# Grounding of Electrical Systems

# NEW CODE: Grounding and Bonding

Presented By
Scott Peele PE

Progress Energy

# Grounding of Electrical Systems Outline

- Defining the Terms
- Why should I Ground?
- Types of Grounding Systems
- Separately Derive System
- Grounding Electrode
- Bonding
- Ground Fault Protection
- Ground Reference or Signal Reference
- Grounding for Lightning Protection

Progress Energy

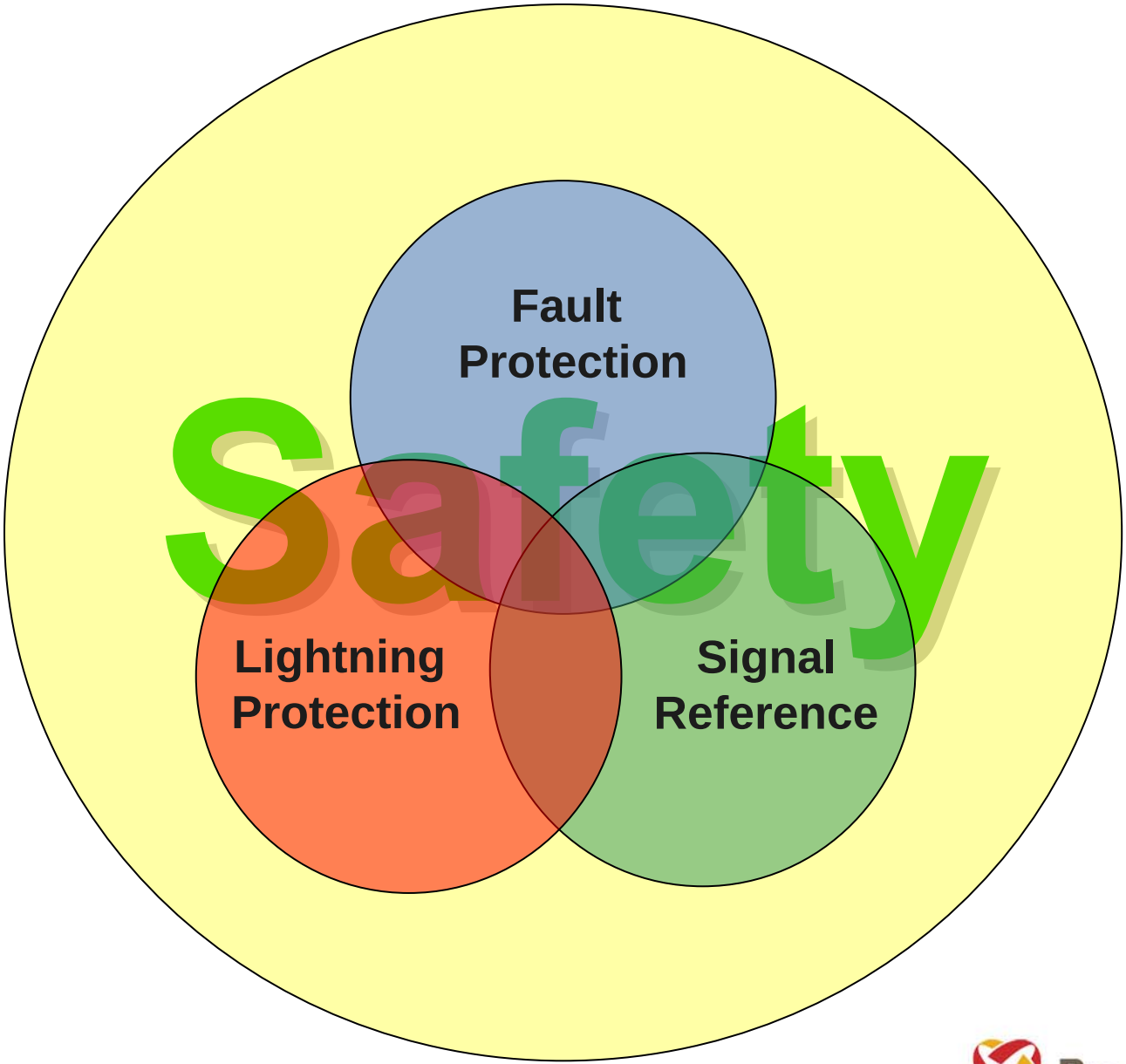
# Definitions

- Review definition as we encounter them.
- Grounded vs Grounding
- Isolated Ground
- Floating Ground
- Ground Loop
- Net Current

