AAHE

Fall Conference

Mercy Hospital, Rogers, AR | October 2, 2026

Grounding , Bonding , Independent Ground Fault Study in Healthcare Facilities

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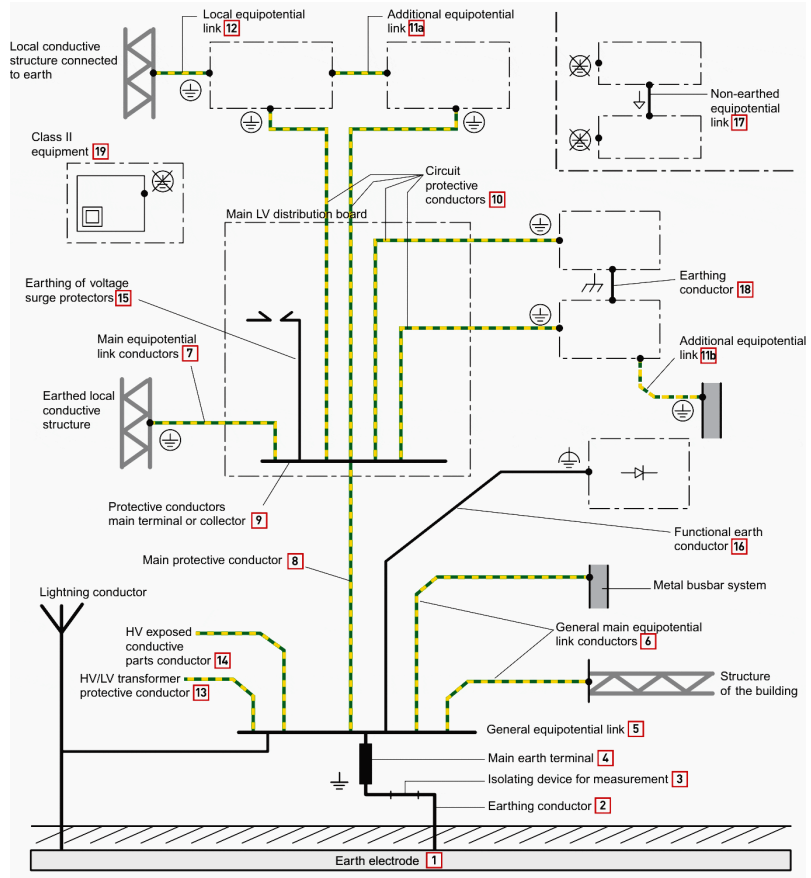
Presenters

Austin Espejo, PE, Brown Engineers

Tom Hanlon, Master Electrician, Brown Engineers

AGENDA

- Compliance with NFPA/NEC, FGI, Joint Commission
- Design Phase
- Construction: Admin & Commissioning
- Bonding Methods-NEC Compliance
- Independent Ground Fault Coordination Study
- Q & A



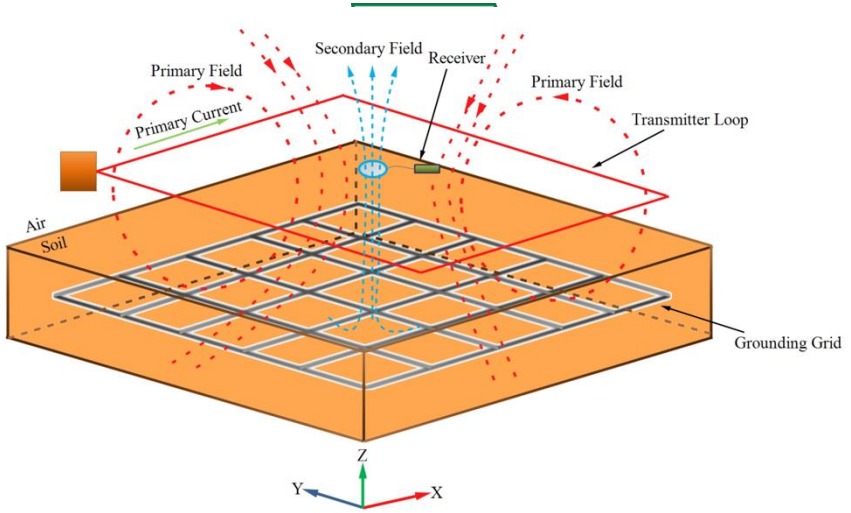
Compliance Grounding and Bonding

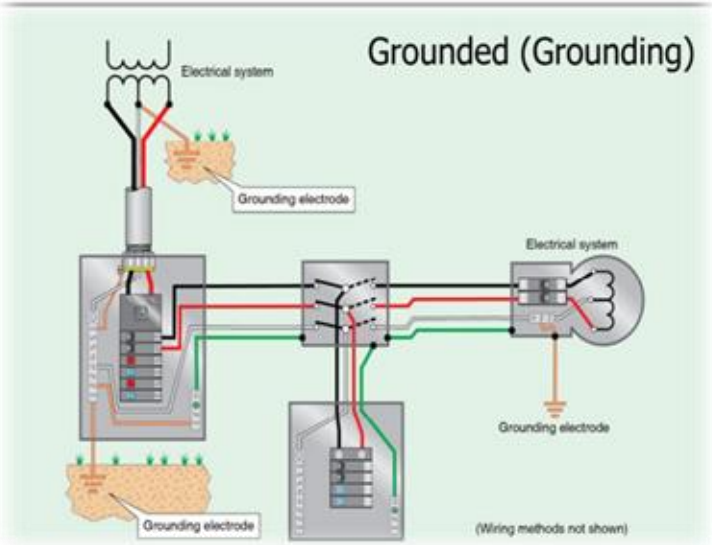
NFPA 70/NEC 250 **What is grounding?**

Grounding is the electrical system's connection to the ground itself.

Article 100 of the NEC defines the ground as the earth. (Earthing)

Section 250.4(A)(1) states that grounded electrical systems "shall be connected to earth in a manner that will limit the voltage imposed by lightning, line surges, or unintentional contact with higher-voltage lines and that will stabilize the voltage to earth during normal operation."





