report shall be provided to the DOA in a 3" binder(s) and in an electronic SKM System Analysis file format via. the PMWeb web-based Project Management software system, IAW P&D Policies and Procedure 02-001 "Document Control" (latest revision).

**G. Voltage Drop Calculations**

1. To mitigate voltage drop concerns during design, the electrical DSP shall take into account factors like cable length, gauge (size) of the conductors and the current load.

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2. A maximum combined voltage drop of 5 % with feeders at 2% and branch circuits at 3% shall not be exceeded.
3. Sensitive circuits: Branch circuits supplying sensitive circuits shall be limited to a voltage drop, not exceeding **1.5** % and the combined voltage drop of feeder and branch-circuit conductors shall not exceed **2.5** % per NEC 647-4(D). For Cord-Connected equipment the voltage drop on branch circuits supplying receptacles shall not exceed 1% per NEC 647-4(D)(2).
4. Prepare voltage drop calculations IAW the National Electrical Code (when required) and place details on drawing(s) or in a stand-alone document and submit as a deliverable via the PMWeb web-based Project Management software system, IAW P&D Policies and Procedure 02-001 "Document Control" (latest revision).
5. See AC 150-5340-30J, section 13.2.6.1.1 for airport airside control voltage drop requirements.

## H. Lighting Calculations

1. Photometric calculations shall be in the point-to-point format. A Photometric calculation summary shall also be provided to describe the output details such as light loss factor used (LLF), the Average fc, Maximum (Max.) fc, Minimum (Min.) fc, Average/Min. fc, Max./Min. fc (maintain ratio between maxima and minimum).
2. Photometric calculation drawings shall be provided for building (interiors and exterior), parking lots, parking decks and other locations where applicable to illustrate the designed fc levels.
3. Provide individual photometric calculations for normal and emergency lighting.
4. Provide final As Built lighting calculations and photometrics drawings at the completion of each project via the PMWeb web-based Project Management software system, IAW P&D Policies and Procedure 02-001 "Document Control" (latest revision).

## 9.0 Equipment Identification

### A. Branch Circuit Panelboard Directories

1. Computer generated panelboard directories shall be created under the As-Built phase and placed under plastic jacket or protective cover for protection from damage or dirt. Handwritten directories are not allowed.
  - a. As a minimum provide the following details on directories:
    - i. Number each single pole space.
    - ii. Odd-numbered circuits on the left side starting at the top, even on right side starting from the top.
    - iii. Securely mount directories on inside face of panelboard door.
    - iv. Define briefly, but accurately, nature of connected load (i.e. lighting office number, receptacles, electrical room, etc..).
    - v. Provide CPTC official GIS room number locations for all loads and indicate panel name on schedule.
    - vi. Multi-pole circuits shall utilize all pole space numbers as its circuit identifier, i.e., a three-pole circuit will have three space numbers.

### B. Identification Nameplate Labels

1. Equipment identification nameplate labels which are different from electrical manufacturers nameplates shall be provided for all electrical equipment located at HJAIA. For CPTC and DOA ancillary facilities, the unique electrical equipment nameplates shall be created using the methodology outlined in this standard and applied to all electrical equipment with the noted exception: Concession spaces shall have unique identification nameplates for all electrical equipment designed by the DSP using a systematic approach. The following is a minimum equipment list:
  - i. Normal and Emergency (Life Safety, Critical, Legally Required Standby, Optional Standby, and Uninterruptible Power Supply)
  - ii. Power electrical equipment including but not limited to, substations, switchgear, switchboards,
  - iii. Panel boards (power, lighting, receptacle),
  - iv. Motor control centers,
  - v. Non-fusible disconnect switches (including individually mounted circuit breakers),

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- vi. Fusible disconnect switches,
  - vii. Wire ways,
  - viii. Bus ducts and associate components when required,
  - ix. Cable trays,
  - x. Automatic transfer switches,
  - xi. Transformers,
  - xii. Uninterruptible power supplies,
  - xiii. Generators,
  - xiv. Miscellaneous electrical components, etc.
2. For new installations label cubicle/compartments/spaces for all Switchgear, Switchboards and MCCs. Label each disconnecting and overcurrent protective device, meter and control device mounted in compartment doors with a nameplate.
  3. Identify fuse type and size on the cover of fusible equipment
  4. Time Delay: Provide 1/8-inch lettering at the control location to identify a motor having a time delay relay – “Time Delay Start to limit System Inrush”.
  5. Identify soft start on motor starter.
  6. All nameplates shall be engraved.
  7. Securely attach engraved nameplates using epoxy adhesive.
  8. No temporary markings are permitted to remain on equipment.
  9. Coordination with the DOA “Assess Management” department is required to determine if specific asset tagging requirements are applicable to the scope of work.

