Traffic Signal Grounding

DMD & Associates Ltd.
www.dmdeng.com

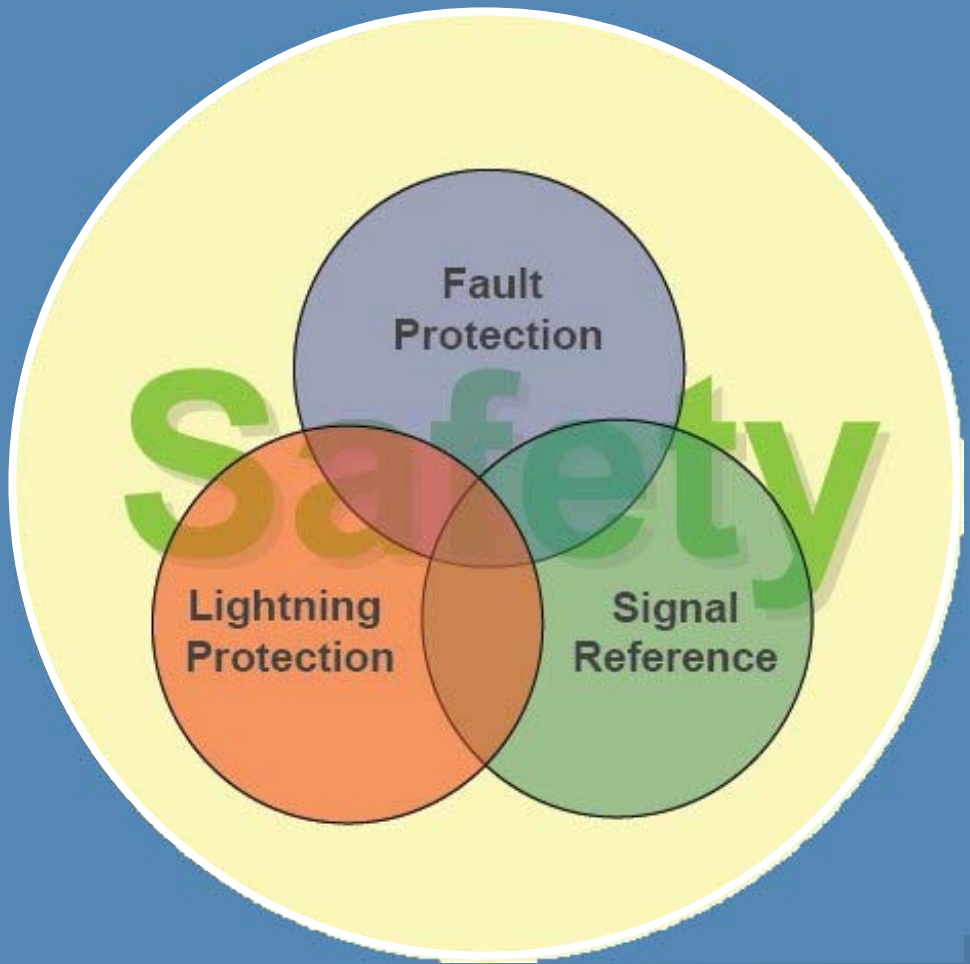
Grounding

- Why is Grounding so Important?
- Grounding Basics
- Existing Signal Grounding – a Snapshot
- Grounding Studies by Others
- Cabinet Assembly Grounding & Surge Protection
- Portable Generators
- Can improvements be made?

Why is Grounding so Important?

- Safety
- Grounding for Fault Current Paths
- Grounding for Touch Potential (static)
- Grounding for Lightning Protection
- Grounding for Signal Reference

Three Reasons for Grounding



Grounded Conductor vs Grounding

- *Grounded conductor* refers to a system where a conductor is grounded in an electrical system and is intended to or may carry a current in normal operation. (AC Neutral)
- *Grounding conductor system* is NOT intended to carry operational current. This path is intended to carry only fault currents.