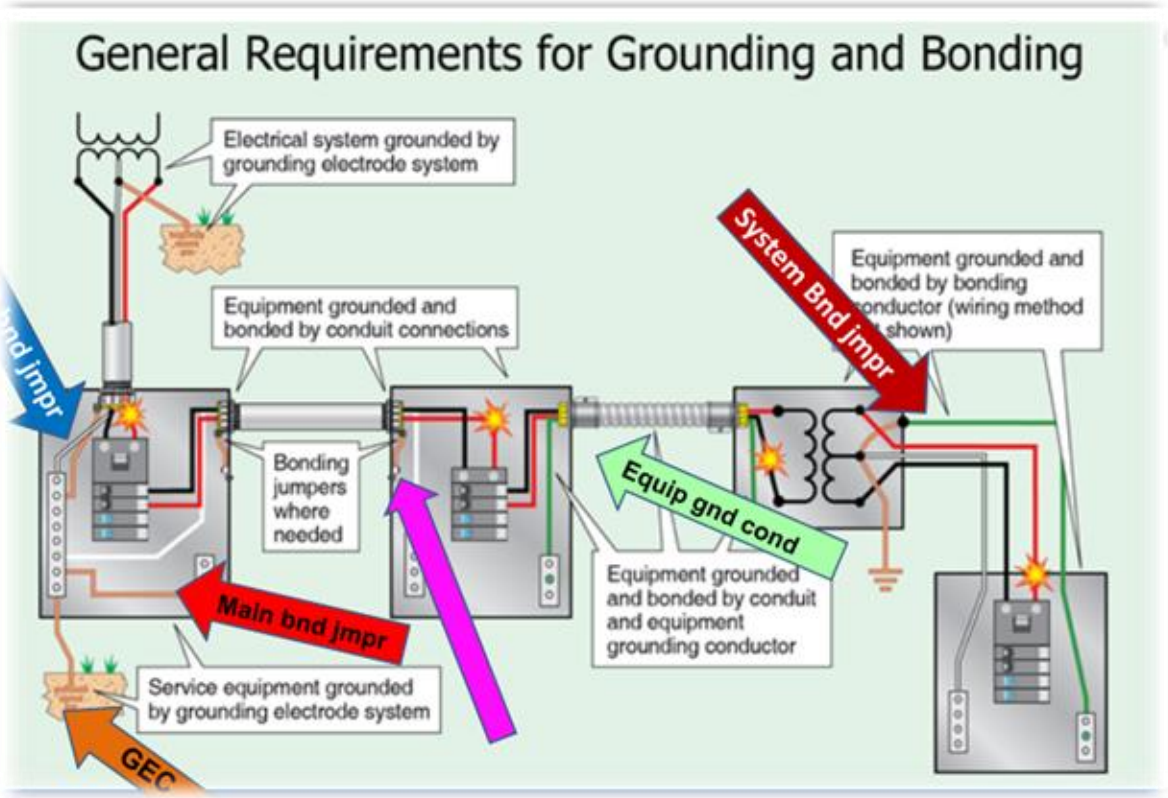
Compliance Grounding and Bonding

What is bonding?

Article 100 of the NEC defines bonded (bonding) as “connected to establish electrical continuity and conductivity.”

- Bonding metal parts, such as enclosures and raceways, ensures that they are all continuous on an effective ground-fault current path (EGFCP) that references back to ground (earth).

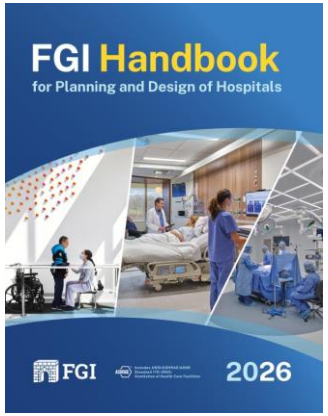
- The EGFCP helps operate devices such as circuit breakers and fuses or ground-fault detectors in ungrounded systems.



Compliance

FGI Electrical Guidelines Overview

The **Facility Guidelines Institute (FGI)** provides comprehensive design standards for healthcare facilities that go beyond minimum code requirements, focusing on operational best practices and evidence-based design.
Its **Guidelines for Design and Construction** are recognized by The Joint Commission, CMS, and state health departments as the primary design reference for healthcare design.



Bonding in Practice

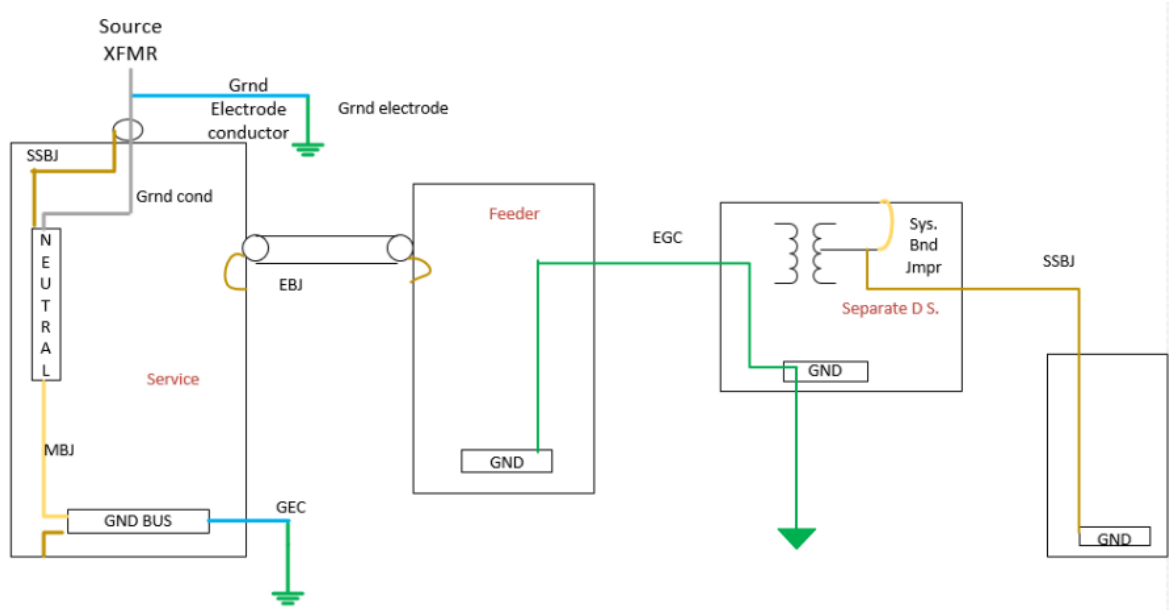
- **Bonding** connects all exposed conductive parts (equipment enclosures, metal raceways, cable armor) to the grounding system to prevent hazardous voltage differences.
- In patient care spaces, the **metal sheath/raceway** must be bonded to the grounding electrode system per NEC 517.13.
- Bonding is part of the **high-risk utility system** inspection and maintenance program under Joint Commission EC.02.05.05 cdn.prod.website-files.com.
- Arc flash and shock hazard assessments (per NFPA 70E) should also consider bonding as part of hazard control.