# Why am I grounding or Not?

- Safety
- Grounding for Fault Current Paths
- Grounding for Touch Potential (static)
- Grounding for Lightning Protection Surge Arresters, TVSS (SPD)
- Grounding for Signal Reference (RF, Data, static ,etc.)
- Not Grounding Continuous operation

# Three reasons for grounding




Progress Energy

# Grounded vs Grounding

- Grounded vs. grounding in an electrical system. Grounded system refers to a system where a conductor is grounded and is intended to or may carry current in the normal operation. The neutral on a wye system is a prime example of a grounded conductor.
- The grounding conductor system is not intended to carry operational current in its design. This path is intended to carry unwanted and fault currents for protection.

# Types of AC Grounded Systems

- Ungrounded system
- Solidly Grounded System
- Resistance Grounded
- Reactance Grounded
- Ground Fault Neutralizer

# Which System to Use??

- Safety - Who is Operating the System
- Ground Fault Detection
- Signal Reference
- Touch Potential (also static)
- Available Fault Currents?
- Operation Stability
- System Response

# Ungrounded System

- Type of system typically used on is a Delta service.
- Some time used on a floating Wye
- Detection System in Place
  - Ground Detection by Lighting
  - Zigzag Grounding Transformer
  - Ground Relay
  - Ground Fault ???

# Detection Devices


Progress Energy

# Solidly Grounded System

- Usually use in Wye systems
- Return Fault current to trip overcurrent protection device quickly
- Usually better reference and safer system
- Much better for lightning protection
- Can be used in Corner Grounded Delta
  - Problems with phase grounded re-grounded
  - Not good on lightning protection equipment

# Resistive grounded

- Low Resistance
  - Limit Fault Current
  - Minimizes the damage at the fault
  - Used usually with multiple sources i.e. transformers, and or generators
- High Resistance
  - Enables system operation with one phase grounded
  - Enables current to flow for detection networks
  - Current is low enough so that no damage occurs

# Reactance Grounding

- Reactor connected between system neutral and ground
  - Reduces the ground fault current between phase and ground
  - Usually higher fault current than low resistance grounding
  - Better coordination with fault currents on multi-grounded system.  Mostly used on system above 5kV.

# Ground-Fault Neutalizer

- Reactor with relatively high value of reactance.
- Usually on system above 15kV phase to ground air exposed. (overhead Transmission and Distribution)
- May provide insulator flashover with self-extinguishing characteristics.

