Fault Current Calculations and NEC Requirements

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Question???

• How many attendees have had a customer designing or owning a commercial or industrial facility ask for the fault current provided by the utility?

• Why are they asking this question and what answer do you provide?
Answer Depends on Concern

• Proper Application of Equipment
  • Interrupting Rating
  • Short-Circuit Current Ratings

• Meeting Requirements of Selective Coordination

• Arc Flash Protection of Employees
OCPD - Interrupting Rating (I.R.)

• **NEC®** Article 100 Definition
  - **Highest** current an **OVERCURRENT DEVICE** (fuse or circuit breaker) is rated to safely interrupt.
  - **Self protection rating only**

• **NEC®** 110.9 Interrupting Rating.
  - Requires the overcurrent device to have an interrupting rating not less than the **maximum** available fault current.
  - The maximum fault current must be calculated and varies based on system size/location.
  - Similar Requirements in **OSHA 1910.303(b)(4)**
Equipment - Short-Circuit Current Ratings

- NEC® Article 100 Definition
  - The **highest** current EQUIPMENT can withstand without extensive damage (fire or shock hazard).
  - May be based on a specific type of overcurrent device

- NEC® 110.10 Circuit Impedance, Short-Circuit Current Ratings, and Other Characteristics.
  - Requires the equipment to have a short circuit current rating not less than the **maximum** available fault current.
  - The maximum fault current must be calculated and varies based on system size/location.
  - Similar Requirements in OSHA 1910.303(b)(5)
Equipment - Short-Circuit Current Ratings

• NEC 110.10: Equipment short-circuit current ratings must be adequate for maximum available fault current.

• Must Assure Proper SCCR for all equipment
  • Panelboards/Switchboards
  • Motor Control Centers/MCCs
  • Disconnects/Transfer Switches
  • Industrial Control Panels
  • HVAC Equipment
  • Conductors/Busway
New Code Change – 2011 NEC

110.24 Available Fault Current.

(A) Service equipment must be marked with the maximum available fault current and date of calculation

(B) If fault current increases due to system modification, the marking must be updated.
How to Comply?

All equipment must comply with: NEC 110.9 (IR) & 110.10 (SCCR)

- Service Equipment
  - Isc = 60,142 A
  - Date Determined/Calculated: 9/2010
  - Max Avail. Fault Current = 58,524 A
  - Required per NEC 110.24

- HVAC
  - Isc = 38,525 A
  - SCCR = 40kA

- Industrial Machinery Panel
  - Isc = 42,153 A
  - SCCR = 65kA

- Industrial Control Panel
  - Isc = 27,532 A
  - SCCR = 30kA

- Motor Controller
  - Isc = 18,752 A
  - SCCR = 25kA

Engineer – Calculate
Contractor – Label

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Selective Coordination

• In the Past:
  • Not required by Code, but “Coordination” Studies were performed to improve system reliability – they did not assure “total” coordination (best you can get)

• As of 2005:
  National Electrical Code (NEC) Article 100 Definitions
  • Coordination (Selective) Localization of an overcurrent condition to restrict outages to the circuit or equipment affected, accomplished by the choice of overcurrent protective devices and their ratings or settings.
  • Overcurrent = overloads, ground faults & short-circuits

SELECTIVE COORDINATION = “TOTAL” COORDINATION
Selective Coordination

Without Selective Coordination

- OPENS
- NOT AFFECTED
- UNNECESSARY POWER LOSS

With Selective Coordination

- OPENS
- NOT AFFECTED

WHY? IMPROVES SYSTEM RELIABILITY TO CRITICAL LOADS
Selective Coordination

Summary of NEC Selective Coordination Requirements

- **620.62** Required for Circuits with multiple Elevators (1993)
- **700.28** Required for Emergency Systems (2005-2014)
- **701.27** Required for Legally Required Standby Systems (2005-2011)
- **695.3(C)(3)** Required for Campus Style Fire Pumps (2011)
- **645.27** Required for Critical Operation Data Systems (2014)
Selective Coordination

700.27 Coordination. Emergency system(s) overcurrent devices shall be selectively coordinated with all supply side overcurrent protective devices.