Design-Requirements & Standards

Healthcare electrical design is governed by strict codes because patient safety directly depends on electrical reliability.

Key Codes and Standards

- NFPA 70 (National Electrical Code)
- NFPA 99 (Health Care Facilities Code)
- NEC Article 517 – Healthcare Facilities
- Local/state health authority regulations
- Facility guidelines for healthcare construction (FGI)

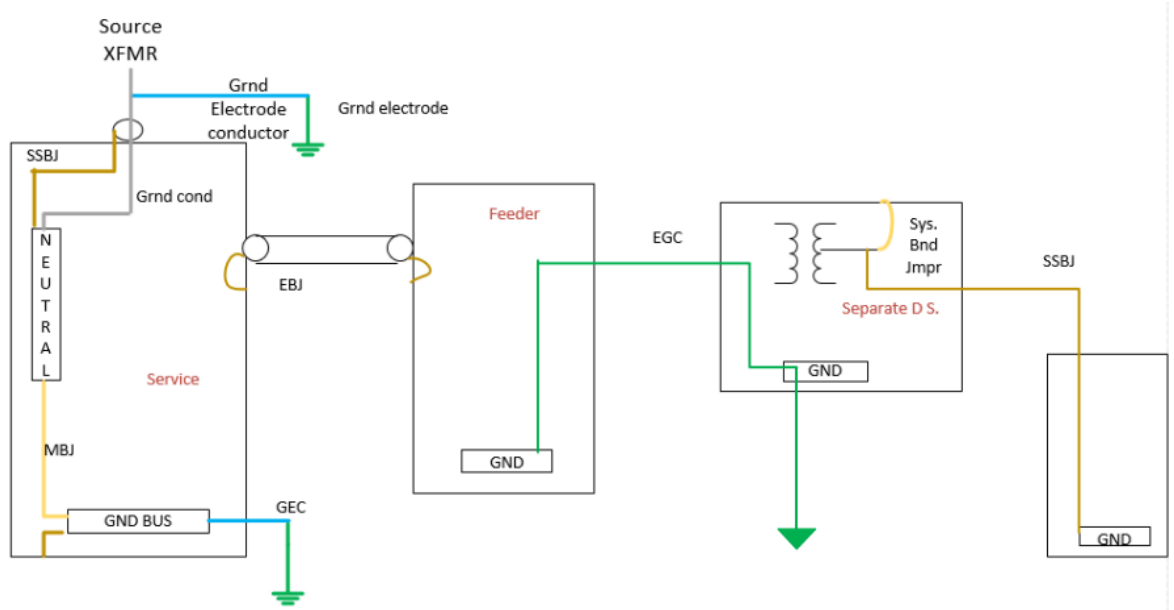


Design-Requirements & Standards

Hospitals operate 24×7. Spaces like ICUs, ORs, ERs and imaging rooms cannot afford even a second of downtime.

Core Elements of a Reliable Power Strategy

- Emergency generators sized for full critical load
- Automatic Transfer Switches (ATS) for quick switchover
- Uninterruptable Power System (UPS) systems for equipment sensitive to voltage fluctuations
- Segregated power distribution (Life-safety, Critical, Equipment)
- Emphasis on Redundancy



Design-Joint Commission

What is Federal Deemed Status?

In order to participate in and receive federal payment from Medicare or Medicaid programs, a healthcare organization must meet the government requirements for program participation, including a certification of compliance with the health and safety requirements called Conditions of Participation, Conditions for Coverage (CfCs), or Conditions for Certification (CfCs), which are set forth in federal regulations. The certification is achieved based on either a survey conducted by a state agency on behalf of the federal government, such as the Centers for Medicare & Medicaid Services (CMS) or by a national accrediting organization, such as Joint Commission, that has been recognized by CMS (through a process called “deeming”) as having standards that meet or exceed Medicare’s requirements and a survey process that is comparable to the government’s.

Healthcare organizations that achieve Medicare certification through a Joint Commission "deemed status" accreditation survey are determined to meet or exceed Medicare and Medicaid requirements.

Construction: Commissioning

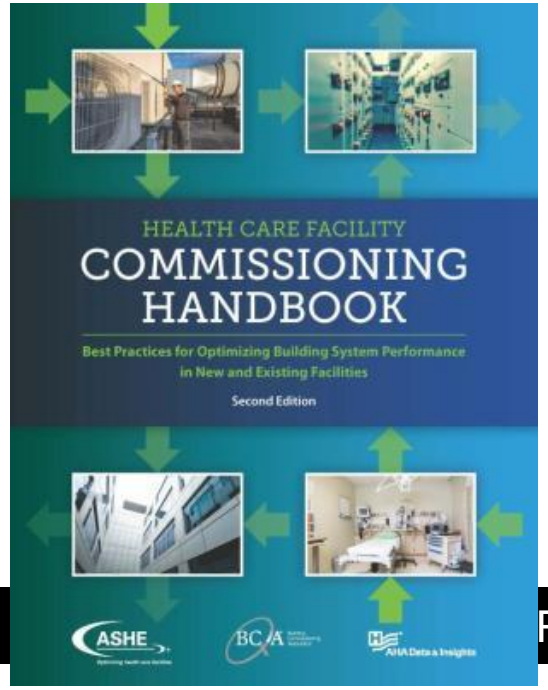
- Systematic verification, documentation and training process
- Begins at pre-design stage, continues through post-occupancy and operations phases
- Integral part of the design and construction process
- Intended to be undertaken throughout the life of a facility
- Completed as part of an operational project team approach
- Used to assess and ensure items are completed before occupancy
- Supports an environment that is safe for all building occupants



Construction: Commissioning & Testing

This approach is aligned with international commissioning guidelines applied to complex buildings and infrastructures, where the process is understood as a structured methodology to verify that systems meet the requirements defined by the owner and the design. The American Society for Health Care Engineering (ASHE) specifically addresses commissioning in healthcare facilities in its guide on **health care facility commissioning**.