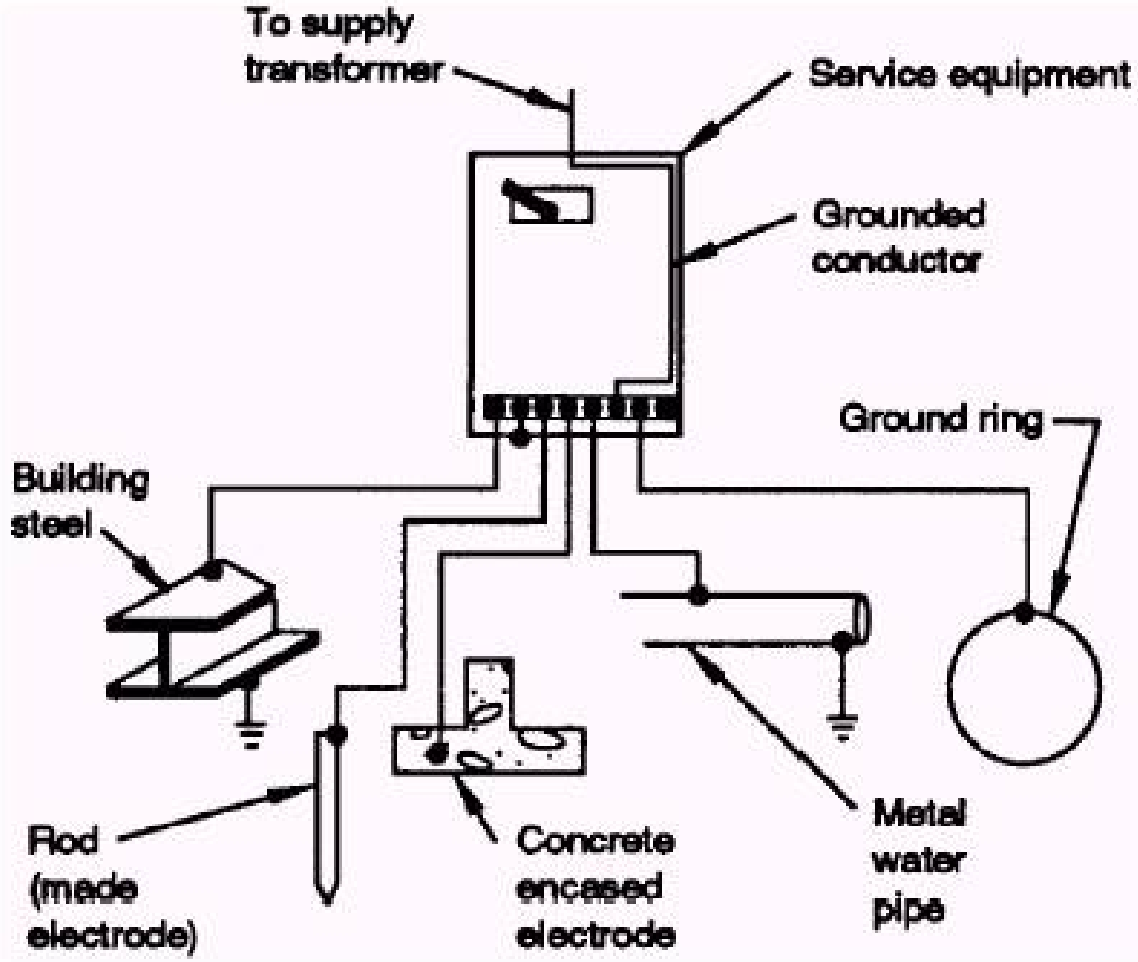
Progress Energy

# Separately Derived System

- The system grounding conductor for a separately derived system shall be grounded at only one point.
- Main system Disconnecting means for a main utility feed, or a step down or step up transformer, or a generator could all be separately derived systems.
- When grounded it will be grounded at the nearest grounding electrode.

# Grounding Electrode System and Grounding Electrode Conductor Part III

- NEC 250.50 (Grounding Electrode System) 250.52 Electrodes
  - Water Pipe if 10 ft. or more of metal water pipe is in contact with the earth.
  - Metal Frame of the Building or Structure where the following methods are used to make an earth connection: (1,2,3,4)
  - Concrete-Encased Electrode in at least 2” of concrete located within and near the bottom of a concrete foundation or footing that is in indirect contact with the earth.
  - Ground Ring encircling the building or structure in direct contact with the earth
  - Rod or Pipe electrode not less than 8 ft in length
  - Plate Electrode not less than 2 square ft.
  - Other Local underground systems such as piping, underground tanks and underground metal well casing
  - NOT Permitted
    - Metal underground gas piping
    - Aluminum electrode




NEC Section 250
OSHA Section 29 CFR 1910.304 (f)