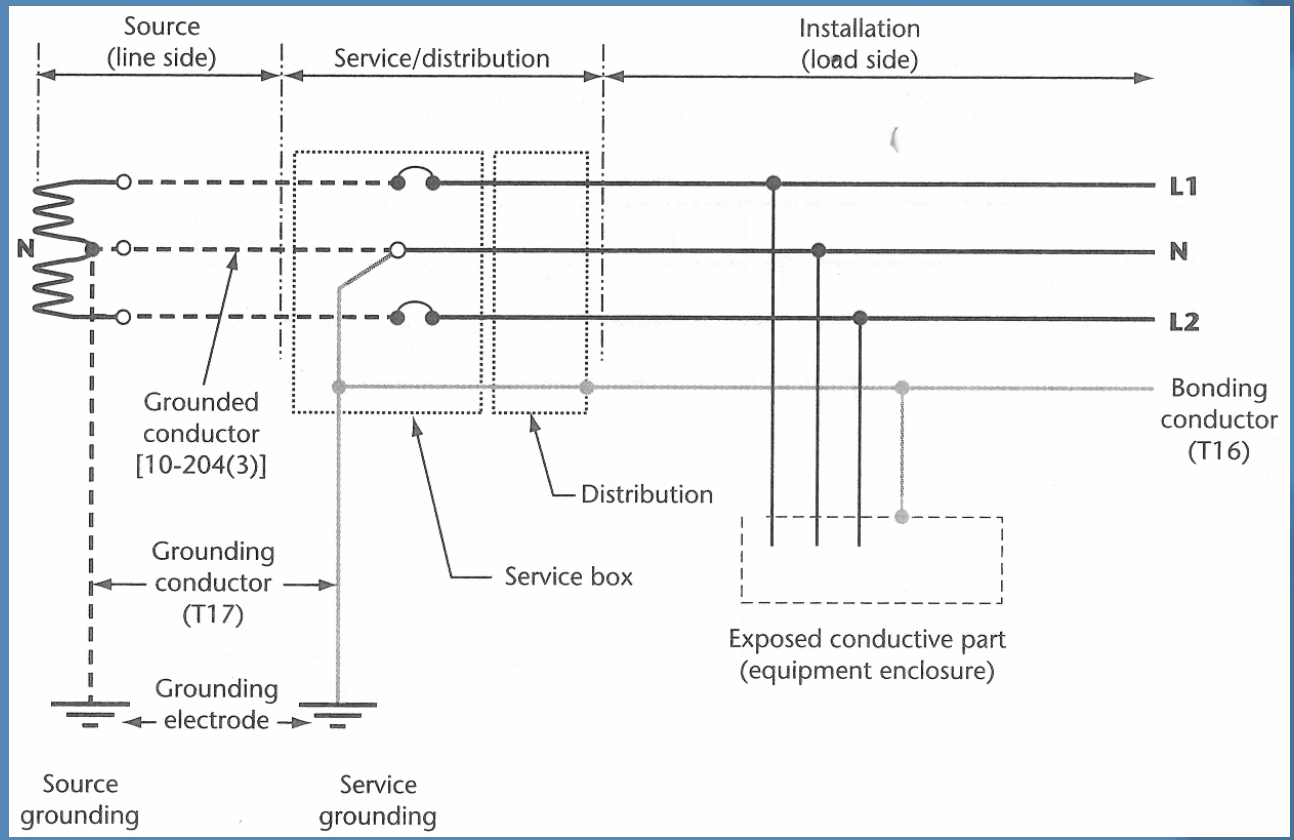
Grounding vs Bonding

- *Grounding* – to make a connection to the earth or some conducting body
  - Provides a path to the earth for lightning, static electricity, high frequency noise
- *Bonding* – bonding all metal parts together to the effective ground fault current path
  - Establishes a “zero system reference”

Canadian Electrical Code

- Rule 10-106 - Alternating Current Systems
  - Alternating current systems shall be grounded if:
    - By doing so, their maximum voltage to ground does not exceed 150 volts, or
    - The system incorporates a neutral conductor
- A solidly grounded system has a solid connection between it's neutral point and earth

