Electrical Drawing Preparation

Do’s & Don’ts

for

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• Types of drawings
  – Diagrammatic, Scaled

• Status of a drawing
  – Conceptual, Bid, Record

• Purpose of a drawing
  – What Belongs, What Doesn’t Belong

Electrical Drawing Preparation

Types of Drawings

• Diagrammatic or Line Drawings

• Scaled or Dimensioned Drawings

• Supporting Documents

Electrical Drawing Preparation

Diagrammatic (Line) Drawings

• Power Flow
  – One Lines
  – Three Lines
  – Risers

Electrical Drawing Preparation

Scaled (Dimensioned) Drawings

• Plan drawings
  – Site Layout
  – Power Plans, Lighting Plans
  – Equipment Room Layouts
  – Grounding Plans
  – Cable Tray Layout
**Scaled (Dimensioned) Drawings**

- Elevations
  - Installation / Mounting Details (Transformer & Panel)
  - Front view Layouts (Switchboard, MCC)
  - Drilling Template (Control Panel)
- Isometrics
  - Cable Tray Layout

**Supporting Documents**

- Legend & Abbreviations
- Bill of Material
- Cable Schedules
- Fixture Schedules
- Panelboard Schedules
- Specifications

**Status of a Drawing**

- Design Stages
  - Conceptual Design
  - Design Development
  - Pre-Final Design
  - Final Design
  - Bid
  - Construction
- Record Drawings

**Purpose of a Drawing**

- Purpose: Type of Drawing and the Design Stage
- Determines:
  - What belongs
  - What doesn’t belong
  (See Matrix)
<table>
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<tr>
<th>Diagrammatic</th>
<th>Conceptual Design (35%)</th>
<th>Design Development (50%)</th>
<th>Pre-Final Design (90%)</th>
<th>Final Design, Bid, Construction</th>
<th>Record</th>
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<td>One Lines</td>
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This document derived from AFCEE UFC 1-300-09N. Reproduction of this document shall include the appropriate reference to the source document.

Prepared by Mark A. Sorrells, PE
1 Show a building’s full floor plan (first, second, etc.) with the location of receptacles, panelboards, switchboards, motor control centers, transformers and any other major equipment. No wiring or circuits required. Scale must be 1:100 (1/8" = 1'-0") minimum.

2 Show a building’s full floor plan (first, second, etc.) with the layout and type of fixtures to be used. No wiring or circuits required. Scale will be 1:100 (1/8" = 1'-0") minimum.

3 Lightning Protection Plan: No details required.; Cathodic Protection Plan: Include the location of soil resistivity measurements. No details required.

4 Special Systems Plans: Show location of devices (e.g., telephone, IDS, others as required).

4.1 Include: Telephone Riser Diagram, Intercommunication Riser Diagram, Fire Alarm Riser Diagram (only when separate Fire Protection Drawings are not included in the design), Other Riser Diagrams for Television, Security, Etc.

5 Submit Design Calculations to substantiate design level shown including: Lighting: Interior and Exterior Foot-candles, Load Analysis, Service size, Feeder size, Larger special circuit sizes, Lightning Risk Assessment

5.1 Updated Calculations from previous submittal to substantiate design level shown including the following as applicable: Short Circuit, Voltage Drop, Motor Starting/Flicker Analysis, Sag, Tension, and Guying Analysis, Manhole Design Calculations, Cable Pulling Tension Calculations, Cathodic Protection Calculations, CATV Network Loss Calculations

6 Submit Outline Specifications

6.1 Submit Redlined Specifications, Sequence of Construction (when applicable)

7 Drawings and specifications must be substantially complete at this stage and require only minor corrections if any. Documents should include response to previous submittal review comments.
Electrical Drawing Preparation

• General Guidelines
• Electronic File Tips
• Specific drawings
  – Single Lines
  – Plan Drawings (Incl. Equipment Layout)
  – Panelboard Schedules

Electrical Drawing Preparation

General Guidelines

• Use a drawing LIST
• Use NUMBERING schemes
• Follow the equipment list NAMES.
• Cross REFERENCE correctly:
  – Between drawings
  – Between drawings AND specifications

Electrical Drawing Preparation

General Guidelines

• DON’T include specific vendor information on equipment RFQ’s
• Include FULL part numbers once vendor selection has been made.
• Show information only ONCE if possible.
• Use a CHECKLIST.

Electrical Drawing Preparation

Electronic File Tips

• Use LAYERS with a standard layer NAMING convention
• Practice FONT simplicity.
• Use standard SYMBOLS.
• Adhere to CLIENT preferences

Electrical Drawing Preparation

Electronic File Tips

• Follow line break & connection CONVENTIONS.
• Use a DATABASE for accuracy of information.
• Don’t OVERCROWD a drawing.