# Grounding Electrode System

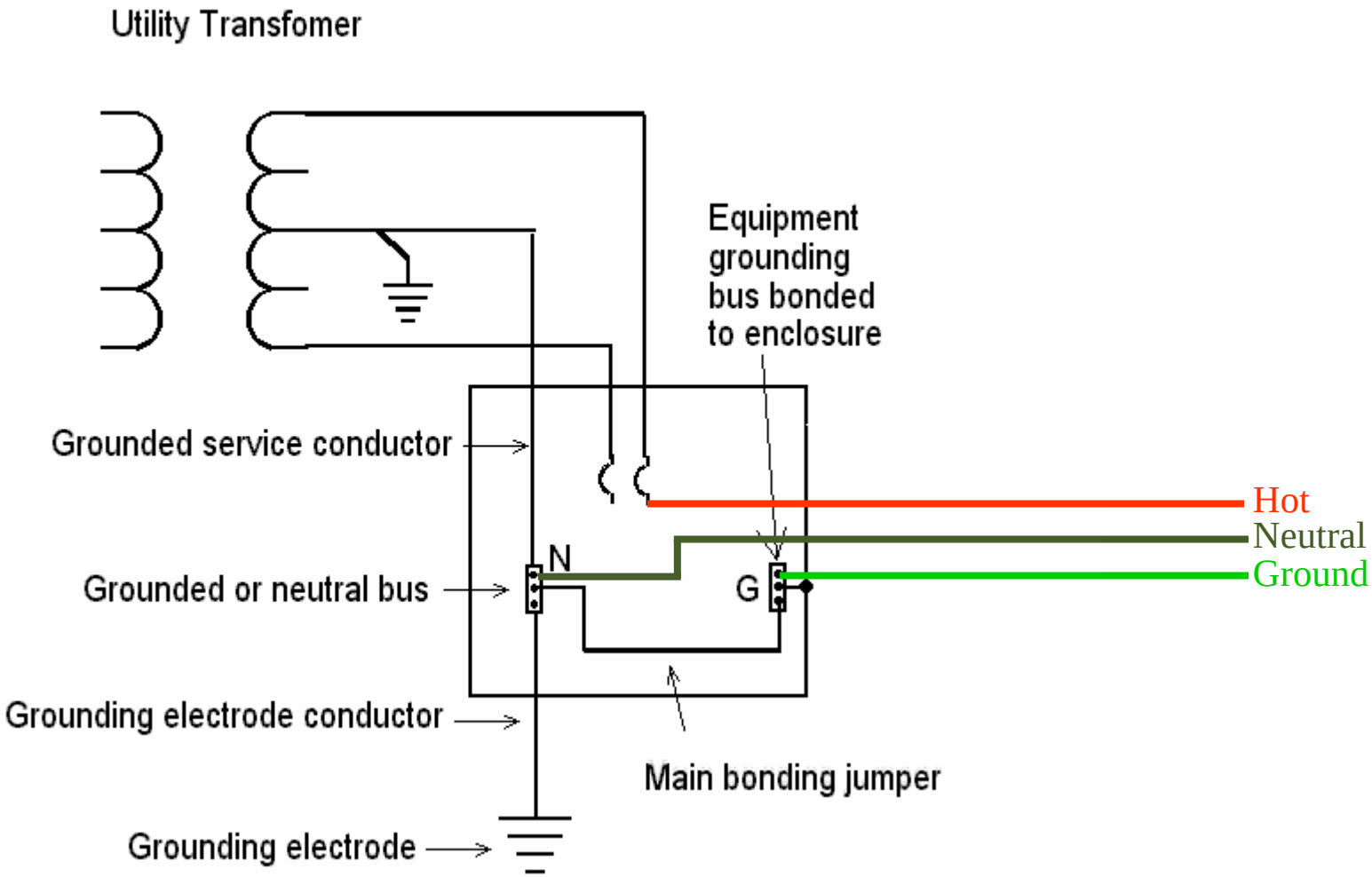
- Installation NEC 250.53
  - This requirement clarifies that the supplemental electrode system must be installed as if it were the sole grounding electrode
- **Bonding NEC 250.53 C**
  - **This requirement is for bonding of multiple electrodes.**

Progress Energy

# Bonding

- Bonding for
  - Main Bonding Jumper
  - System Bonding Jumper
  - Electrode Bonding
  - Part V Bonding
    - Where necessary to ensure electrical continuity and the capacity to conduct safely and fault current likely imposed.

