IEEE-IAS Atlanta Section

Electrical Drawing Preparation
Single Lines and Grounding Plans

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Electrical Drawing Preparation
Single Lines
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■ INPUTS:
  – P&ID’s
  – Load List
  – Distribution Philosophy
  – Basis of Design
  – Layout Drawings
Electrical Drawing Preparation
Single Lines

- **P&ID’s**
  - Process Motor Loads
  - Process Heater Loads
  - Heat Tracing

- **Load List**
  - Non-Process Motors
    - HVAC
    - Air Compressors / Vacuum Pumps
  - Lighting
    - Indoor
    - Outdoor
  - UPS for Communications / Security / Fire Alarm
Electrical Drawing Preparation
Single Lines

- Distribution Philosophy
  - Voltage Level(s)
  - Distribution Scheme
  - Protection Scheme / Philosophy
  - Selectivity

- Basis of Design
  - Motor HP / Voltage Ranges
  - Motor Protection Philosophy
  - Lighting Voltage

- Layout Drawings
  - Location of Electrical Rooms & Transformers
  - Load Concentration(s)
Electrical Drawing Preparation
Single Lines

- Use the proper ABBREVIATIONS.
- Follow the LEGEND sheet.
- Don’t mix ANSI and IEC symbols for the same item type.
- Proper TERMINOLOGY (Ratings, Equipment)
- Indicate FUTURE expansion capability.
- Indicate normal operational mode (OPEN/ CLOSE) for all switching devices
- Provide a front VIEW.
Include the following:

- Utility Supply System
  - Available SC current (including X/R ratio)
  - Line supply voltage
  - High-voltage protective devices and switches
  - Show the normal operating mode
  - Type(s) of relays
Transformers
- Nameplate rating(s) (kVA and kV) and temperature rise
- Cooling Method (ONAN, ONAF {AA, FA})
- High-voltage winding voltage taps and winding connection (delta/wye)
- Low-voltage winding voltage taps and winding connection (delta/wye)
- Impedance and kVA base
- Grounding scheme and ohmic value of neutral resistor(s) if used; show connections
- Surge arrestors and capacitors (show switching if switched), and connections
- Metering of utility supply, primary protective devices
• Switchgear
  – Manufacturer(s), type, model, current rating, MVA class
  – Symmetrical interrupting current rating, and asymmetrical momentary/closing-and-latching current rating for main, tie, and feeder devices
  – Phase arrangement, voltage, ampacity, bracing of bus
Motor loads
- List individual medium-voltage motors including HP/KW, RPM, and type (induction, synchronous)
- Include powerhouse motors (chillers, compressors, etc.)
- LV motors on MCC’s: Categorize load by size(s) at a minimum
- Indicate all VFD motors, RV starters
Feeder cables

- Number of feeders
- Cable insulation and type
- Installation design (conduit, IAC in tray, size of tray, number of cables in tray, etc.)
- Nominal maximum current rating and basis
- Cable callouts are consistent
Other

- Dedicated lighting loads
- Special purpose loads, such as data processing and computer applications
- Capacitor banks, including switching
- Relay coordination and protective-device settings (on separate documentation)
- Standby Generators
Electrical Drawing Preparation
Grounding Plans
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Grounding Plans

**INPUTS:**
- Basis of Design
- Ground Resistance Data
- Grounding Calculations
- Layout Drawings
  - Process Equipment (Large Motors, Tanks)
  - Electrical Rooms
- Structural Drawings
  - Foundations
  - Columns
Electrical Drawing Preparation
Plan Drawings

- Overall Plan
  - North ARROW
  - SCALE: Consistent, include graphic bar
  - Match lines
  - Reference drawings
  - TITLE Block
  - Follow LEGEND Sheet
  - General notes: Generic to Specific
  - COLUMN line numbers
  - General arrangement of process equipment
Electrical Drawing Preparation
Grounding Plans