Compliance-Bonding-NEC Rules

1. Service conductors (250.92(B))

At the service entrance, **bonding jumpers are required around concentric or eccentric knockouts that impair the electrical connection to ground, unless all such knockouts are removed**

- **Bonding must be done with listed bonding jumpers, bonding-type locknuts, wedges, or bushings per NEC Article 250.**
- **Reducing washers alone are not acceptable as the bonding means**
- **2. Circuits over 250 V to ground (250.97)**

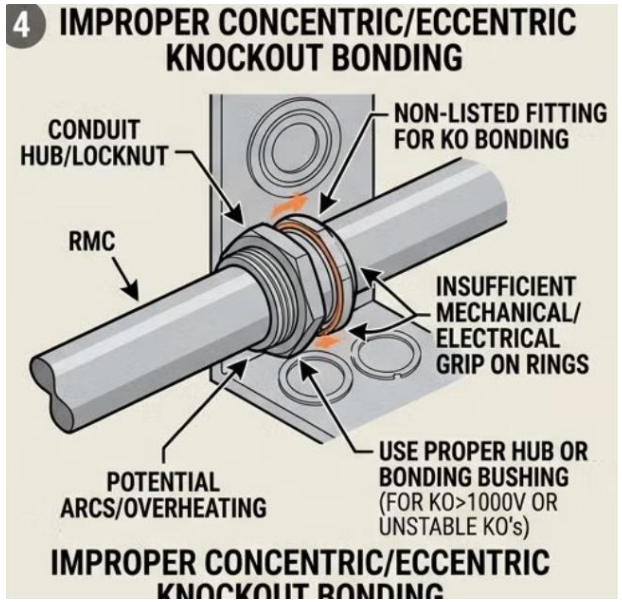
For metal raceways or enclosures with concentric/eccentric knockouts carrying 277 V, 480 V, or other over-250 V circuits, bonding jumpers are required unless the enclosure is listed to provide a reliable bonding connection

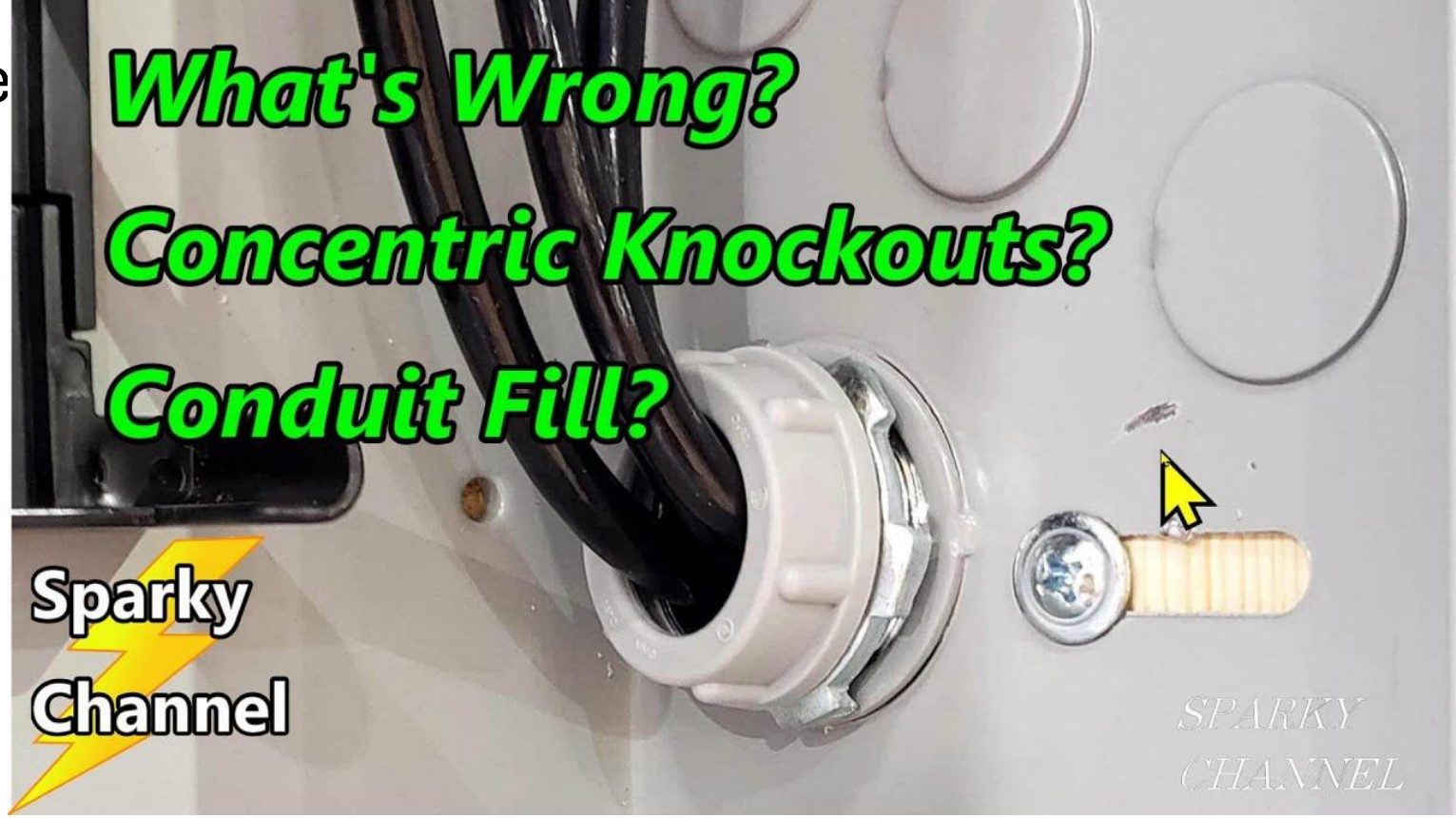
- **NEC 250.97 allows the use of knockouts without jumpers only if the box is UL-listed for bonding and marked accordingly**
- **If the knockout integrity is compromised during installation, a bonding jumper must be provided**