**C. Color Scheme for Engraved Electrical Nameplate Labels****Table 2 – Nameplate Voltage Color Identifier**

System	Label Background Color	Lettering Color
120/240 Volts, Single Phase – Normal	Black	White
208/120 Volts, Three Phase – Normal	Black	White
480/277 Volts, Three Phase – Normal	Black	White
120/240 Volts, Single*	Red	White
208/120 Volts, Three Phase*	Red	White
480/277 Volts, Three*	Red	White

\* Connected to generator power source (Emergency, Legally Required Standby and Optional Standby).

**D. Nameplates: Electrical Equipment Identification Methodology**

1. All new electrical equipment shall have a unique identification number.
2. The identification number shall be annotated on three lines, centered within a nameplate with a minimum 1/2 inch margin maintained around the outer edges.
3. The methodology used to create an electrical equipment nameplate identification number is outlined in Table 3:

**Table 3 – Nameplate Label Description**

Line One	<p>Line one shall list the official H-JAIA GIS room number where equipment is located. Room numbers for existing spaces are located near each electrical room at the CPTC.</p> <p>For existing CPTC electrical rooms without GIS room number identification nameplates or for new proposed electrical rooms, the DSP shall contact the HJAIA DOA planning department to obtain the official GIS room number identification which is required to build unique identification labels.</p> <p>For CPTC electrical designs, which utilize existing open spaces, where electrical equipment will be or is located and a CPTC space number has not been assigned for this area, an identifier shall be developed by using the following method:</p> <ul style="list-style-type: none"> <li>• step one) obtain the CPTC zone number for this area by contacting the H-JAIA DOA planning department. This designator will become the first identifier for line one,</li> <li>• step two) add the CPTC level. This designator will become the second identifier for line one,</li> <li>• step three) locate the closest vertical and horizontal column identifier which is typically a letter and number and add to line separated by a back slash. This designator will become the third identifier for line one. These key designators together and separated by a hyphen will become the new electrical equipment location name.</li> </ul> <p><u>Example:</u>                  CPTC zone designator is <b>AS17</b>, CPTC level number designator is <b>1</b>, and horizontal/vertical column number designators are <b>A/16</b>.                  Line one will now become <b>AS17-1-A/16</b></p>
Line Two	<p>Line two shall include the <b>Power</b> Type - <b>Voltage</b> Type - <b>Equipment</b> type (plus sequential number) - <b>Source</b> identifier and CPTC concourse identifier. A hyphen shall be used to separate the categories identified. See Table 4, 5, 6, 7 and section 1.14 for type descriptions which shall be used when creating the identification number for line 2.</p>
*Line Three	<p>Line three shall include the word Concession in parentheses.</p>

\*Applicable to concession distribution equipment only.

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**Table 4 - POWER TYPE IDENTIFIER**

N	Normal Power
E	Standby Power
R	Legally Required
S	Life Safety
U	Uninterruptible Power Supply (UPS) Power

**Table 5 - VOLTAGE TYPE IDENTIFIER**

M	Medium (above 480VAC)
H	277/480 VAC, 3 phase
L	120/208 VAC, 3 phase
B	120/240 VAC, 1 phase
O	Other (24VDC and below 120VAC)

**Table 6 - EQUIPMENT TYPE IDENTIFIERS:**

The below listed identifier abbreviations approved by the DOA Electrical Department shall be used. To use abbreviations not listed, submit a descriptive written request to the DOA Electrical Department for approval.

Identifier	Equipment Type
AT	Automatic Transfer Switch
BD	Bus Duct
BP	Bus Plug
BTB	Bus Tap Box
CB	Cable Bus
CT	Cable Tray
DF	Fusible disconnect Switch
DP	Distribution Panelboard
DS	Non-Fusible disconnect Switch
EG	Emergency Generator
FA	Fire Alarm Control Panel
IB	Individually mounted circuit breaker
LC	Lighting Control Panel
MC	Motor Control Center
M1	Meter (number denotes the meter type)
PP	Panel board (Power, Lighting, Receptacle)
SB	Switchboard
SG	Switchgear
TR	Transformer
TV	Transient Voltage Surge Suppressor
UP	Uninterruptible Power Supply (UPS)
UT	Utility Transformer or Bus
WW	Wire way