What about the overcurrent devices in the normal source path that supply the emergency system?

Red-striped emergency system overcurrent devices must selectively coordinate with all blue-striped supply side normal system overcurrent protective devices as required in 700.27.
Selective Coordination – Circuit Breakers

• How to Selectively Coordinate with Circuit Breakers?

• Answer:
• Do short-circuit current study and coordination study investigating various types and options of CBs for specific project
Selective Coordination – Circuit Breakers

How to Selectively Coordinate with Circuit Breakers?

• Do short-circuit current study and coordination study
• Use time current curves to identify types and options of CBs required to achieve selective coordination (select breaker needed eliminate overlap of curves for fault current available)
• Even small changes in fault current can result in lack of compliance

1. Short-Circuit Current Study
   By Ace Engineering
Selective Coordination – Fuses

• How to Selectively Coordinate with Fuses?

• Answer:
  • Use fuse selective coordination ratio tables and new fusible branch panels
## Selective Coordination

### Selectivity Ratio Guide (Lineside to Loadside Coordination)

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1. Where applicable, ratios are valid for indicating values only for the section of the same fuse. At some values of fault current, specified ratios may be lowered to permit closer fuse sizing. Consult with Cooper Bussmann. Ratios given in this section apply only to Cooper Bussmann® fuses. When fuses are within the same fuse size, consult Cooper Bussmann.
2. TCF (CUBEFuse®) is 1 to 100A Class J performance; dimensions and construction are unique, finger-safe IP20 design. NOTE: All the fuses in this table have interrupting ratings of 200kA or greater, except the SC fuses have 100kA IR.

### Annotations
- **LOW-PEAK® : LOW-PEAK®**
- **2:1 Line:Load Ratio**
- **No plotting required! Valid up to 200kA**
Branch Panel Applications

- All Low-Peak Fuses
- Minimum Ratio 2:1 met
- Use the Quik-Spec™ Coordination Panelboard at branch level
- Also used by Utilities in 125Vdc MV Control Applications
Arc Flash Energy

• Arc flash Energy Is Dependent On:
  • Arcing fault duration or time to clear
    • Speed of the overcurrent protective device
  • Arcing fault current magnitude
    • Available fault current
    • Current-limitation can reduce
Arc Flash Hazards – Circuit Breakers

- Circuit Breaker (Property Maintained)
- Short Time Delay
- Instantaneous
- CLCB

Incident Energy

Arcing Current

Current in Amperes

Time in Seconds

- LVPCB-STD
- CLCB
- Inst Trip CB
Arc Flash Hazards - Fuses
Bussmann Short-Circuit Calculator

- NEW version
  - Apple or Android Apps
  - Web (run from homepage after entering contact info)
Fault Current Calculation Example

**Main Switchboard**

- **SCCR** = 200kA
- **Isc** = 8,562 A
- **Isc** = 50,000 A
- **Isc** = 54,688 A
- **Isc** = 42,575 A

**HVAC RTU1**

- **SCCR** = 5kA
- **Isc** = 8,562 A

**Marking Required per NEC 110.24**

Fault current at RTU1 > SCCR of RTU1

**CODE VIOLATION!**
Selecting Protective Devices Handbook (SPD)

- This comprehensive guide to electrical overcurrent protection and electrical design considerations is based on the 2014 NEC®.
- With over 250 pages, this industry-leading handbook has new or expanded information on the following:
  - OCPD servicing and maintenance
  - Industrial control panels
  - Electrical safety
  - Fuses for hazardous locations
  - Photovoltaic systems and fuses
  - Data centers
  - Fuse sizing for buildings
  - Surge protective devices
- View on-line or save as PDF
Questions?

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