3. Under 250 V

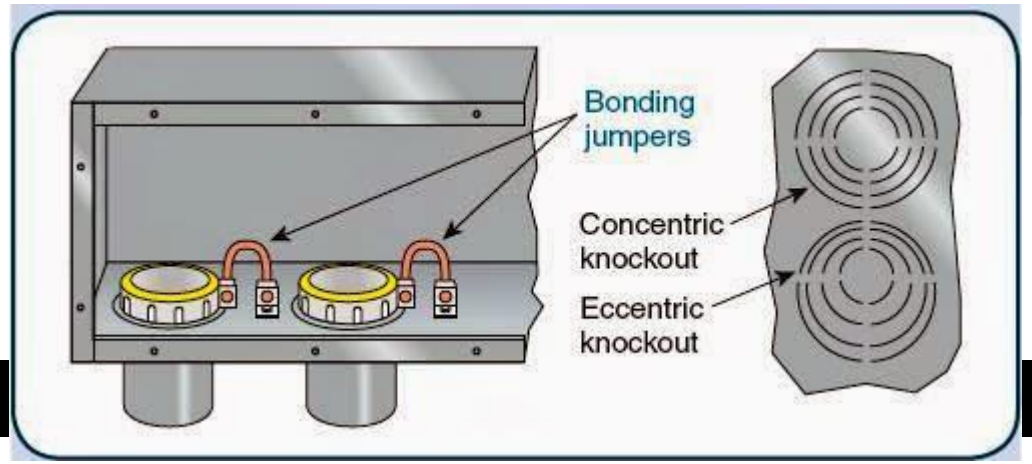
For circuits ≤250 V, the same principle applies: bonding jumpers are required unless the enclosure is listed for bonding and knockouts are removed