**Table 7 – CPTC CONCOURSE IDENTIFIERS**

A	Concourse A	E	Concourse E
B	Concourse B	F	Concourse F
C	Concourse C	M	Main Terminal including Atrium
D	Concourse D	T	Concourse T

**E. Source Identifier Methodology**

1. Any electrical distribution equipment connected directly to a utility bus (or utility transformer) will be considered a SOURCE.
2. The equipment type identifier shown in table 4 shall be used to identify the source.
3. Once the source equipment type identifier has been defined, a proxy shall be assigned using letter **S** (for source) followed by a numeric number and location. Locations are as follows:
  - a. Example: three Switchgear and two Switchboard's fed directly from the utility bus and all equipment located in the same CPTC electrical room with the official GIS room number **AS17-1- F1**: the identifications
    - i. Line One Line one shall list the official HJAIA GIS room number where equipment is physically located. **AS17-1-F1**
    - ii. Line Two Line two shall list the **Power** Type - **Voltage** Type - **Equipment** type (plus sequential number) - **Source** and Concourse Designator. A hyphen shall be used to separate the categories identified from Tables 4, 5, 6 and 7: **N – H – SG1 – UT – S1A**.
4. The designation **UT** will only be used in the equipment identification name at the Main SWGR or SWBD level. This **UT** identifier shall not appear in any downstream equipment identification numbers.
5. If any downstream equipment is fed from two upstream sources, then list both sources separated by a back slash, example **S1A/S2A**. See Figures 1, 2, 3 and 4 for examples.

## 10.0 Quality Assurance

### A. Requirements

The DSP shall submit project deliverables reviewed under their approved Quality Assurance (QA) program.

### B. Redi-Check Interdisciplinary Coordination Review

The DSP shall develop and implement a “Redi-Check Interdisciplinary Coordination” review methodology to document review results.

### C. Quality Assurance (QA) Checklists

The DSP shall submit a draft QA checklist to the DOA Assistant Director Electrical (or designee) prior to all initial schematic 30% deliverable for “Capital Projects”. Once approved by DOA a completed QA checklist shall be submitted with each contract submittal to demonstrate compliance. The DSP will be notified by the DOA if the QA expectations are not met. An in-person meeting may be required to discuss the corrective actions.

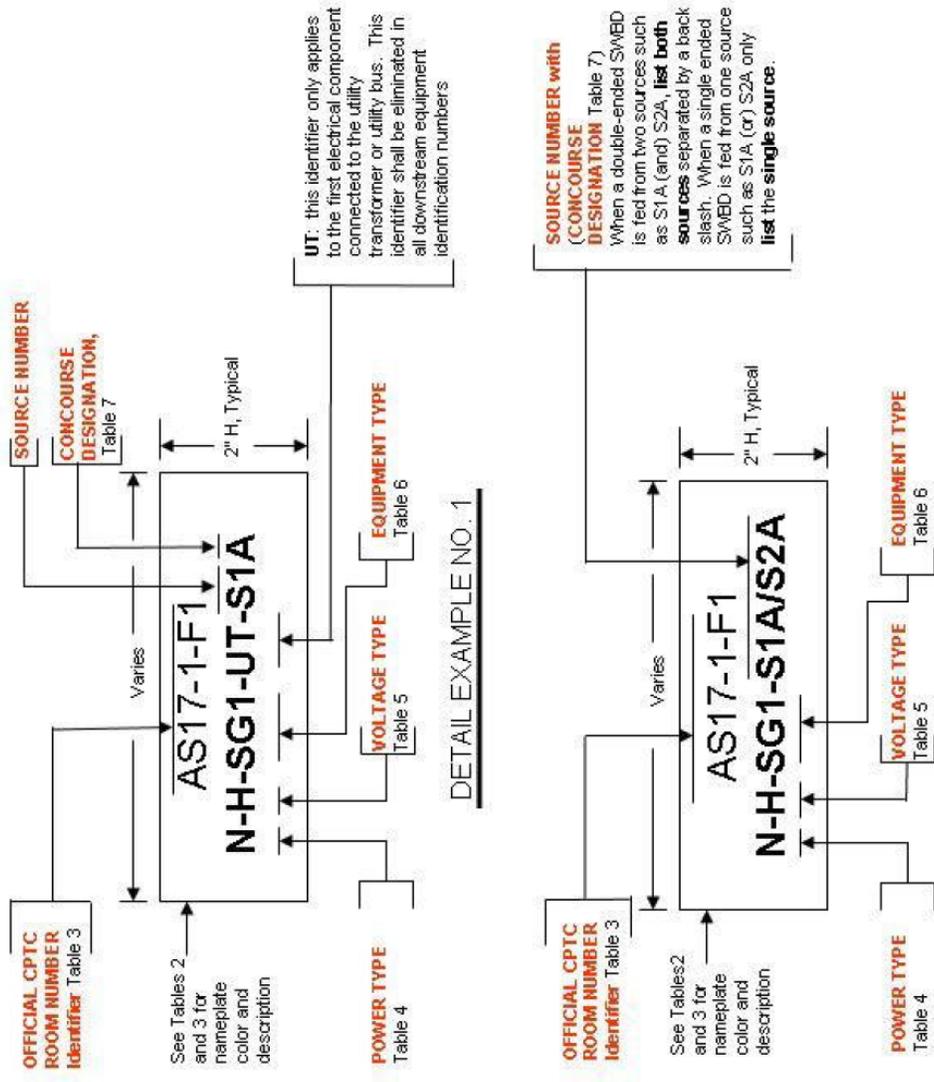
### Figure Index:

Figure 1 - Equipment Nameplate Detail Examples

Figure 2 - Equipment Nameplate Detail Examples

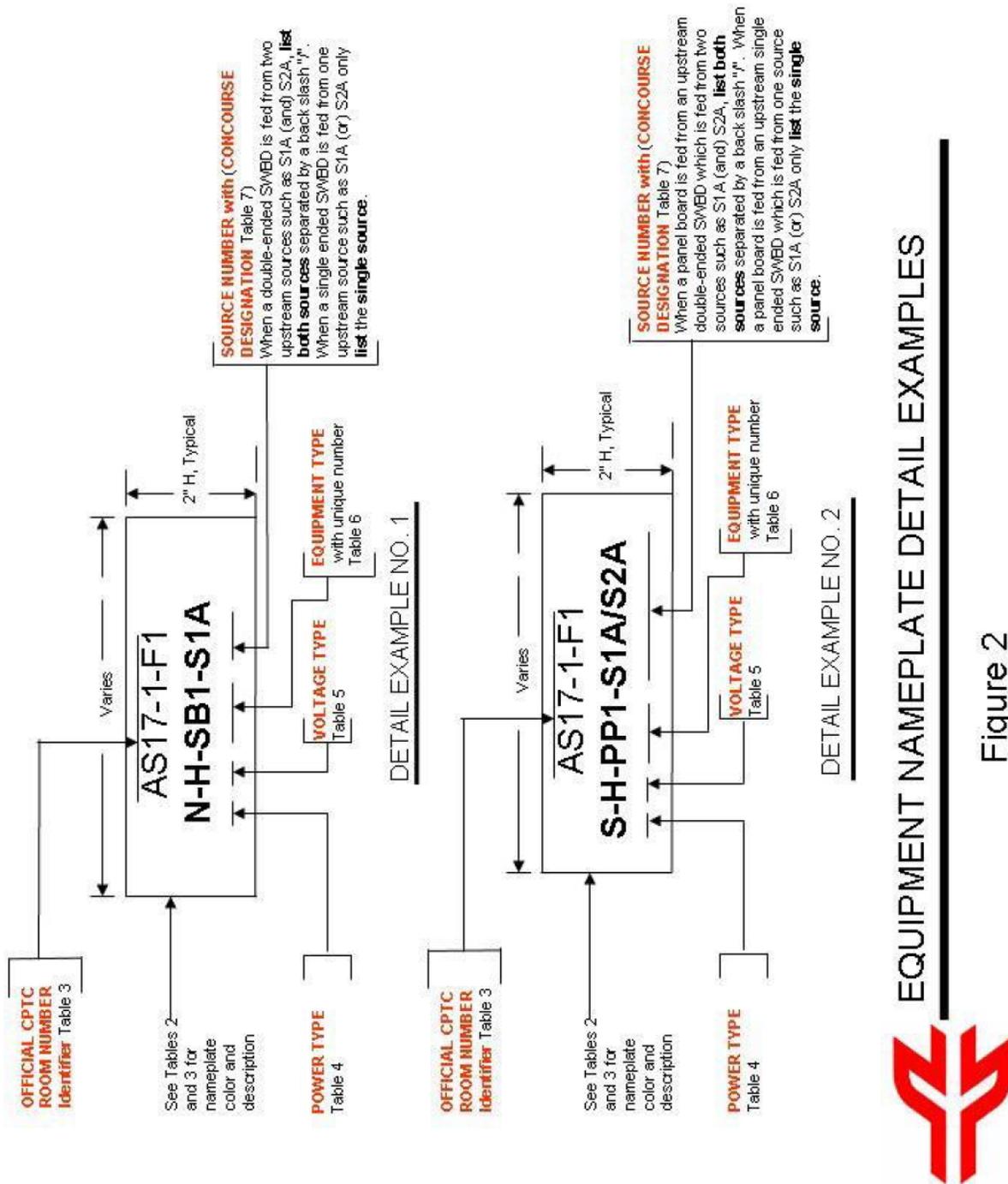
Figure 3 - Equipment Identification Riser Diagram