# Ground ?

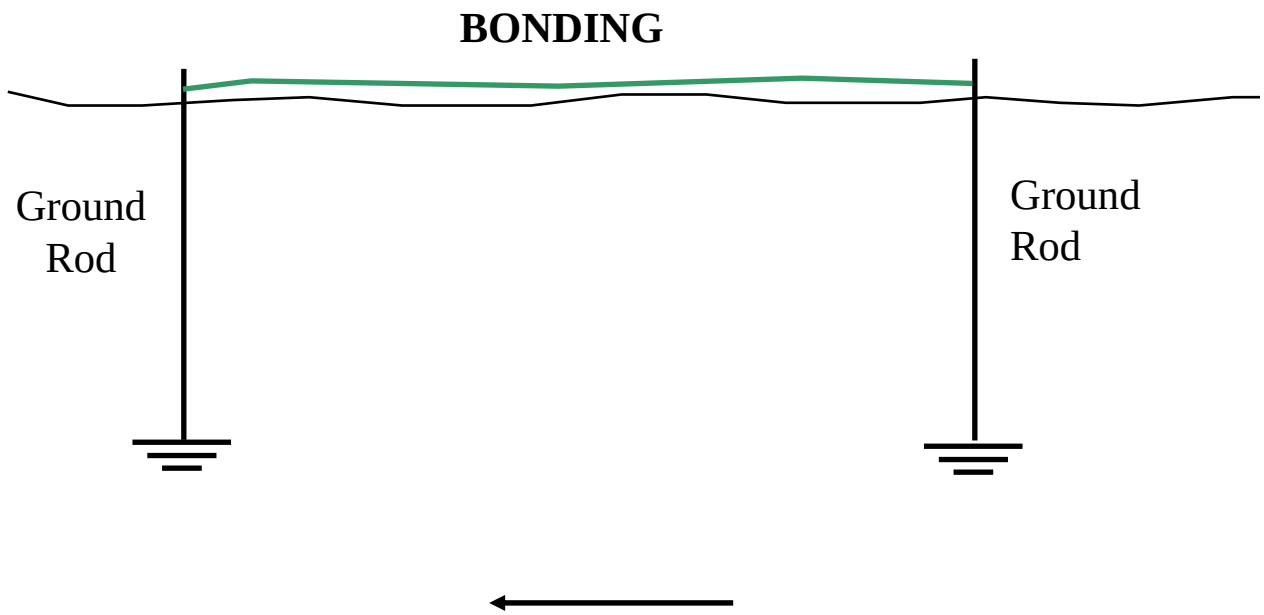



Progress Energy

# Review Ohms Law

**Voltage = Current X Resistance**

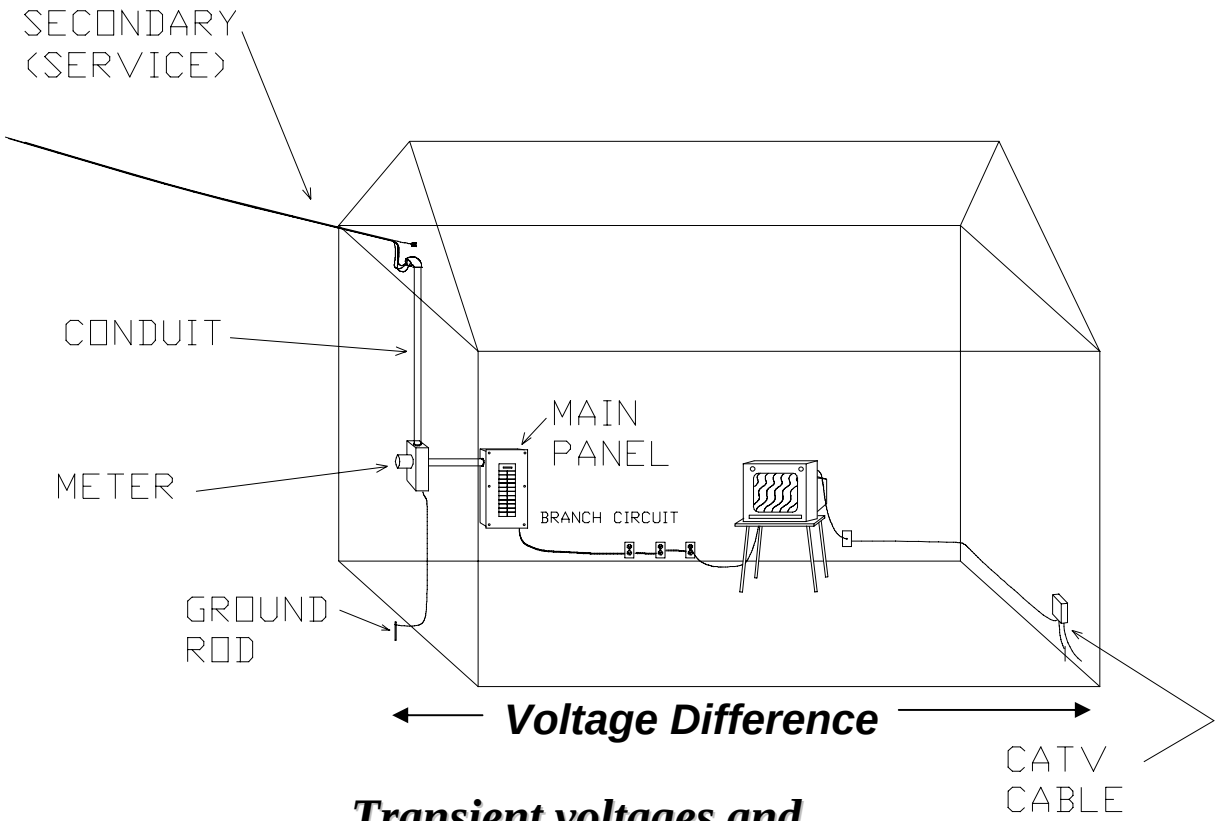
**(Potential) (amps) (ohms)**




**Current Source Lightning**
**Average current 30,000 amps**

Progress Energy

# Grounding and Bonding




***Transient voltages and currents*** *at data port or cable connections*

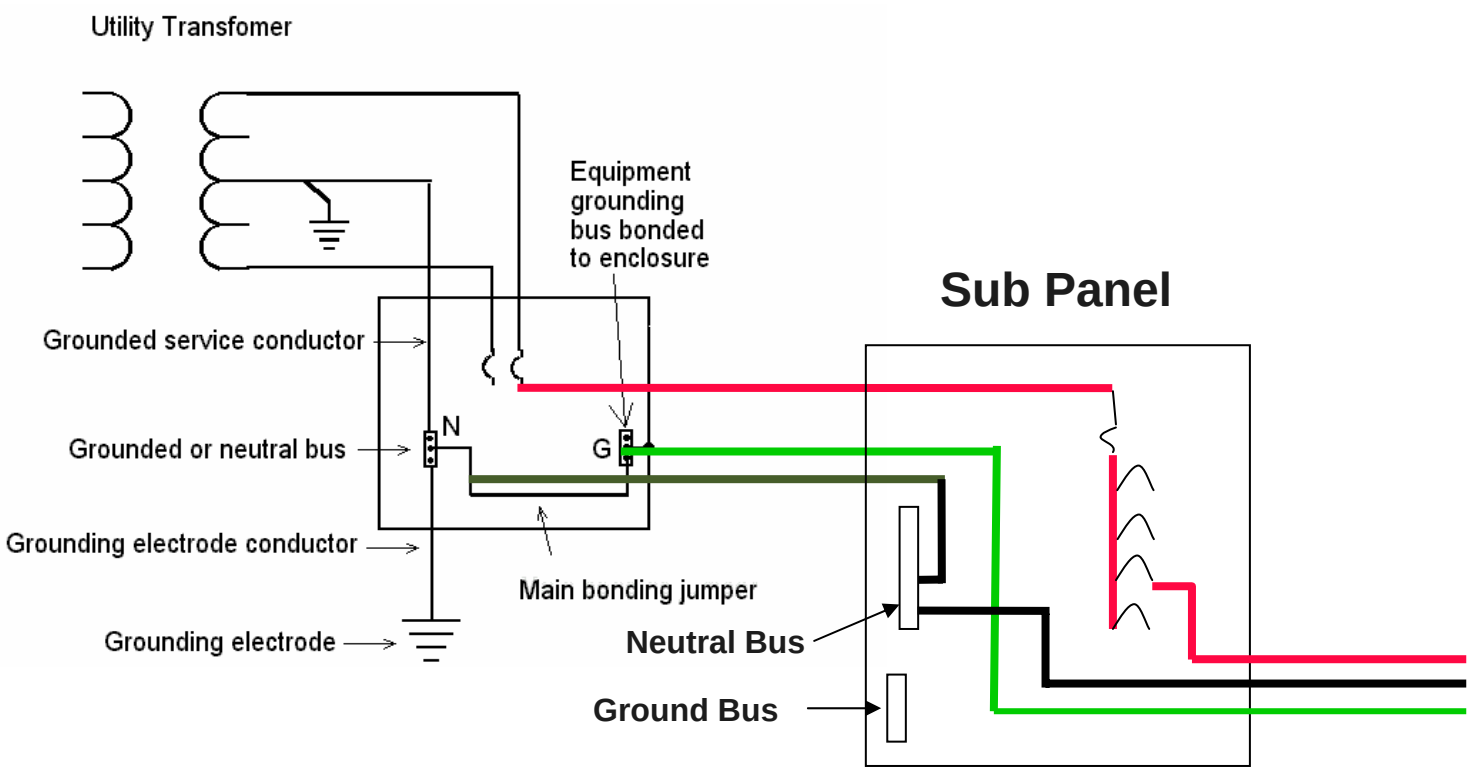
Progress Energy

# Isolated Ground

- NEC 250.146 (D) Isolated ground receptacle (orange triangle) NEC 406.2(D)
- NEC 250.96 (B) Isolated Grounding Circuits
- NEC 647 Section Sensitive Electronic Equipment.
- NEC 647.6 Grounding.
  - “Technical Equipment Ground”

# Isolated Ground

**Isolated grounded receptacle has an isolated terminal from the yoke to the ground Lug. These receptacle are usually marked with an orange triangle or all orange.**




Progress Energy

# Floating Ground

- The neutral on a wye system is not intentionally grounded
- Signal conductor shielding is not intentionally grounded
- Problem is high transient voltage or overvoltages may exist causing damage.
- Not a good way for lightning protection