Compliance-Bonding-NEC Rule Concentric/Eccentric Examples









Mercy

Case Study-Bonding Compliance

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Full Service Medical Center

Built mid 1980s

Approximately 885K Sqft

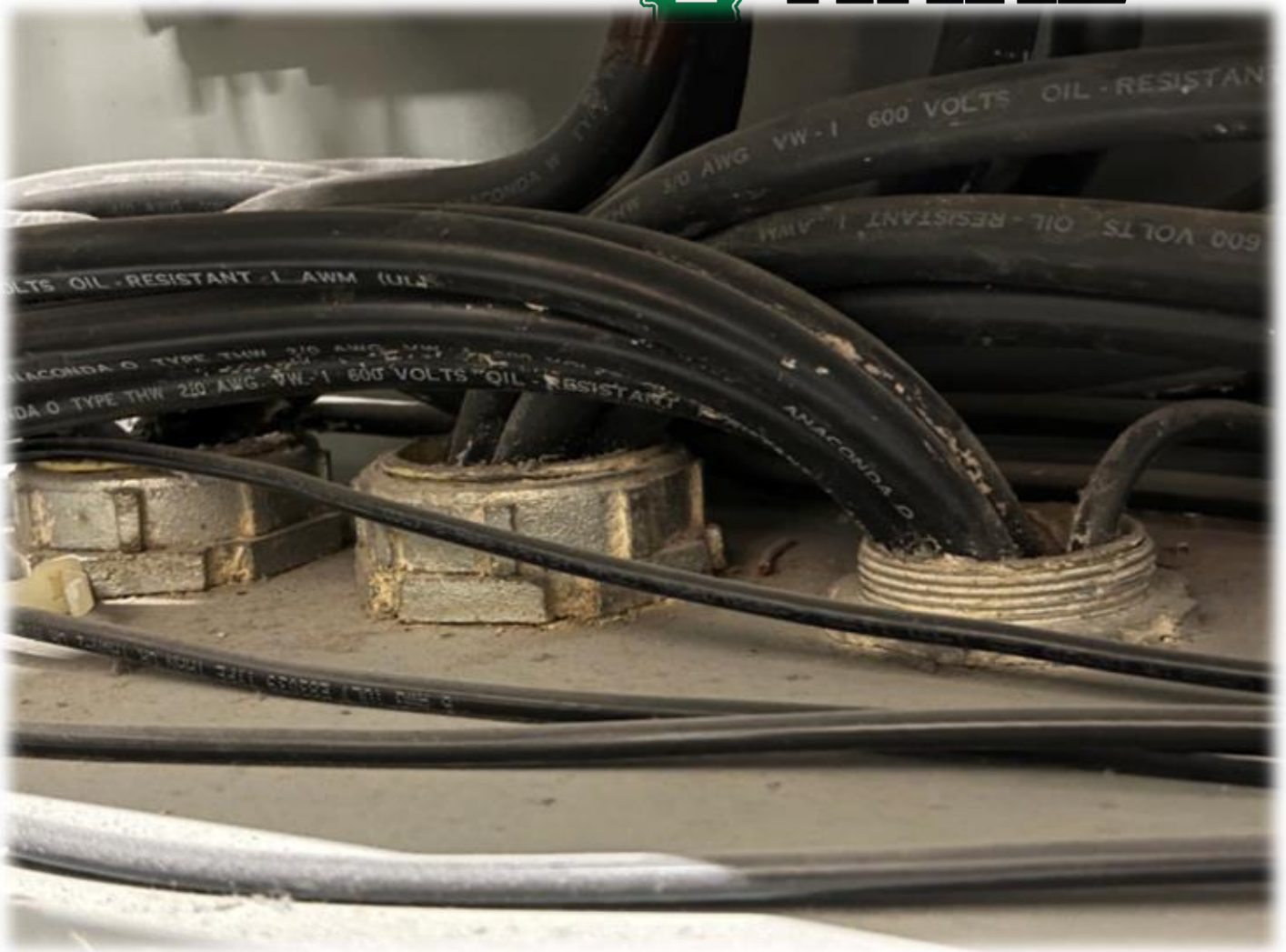
Minor electrical upgrades to date

Recently identified numerous out of compliance grounding & bonding requirements

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Examples-Non-Compliance





Examples-Non Compliance





Bonding Compliance-NEC Articles

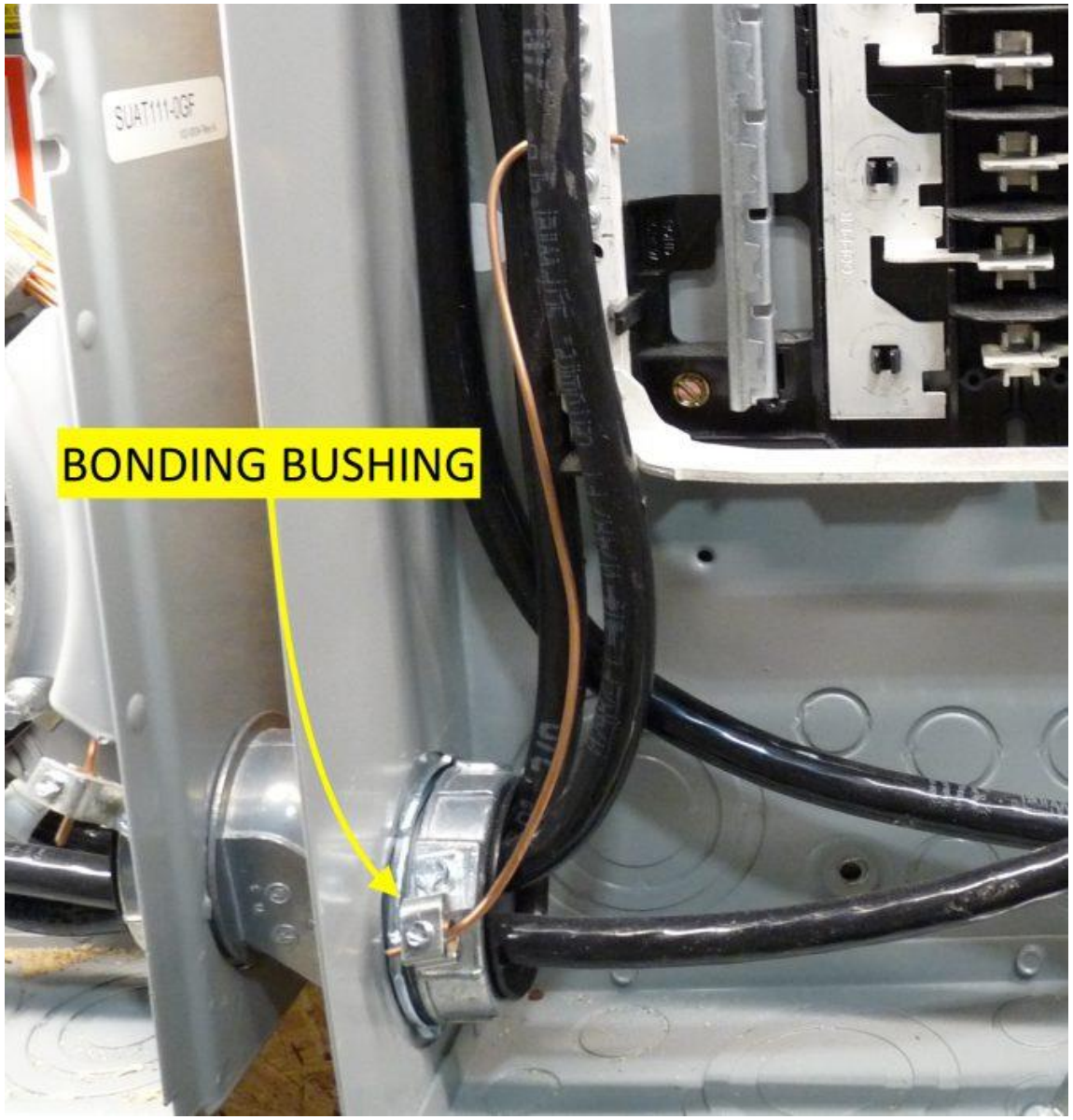
NEC bonding requirements ensure all metal parts are electrically continuous and provide a low-impedance fault path.

Primary Compliance: Grounding Bushings as per 250.92.B. Full size or split.

Grounded conductor compliant with Table 250.102.C.1







Bonding Compliance-NEC Article 250.102.E.1



Grounding/Bonding Wedge

“Inside a Raceway or Enclosure”

UL 467 rated Bonding Wedges. Vendors Crouse Hinds, Bridgeport, T&B, etc.

Prefer lay in lugs.
Grounded conductor compliant with Table 250.102.C.1



Bonding Compliance-NEC Article 250.102.E.2

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"Outside a Raceway or Enclosure"

UL 467 rated conduit/pipe clamps. Vendors Crouse Hinds, Bridgeport, T&B, etc.

Prefer lay in lugs.

Grounded conductor compliant with Table 250.102.C.1



Least Expensive and Least Intrusive Solution!!

Independent Ground Fault Coordination Study

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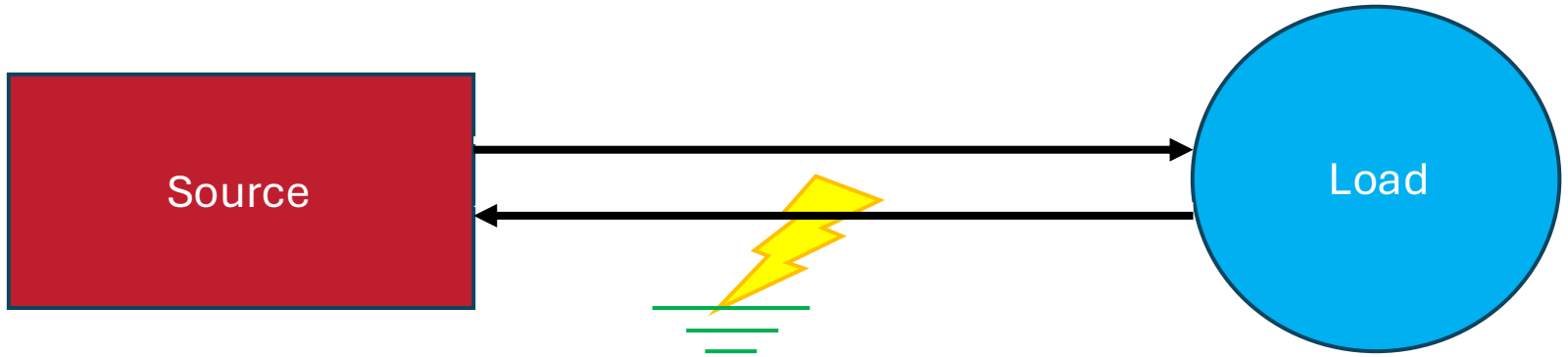
- Electrical Systems designed to prevent or minimize damages when ground fault occurs
- What do you do when there is a ground fault in your power system?