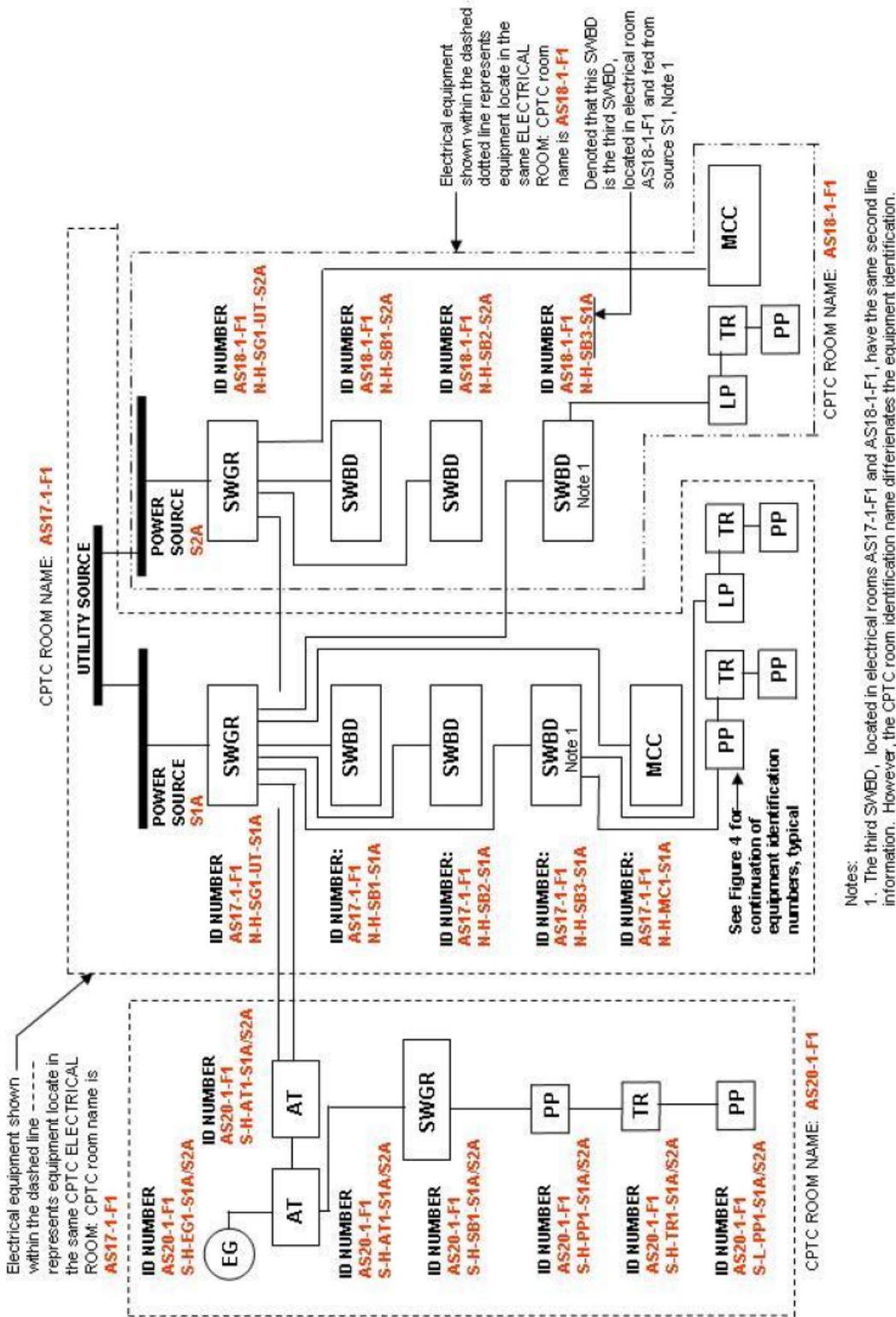
Figure 4 - Electrical Equipment Room Layout Riser Diagram



**EQUIPMENT NAMEPLATE DETAIL EXAMPLES**

Figure 1





EQUIPMENT IDENTIFICATION RISER DIAGRAM

Figure 3