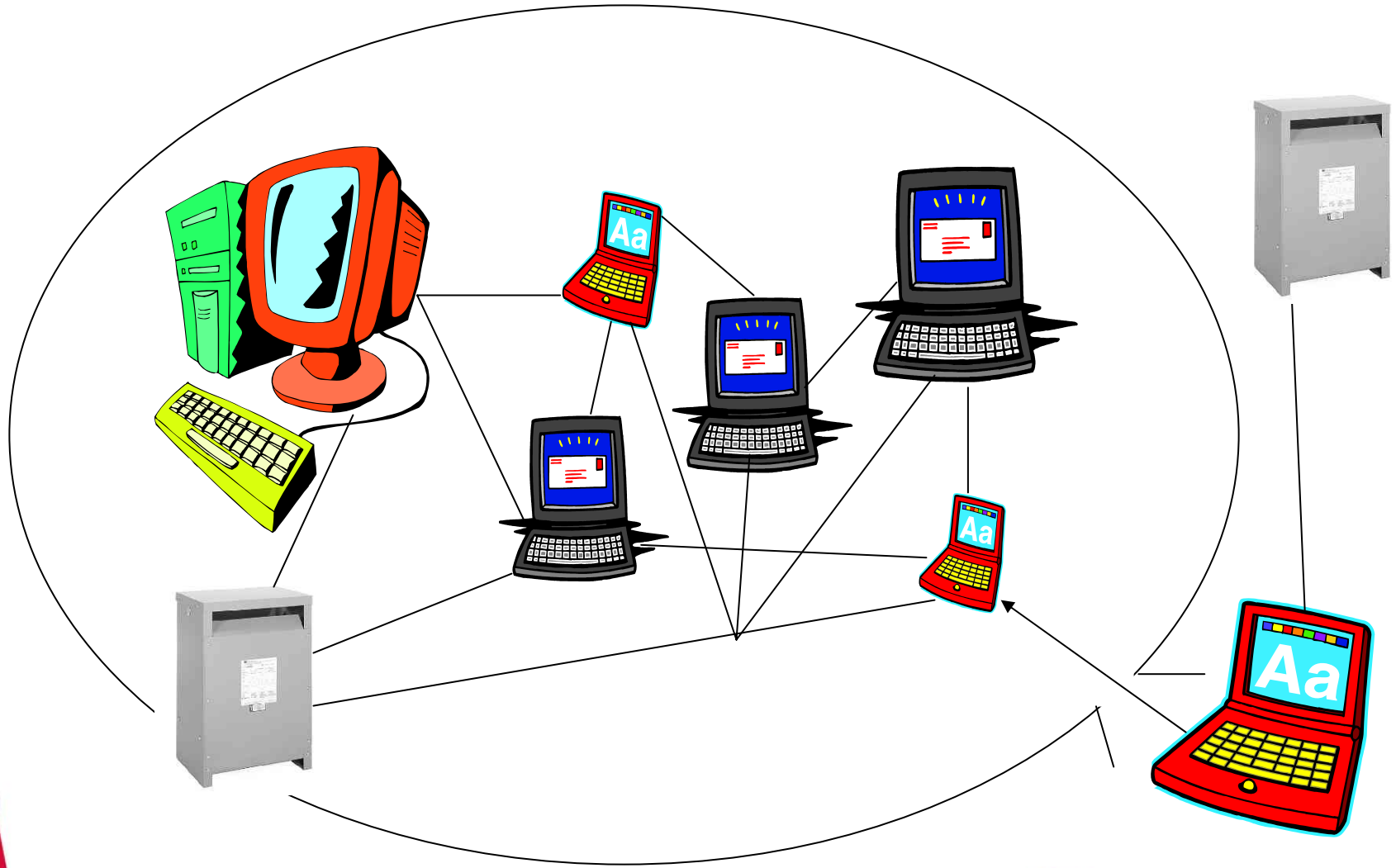
# Ground Loop

- Grounds from two different derived system are connected
- Open ground loops.  Grounds are not bonded properly and cause damage.
- Ground loops cause circulating current between systems and cause transformer coupling (CT's)
- Signal reference can be compromised causing data errors.