Independent Ground Fault Coordination Study

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Direct or indirect contact with energized conductors causing current to flow through inadvertent path

Most common electrical hazard



Independent Ground Fault Coordination Study

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- Part of scope of services industry calls “Power System Analysis”
  - Part of the “Overcurrent Protective Device Coordination Analysis”
- Accomplished by some type of Overcurrent Protective Device
- Important to **localize a ground fault** to stop the ground fault and **localize power disruption.**



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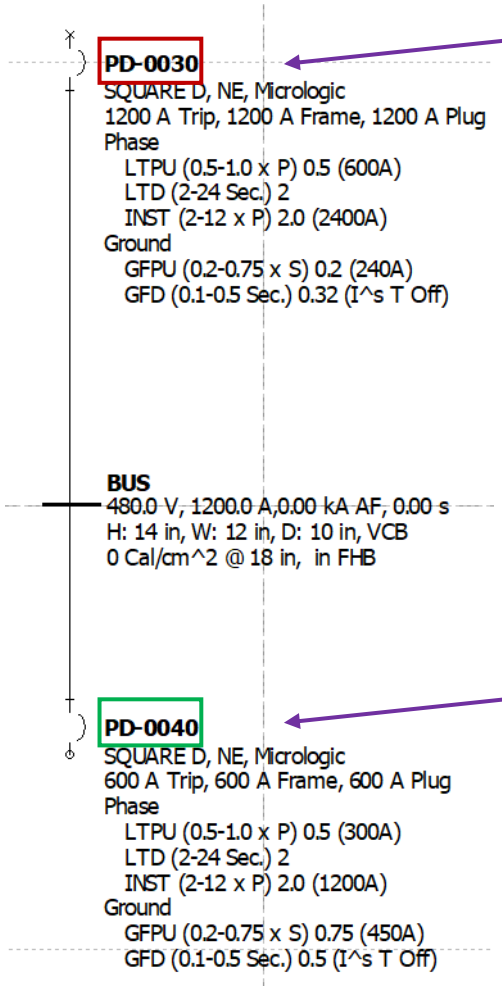
“We are conducting analysis on a power systems that would be **consequential and expensive** to test on the actual system”

Independent Ground Fault Coordination Study

- Breakers have many settings to adjust; at specific current and time
  - Displayed by Time Current Curves (TCCs).
- Think about settings within context of whole system
- Many larger breakers have ground fault settings



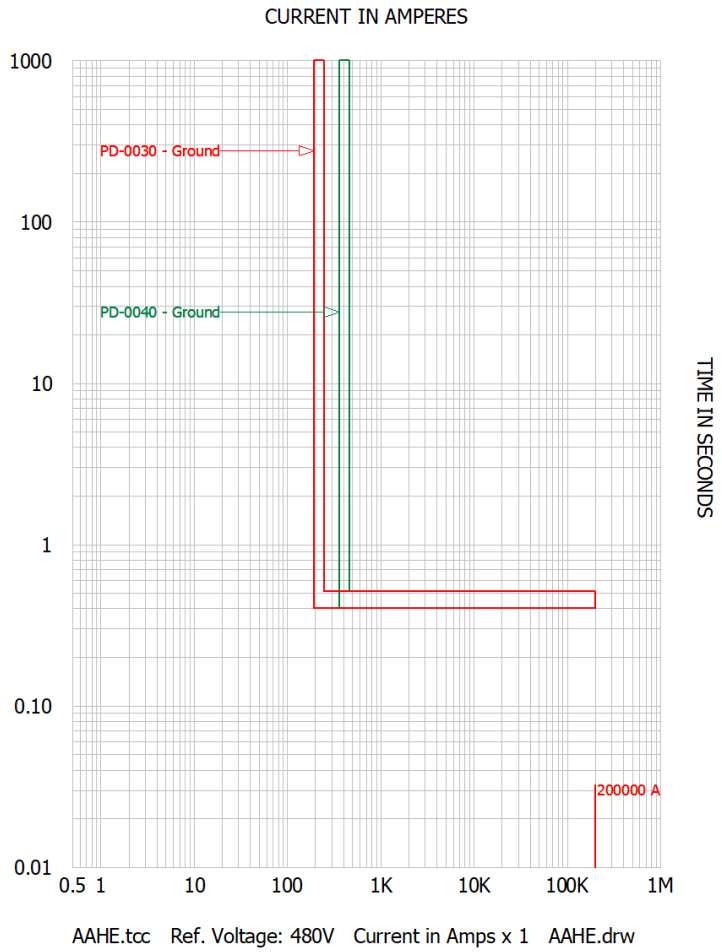
Independent Ground Fault Coordination Study