Electrical Drawing Preparation

Drawing Cross References

• Cross reference the parent document
  – Single Line <=> Motor Elementary
  – Power Plan <=> Equipment Room Layout
• Cross reference support documents
  – Single Line <=> Legend & Symbols
  – Lighting Plan <=> Fixture Schedule
  – Power Plan <=> Cable Schedule
**Electrical Drawing Preparation**

**Drawing Cross References**

- Cross reference “sibling” documents
  - Between types (single lines, key power plans)
  - Between categories of plans (grounding, power, lighting)
  - Between disciplines (structural, mechanical)

**Methods:**
- In body of drawing (Parent – Child)
- Notes (Support documents)
- References Table (Sibling documents)
- Match Lines
- Key Plans
- Traceability: two to three cross references

**Single Lines**

- Follow the LEGEND sheet.
- Don’t mix ANSI and IEC symbols for the same item type.
- Indicate FUTURE expansion capability.
- Indicate normal operational mode (OPEN/CLOSE) for all switching devices
- Provide a front VIEW.

**Single Lines (IEEE 141-1993)**

- Includes the following:
  - Utility Supply System
    - Line supply voltage
    - High-voltage protective devices and switches
    - Show the normal operating mode
    - Available SC current
    - Type(s) of relays

**Single Lines (IEEE 141-1993)**

- Transformers
  - Nameplate rating(s) (kVA and kV) and temperature rise
  - High-voltage winding voltage taps and winding connection (delta/wye)
  - Low-voltage winding voltage taps and winding connection (delta/wye)
  - Impedance and kVA base

**Single Lines (IEEE 141-1993)**

- Transformers (cont.)
  - 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
Electrical Drawing Preparation
Single Lines (IEEE 141-1993)

- 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

- 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

- 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)

Electrical Drawing Preparation
Plan Drawings

- Overall Plan
  - North Arrow
  - Column line numbers
  - Matchlines
  - Reference drawings
  - General arrangement of process equipment
  - Scale: Consistent, include graphic bar

- Cable tray layouts checked for physical interferences
- Cable trays dimensioned from tray to column lines
- All trays have appropriate bend radii (especially 5 and 15 kV cables)
**Electrical Drawing Preparation**

**Plan Drawings**

- Cable tray fill calculations are verified
- All cable tray sections are identified
- Each cable tray elevation is shown
- Cable tray and cables routed in air plenums are suitable for use in air plenums.

**Wall and floor openings**
- Coordinated with architectural and structural drawings
- Appropriate for the cable tray and conduit designs
- Installation detail maintains the integrity of the wall (fire stops)
- Blast-proof walls have not been penetrated

**Motors at least 1-½ feet (450mm) away from walls, tanks, columns, etc.**
- Motors may overheat due to poor air flow
- Maintain adequate maintenance clearance
- Local disconnecting means (where required)
- Equipment at both ends of each cable on the cable schedule is shown

**Electric equipment locations are dimensioned**
- Sufficient access and working space is provided about all electrical equipment
- At least two doors are provided, remotely located from each other, in every electric room
- All electrical equipment can be installed and removed without removing structural members, piping, or other pieces of equipment

**Specifications for the panelboard are appropriate**
- Panelboard identification number and location are correct
- Main bus rating
- Neutral bus, Ground bus
- Main breaker, Branch breakers

**Main bus**
- Tin-plated copper, Aluminum
- Bracing adequate
- Ampere rating appropriate (125% FLA, Spare capacity)
- Voltage matches the supply system
- Supply system kVA rating is adequate
- Number of conductors, sizes, and overcurrent protection are correct
Panelboard Schedules

- Neutral conductor is appropriately sized
- Neutral bus material matches main
- Isolated neutral bus
  - Always preferred
  - Required for a separately derived system
- Ground bus material matches main and neutral

Main Breaker

- Sized in accordance with NEC
- Coordinated with upstream devices
- Short Circuit / Interrupting capability
- Series Rated System?

Branch Breakers

- Spare breakers are provided
- Correctly Specified GFCI's
- All data included for each circuit
  - Estimated Load
  - Location of load (column lines, room #’s)
  - Loads balanced on each phase

Standards, Regulations

- NEC® 2005 ¶408.4
- Proposed update to 29CFR 1910 Subpart S [FR 69:17773-17842]
- IEEE 315-1975 (R1993)
- IEEE 141-1993
- IEEE 902-1998
- ANSI Y32.9-1972

Bibliography

- AFCEE UFC 1-300-09N
- IEEE 141-1993

Review

- Types of drawings
- Status of a drawing
- Purpose of a drawing
- General Guidelines
- Electronic File Tips
- Specific drawings
Electrical Drawing Preparation
Do’s & Don’ts

QUESTIONS?

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