



Electrical Drawing Preparation
Do's & Don'ts
for


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Electrical Drawing Preparation


- Types of drawings
 - Diagrammatic, Scaled
- Status of a drawing
 - Conceptual, Bid, Record
- Purpose of a drawing
 - What Belongs, What Doesn't Belong

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Electrical Drawing Preparation
Types of Drawings


- Diagrammatic or Line Drawings
- Scaled or Dimensioned Drawings
- Supporting Documents

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Electrical Drawing Preparation
Diagrammatic (Line) Drawings


- Power Flow
 - One Lines
 - Three Lines
 - Risers

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Electrical Drawing Preparation
Diagrammatic (Line) Drawings

- Schematics
 - Ladder Logic
 - Motor Elementaries
 - Block Diagrams
- Wiring
 - Connection
 - Interconnection

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Electrical Drawing Preparation
Scaled (Dimensioned) Drawings

- Plan drawings
 - Site Layout
 - Power Plans, Lighting Plans
 - Equipment Room Layouts
 - Grounding Plans
 - Cable Tray Layout

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Electrical Drawing Preparation Scaled (Dimensioned) Drawings

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

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Electrical Drawing Preparation Supporting Documents

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

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Electrical Drawing Preparation Status of a Drawing

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

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Electrical Drawing Preparation Purpose of a Drawing

- Purpose: Type of Drawing and the Design Stage
- Determines:
 - What belongs
 - What doesn't belong

(See Matrix)

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| | Conceptual Design (35%) | Design Development (50%) | Pre-Final Design (90%) [Note 7] | Final Design, Bid, Construction | Record |
|-------------------------------|-------------------------|--------------------------|---------------------------------|---------------------------------|----------|
| <u>Diagrammatic</u> | | | | | |
| Power Flow | | | | | |
| One Lines | Large Equip. | 50% (Note 1) | 90% | Complete | IEEE 902 |
| Three Lines | | | | | |
| Risers | | | | | |
| Schematics | | | | | |
| Ladder Logic | | | | | |
| Motor Elementaries | | | | | |
| Block Diagrams | | | | | |
| Wiring | | | | | |
| Connection | | | | | |
| Interconnection | | | | | |
| <u>Scaled</u> | | | | | |
| Plan drawings | | | | | |
| Site Layout (& Demo) | Sketches | 50% | 90% | Complete | |
| Power Plans | Prelim | Note 1 | 90% | Complete | IEEE 902 |
| Lighting Plans | | Note 2 | 90% | Complete | |
| Equipment Room Layouts | Large Equip. | 50% | 90% | Complete | |
| Grounding & Lightning Prot. | | Note 3 | 90% | Complete | |
| Cable Tray Layout | | | | | |
| Special Systems (Phone, etc.) | | Note 4 | 90% (Note 4.1) | Complete | |
| Elevations | | | | | |
| Power Panel Layouts | | | | | |
| MCC Layouts | | | | | |
| Equipment Mounting Details | | | | | |
| Cable Tray Racks | | | | | |
| Isometrics | | | | | |
| Cable Tray Routing | | | | | |
| <u>Supporting Documents</u> | | | | | |
| Legend & Abbrev. | | Complete | | | |
| Bill of Material | | | | | |
| Panelboard | | | 90% | Complete | IEEE 902 |
| Fixtures | | | 90% | Complete | |
| Cabling | | | | | |
| Specifications | | Note 5, 6 | Note 5.1 & 6.1 | Final | |

This document derived from AFCEE UFC 1-300-09N. Reproduction of this document shall include the appropriate reference to the source document.

- 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

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Electrical Drawing Preparation General Guide Lines

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

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Electrical Drawing Preparation General Guide Lines

- 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.

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Electrical Drawing Preparation Electronic File Tips

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

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Electrical Drawing Preparation Electronic File Tips

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

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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

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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)

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Electrical Drawing Preparation Drawing Cross References

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

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Electrical Drawing Preparation 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.

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Electrical Drawing Preparation Single Lines (IEEE 141-1993)

Include 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

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Electrical Drawing Preparation 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

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Electrical Drawing Preparation 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

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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

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Electrical Drawing Preparation Single Lines (IEEE 141-1993)

- 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

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Electrical Drawing Preparation Single Lines (IEEE 141-1993)

- 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

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Electrical Drawing Preparation Single Lines (IEEE 141-1993)

- 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)

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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

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Electrical Drawing Preparation Plan Drawings

- 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)

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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.

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Electrical Drawing Preparation Plan Drawings

- 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

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Electrical Drawing Preparation Plan Drawings

- 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

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Electrical Drawing Preparation Equipment Layout

- 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

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Electrical Drawing Preparation Panelboard Schedules

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

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Electrical Drawing Preparation Panelboard Schedules

- 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

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Electrical Drawing Preparation 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

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Electrical Drawing Preparation Panelboard Schedules

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

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Electrical Drawing Preparation Panelboard Schedules

- 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

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Electrical Drawing Preparation 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

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Electrical Drawing Preparation Bibliography

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

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Electrical Drawing Preparation Review

- Types of drawings
- Status of a drawing
- Purpose of a drawing
- General Guidelines
- Electronic File Tips
- Specific drawings

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*Electrical Drawing Preparation
Do's & Don'ts*



QUESTIONS?

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