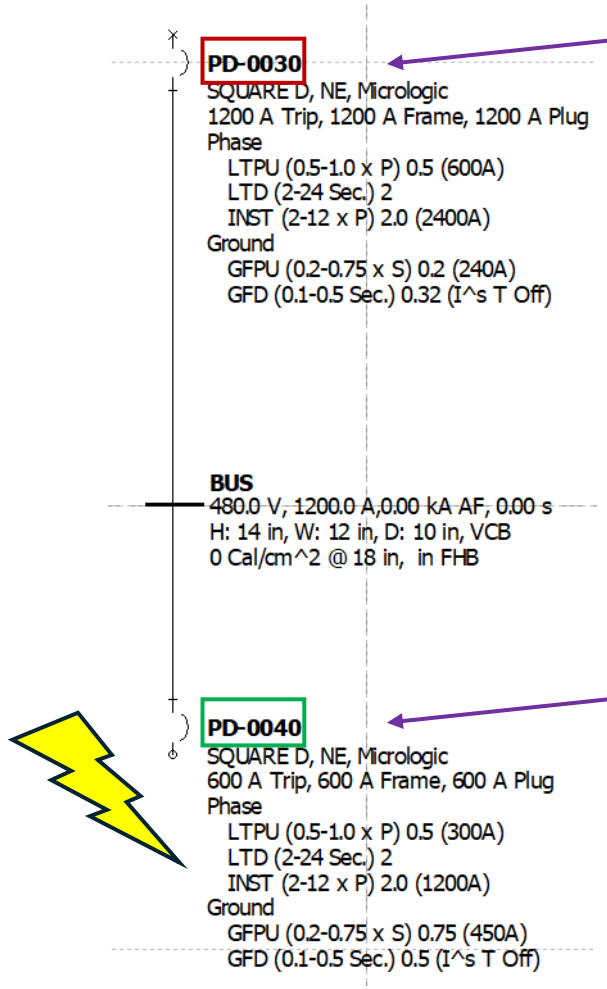
Main Breaker at Facility

One Feeder Breaker at Facility

Independent Ground Fault Coordination Study



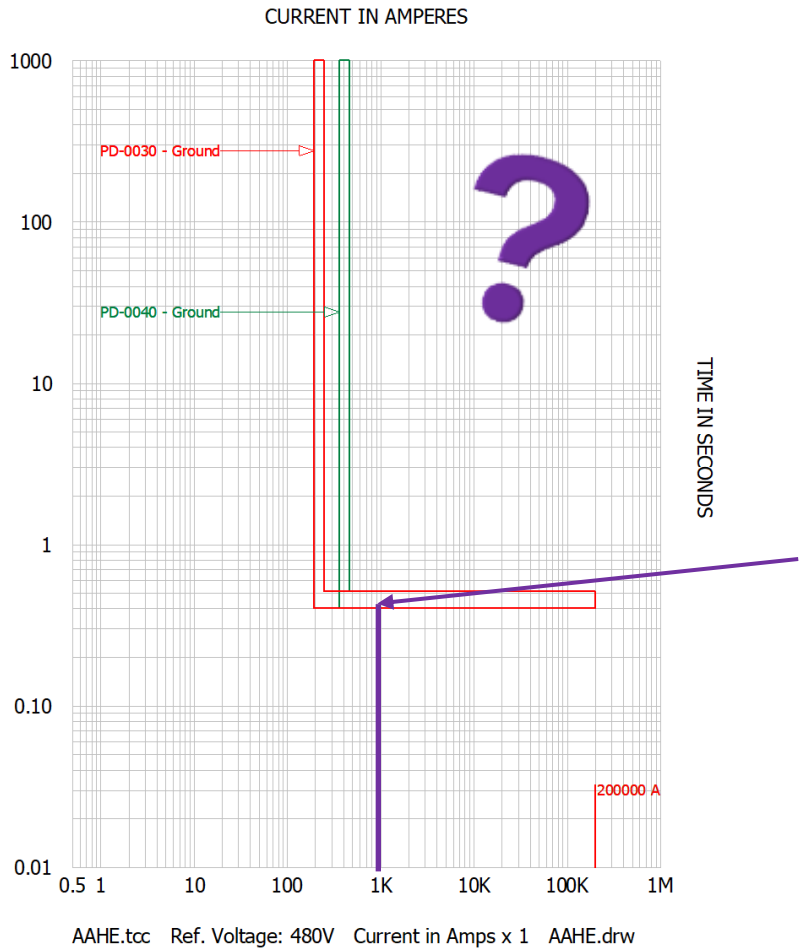
Independent Ground Fault Coordination Study



Main Breaker at Facility

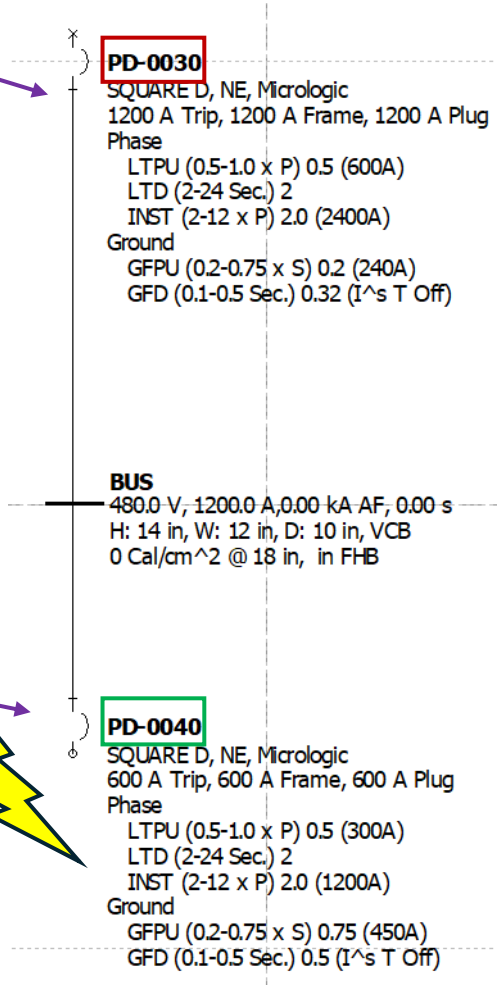
One Feeder Breaker at Facility

Independent Ground Fault Coordination Study



Independent Ground Fault Coordination Study

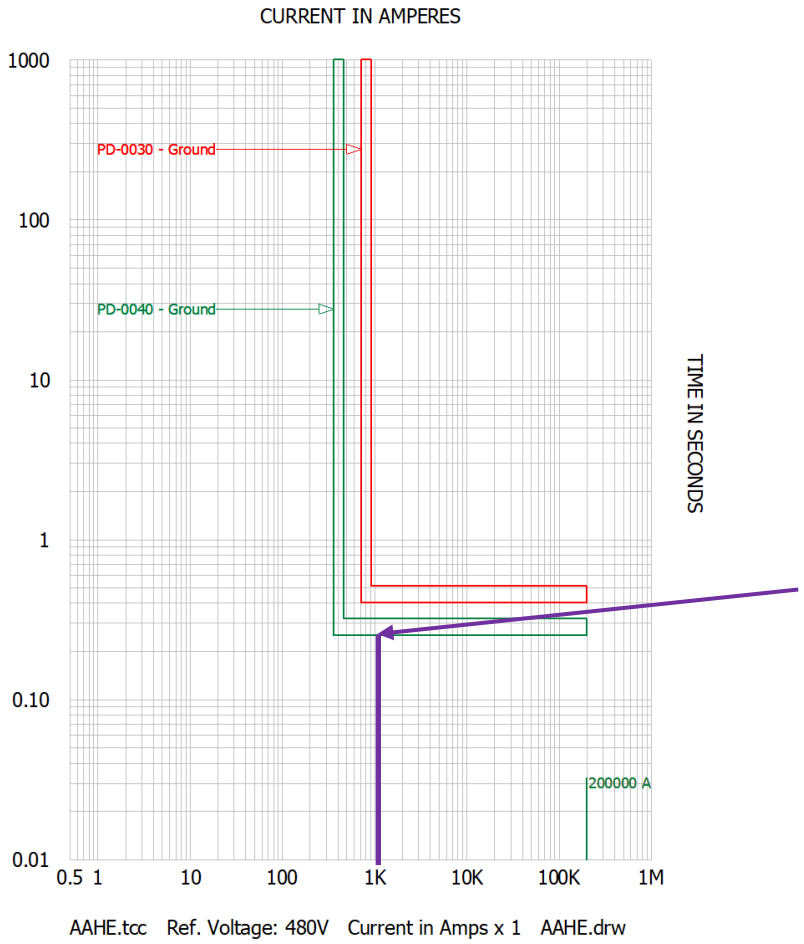
Main Breaker at Facility



One Feeder Breaker at Facility



Independent Ground Fault Coordination Study



Independent Ground Fault Coordination Study

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- Having ground fault settings on breakers is not sufficient alone
- Must have a licensed engineer determine settings for your power system
- Important to support uptime for critical areas in facility – Localize the fault!
- Important for safety of folks working on electrical system

THANKS

Questions?



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