

ECET 211 Electric Machines & Controls

Electrical Safety in the Workplace (part 2)

Text Book: Electric Motors and Control Systems, by Frank D. Petruzella, published by McGraw Hill, 2015.

Other References

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1-2. Electrical Safety in the Workplace

- 1. An Overview of Electrical Safety
- 2. Protecting against Electrical Shock
 - Electrical Shock
 - Arc Flash Hazards
 - Personal Protective Equipment
- 3. Grounding – Lockout – Codes
 - Grounding and Bonding
 - Lockout and Tag-out
 - Electrical Codes and Standards

Part 2. Grounding-Lockout-Codes

- **Grounding and Bonding**
- **Grounding** – connection of a current carrying conductor to the Earth
 - Intentional grounding – required for the safe operation of electrical systems and equipment
 - Unintentional or accidental grounding – a fault in electrical wiring systems or circuits
- The primary reasons for grounding
 - To limit the voltage surge: lightning, utility system operations, accidental contacts with higher voltage lines
 - To provide ground references: stabilizing the voltage under the normal operating conditions
 - To facilitate the operation of over current devices: circuit breakers, fuses, and relays under ground-fault conditions

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Part 2. Grounding-Lockout-Codes

- A **Grounding System** has two parts:
 - **System Grounding** – the electrical connection of one of the current carrying conductors to the ground
 - **Equipment Grounding** – the electrical connection of all the metal parts that do not carry current to ground
- Important Grounding & Bonding Definitions, video, <https://www.youtube.com/watch?v=25qJnyogWdY>

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Part 2. Grounding-Lockout-Codes

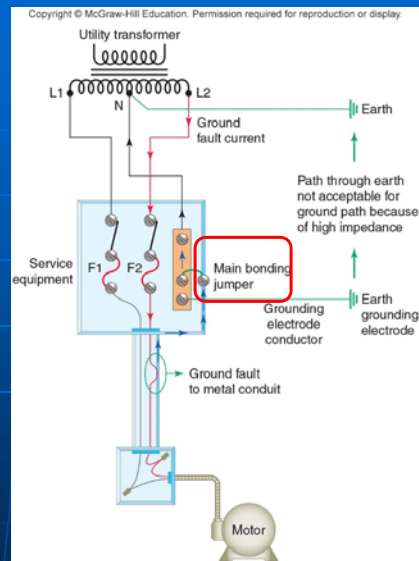
- **Bonding** – the permanent joining together of metal parts that aren't intended to carry current during normal operation, which creates an electrically conductive path that can safely carry current under ground-fault conditions.
- The primary reasons for bonding are:
 - To establish an effective path for fault current that facilitates the operation of overcurrent protective devices.
 - To minimize shock hazards to people by providing a low-impedance path.

The National Electrical Code (NEC)

- The Code (NEC) requires all metal used in the construction of a wiring to be bonded to, or connected to, the ground system. The intent is to provide a low-impedance path back to the utility transformer in order to quickly clear the faults

Figure 1-9 Ground-fault current path

- **Figure 1-9** illustrates the ground-fault current path required to ensure that overcurrent devices operate to open the circuit
 - Earth resistance is high
 - Main bonding jumper
- **Grounding:** Circuit ⇔ a metal underground water pipe; or the metal frame of a building, a concrete-encasted electrode or a grounding ring

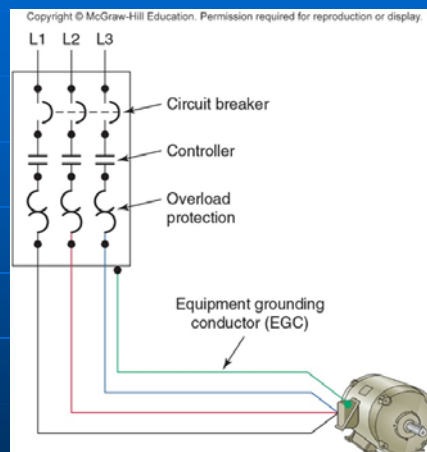


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Figure 1-10 Equipment grounding conductor

- **Equipment Grounding Conductor (EGC)**
 - Provides a low-impedance ground path between electrical equipment and enclosures within the distribution system
 - If motor insulation should fail => may cause person injury, but due to the present of EGC => motor frame would be at ground potential (~ zero volts)

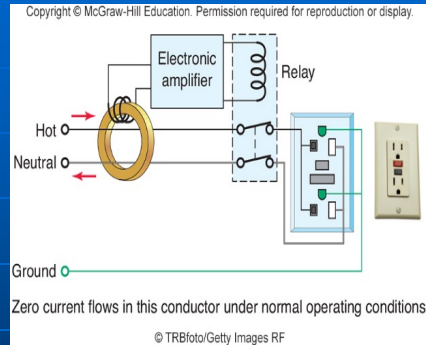


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Ground Fault Circuit Interrupter (GFCI)

- Ground Fault
- CFI – senses small ground-fault currents and shut off the current or interrupt the circuit within 1/40 seconds
- Figure 1-1 CFI receptacle – simplified circuit
- OSHA Requirements



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Part 2. Grounding-Lockout-Codes

- Electrical **“Lockout”**: the process of removing the source of electrical power and installing a lock
- Electrical **“Tagout”**: the process of placing a danger tag on the source of electrical power, which indicates that the equipment may not be operated until the danger is removed.
- **Figure 1-12** Lockout and Tag-out devices



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Part 2. Grounding-Lockout-Codes

- Basic steps in Lockout procedure
 - Prepare for machinery shutdown
 - Machinery or equipment shutdown
 - Machinery or equipment isolation
 - Lockout and tagout application
 - Release of stored energy (Capacitor, Motor coils, etc)
 - Verification of isolation
 - Lockout/tagout removal
- Figure 1-12 Testing for the presence of voltage



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Electrical Codes and Standards

- Occupational Safety and Health Administration (OSHA)
- National Electrical Code (NEC)
 - Article 430 – Motors and all associated branch circuits, over current protection, overload, etc
 - Article 490 – The installation of motor-control centers
 - Article 440 – Air conditioning equipment

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Electrical Codes and Standards

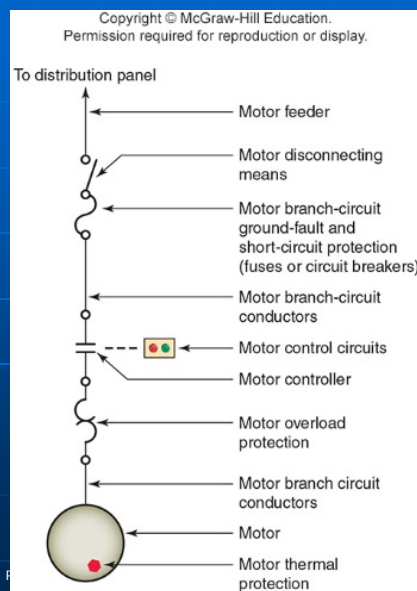
- Occupational Safety and Health Administration (OSHA)
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 - Article 430 – Motors and all associated branch circuits, over current protection, overload, etc
 - Article 490 – The installation of motor-control centers
 - Article 440 – Air conditioning equipment
- National Fire Protection Association (NFPA)
- Nationally Recognized Testing Laboratory: UL – Underwriter's Laboratory
- National Electrical Manufacturers Association (NEMA)
- International Electrotechnical Commission (IEC)

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Figure 1-14 Motor terminology

- The single line diagram



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Summary & Conclusion

Questions?

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