# Grounding for Signal Reference

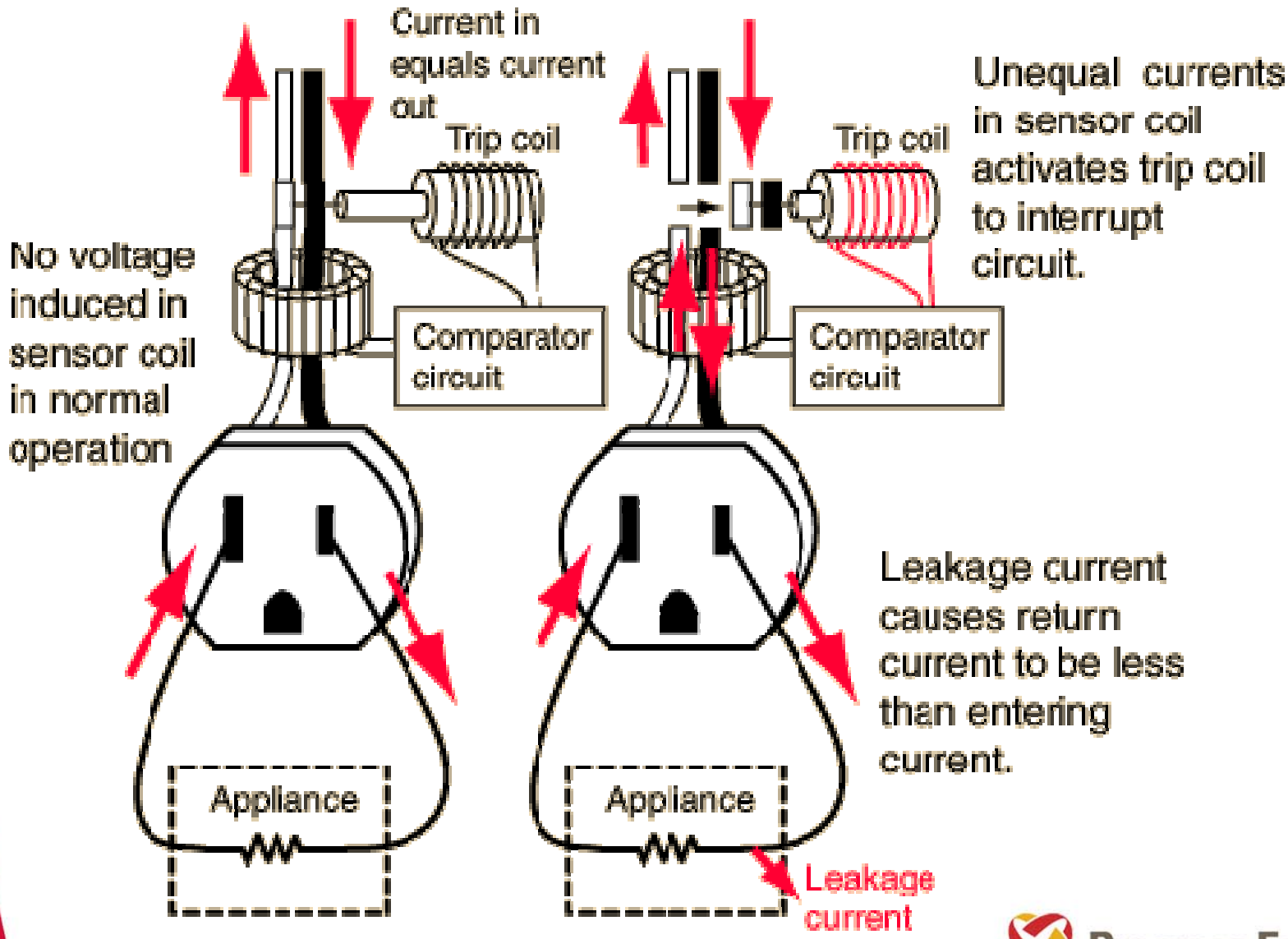
- Don’t Burst the Bubble.
- Ground on one end
- Ground on both ends
- Ground on neither end
- Fiber Optic  Best Answer
- Optical Coupler

# Don’t Burst the Bubble




Progress Energy

# Ground Fault Interrupter Function




Progress Energy

# Net Current

- Currents that are not apart of the normal operation of a derive electrical system.
  - All positive, negative, and zero sequence currents added and the resultant current are net currents.

# Books On Grounding

- NEC
- IEEE
  - Green Book 142-1991“Recommended Practice for Grounding of Industrial and Commercial Power Systems”
  - Emerald Book 1100-1999 “Recommended Practice for Powering and Grounding Sensitive Electronic Equipment”
- Industrial and Commercial Power system Handbook