- Facility Ground System
  - Primary
    - Earth Electrode Subsystem
    - Fault Protection Subsystem
    - Lightning Protection Subsystem
    - Signal Reference Subsystem
  - Secondary
    - Static Protection
    - Cathodic Protection
    - Safety (Maintenance) Grounding
Primary

- Earth Electrode Subsystem
  network of interconnected rods, wires, pipes, or other configuration of metals which establishes electrical contact between the elements of the facility and the earth¹

- Fault Protection Subsystem
  ensures that personnel are protected from shock hazard and equipment is protected from damage or destruction resulting from faults that may develop in the electrical system¹
Primary

- Lightning Protection Subsystem
  provides a nondestructive path to ground for lightning energy contacting or induced in facility structures¹

- Signal Reference Subsystem
  The purpose of a signal reference ground is to provide a low impedance signal reference system for electronic equipment to minimize noise-induced voltages and thereby reduce equipment malfunctions²
Secondary

- Static Protection
  static ground is a connection between a piece of equipment and earth to drain off static electricity charges before they reach a sparking potential.²

- Cathodic Protection
  Cathodic protection is a method to reduce corrosion by minimizing the difference in potential between anode and cathode.³

- Safety (Maintenance) Grounding
  Temporary grounding is provided to protect workers engaged in deenergized electric line maintenance.⁴
Facility Ground System

- Primary
  - Earth Electrode Subsystem IEEE 142-2007 (Green Book)
  - Fault Protection Subsystem NFPA 70 (NEC®)
  - Lightning Protection Subsystem NFPA 780
  - Signal Reference Subsystem IEEE 1100-2005 (Emerald Book)

- Secondary
  - Static Protection NFPA 77
  - Cathodic Protection NACE SP9999
  - Safety (Maintenance) Grounding NFPA 70E, IEEE C2
IEEE 142-2007 (Green Book)

- Chapter 4 Connection to earth
  - 4.1 Resistance to earth (Table 4-5—Formulas for the calculation of resistances to ground)
  - 4.2.3 Concrete encased electrodes
  - 4.3.1 Choice of rods
  - 4.3.3 Connecting to electrodes
  - 4.4 Measurement of resistance to earth
    - Chapter 1 System grounding
    - Chapter 2 Equipment grounding
    - Chapter 3 Static and lightning protection grounding
    - Chapter 5 Electronic equipment grounding
NFPA 70 (NEC®) ARTICLE 250 Grounding and Bonding

II. System Grounding
- 250.20 Alternating-Current Systems to Be Grounded
- 250.24 Grounding Service-Supplied Alternating-Current Systems
- 250.30 Grounding Separately Derived Alternating-Current Systems

III. Grounding Electrode System and Grounding Electrode Conductor
- 250.50 Grounding Electrode System
- 250.52 Grounding Electrodes
- 250.66 Size of Alternating-Current Grounding Electrode Conductor

V. Bonding
- 250.106 Lightning Protection Systems
NFPA 780 Standard for the Installation of Lightning Protection Systems

- Chapter 4 Protection for Ordinary Structures
  - 4.2 Materials
  - 4.7.4 Rolling Sphere Method
  - 4.9.10 Number of Down Conductors
  - 4.13 Grounding Electrodes
  - 4.14 Common Grounding
  - 4.16.4 (Structural Metallic Systems) Grounding Electrodes

- Annex L Lightning Risk Assessment
IEEE 1100-2005 (Emerald Book)
- Chapter 3 General needs guidelines
  • 3.3 Grounding considerations
- Chapter 8 Recommended design/installation practices
  • 8.2 Equipment room wiring and grounding
  • 8.5 Grounding considerations
  • 8.6 Lightning/surge protection considerations
- Chapter 9 Telecommunications, information technology, and distributed computing
  • 9.9 Grounding and bonding
¹ MIL-HDBK419A
² AFI 32-1065
³ UFC 3-570-02A
⁴ UFC 3-560-01