Canadian Electrical Code 2006



Single Phase 3 Wire Solidly Grounded System

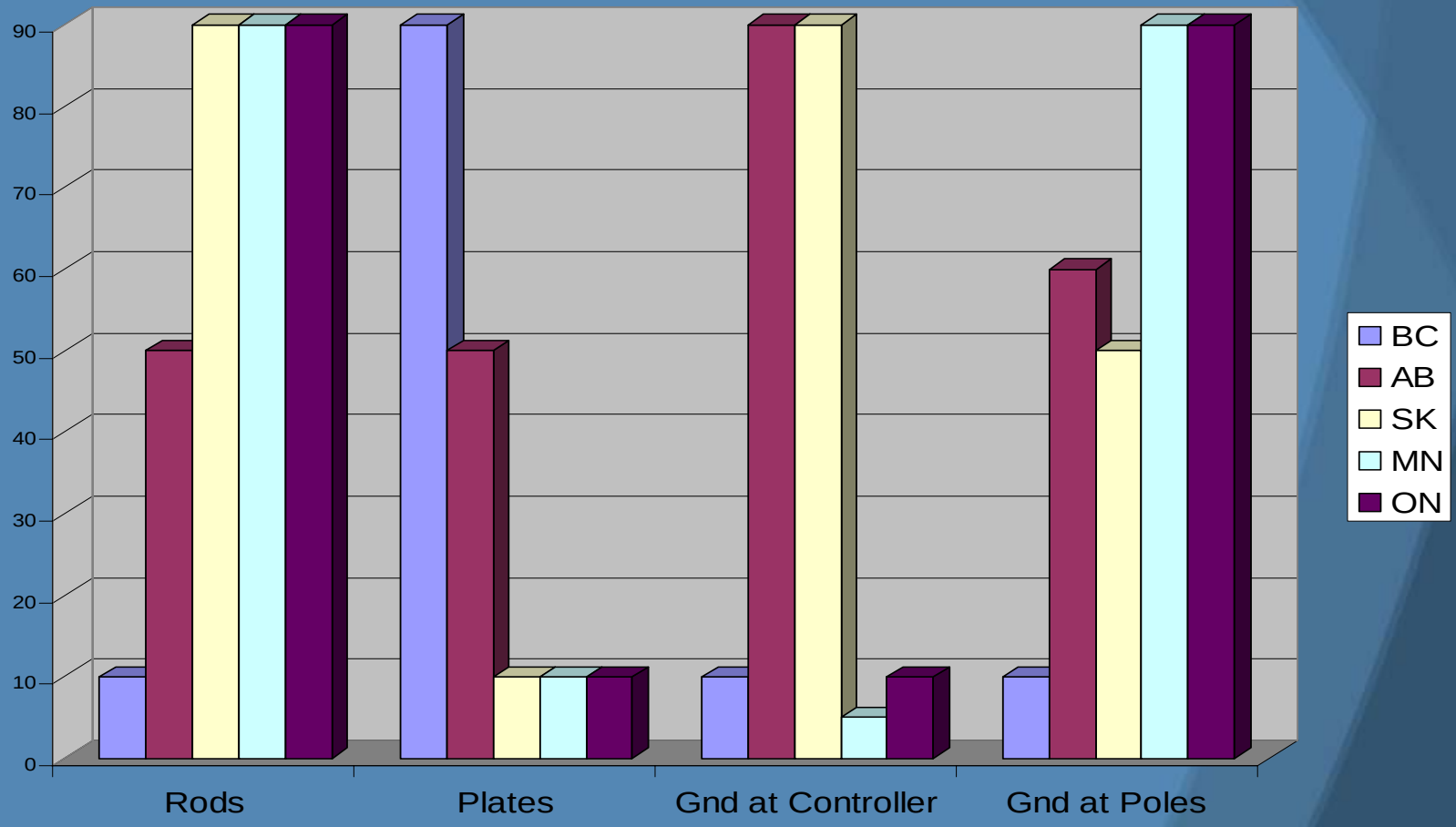
Canadian Electrical Code 2006

- Rule 10-700 – Grounding Electrodes
  - Consist of two rods spaced no less than 3 m apart, or
  - A plate electrode
    - In direct contact with the soil no less than 600mm below grade, or
    - Encased in the bottom 50 mm of a concrete foundation in direct contact with the earth not less than 600 mm below grade

Signal Grounding Survey

- Type of Grounding Electrodes
  - Rods or Plate?
- Location of Grounding Electrodes
  - Each signal pole? Controller Cabinet? Service Only?
- Grounding System Testing
  - During installation?
  - Ongoing maintenance?

Ground Installation Trends



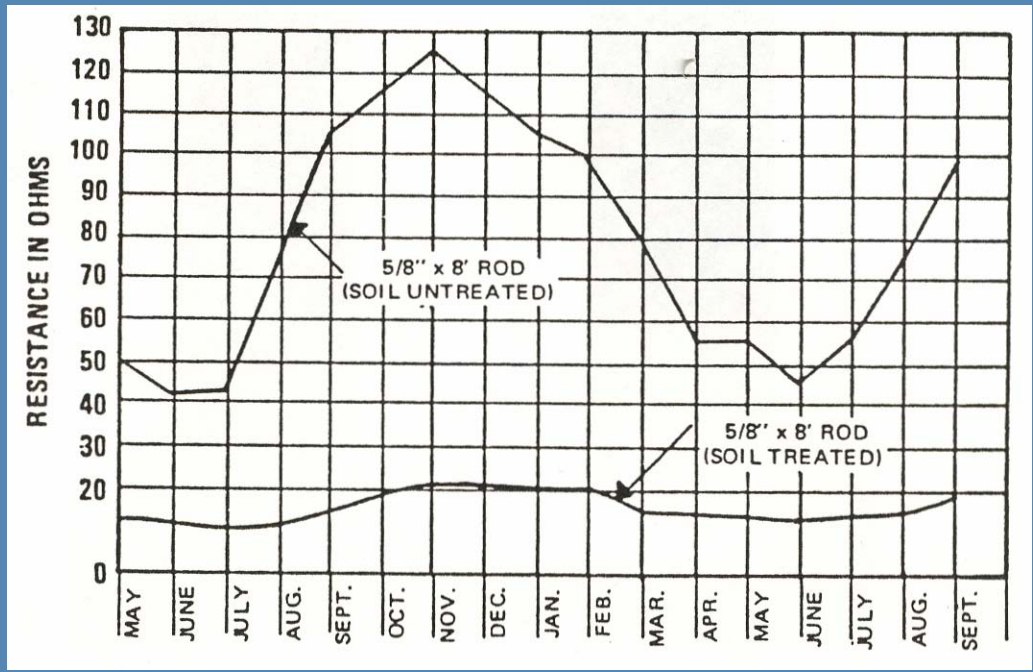
Canadian Electrical Code 2006

- Rule 10-500 Effective Grounding
  - Path to ground shall be permanent and continuous
  - Shall have ample capacity to conduct safely, any currents liable to be imposed on it
  - *Impedance shall be sufficiently low* to limit the voltage above ground and to facilitate the operation of the over current devices in the circuit

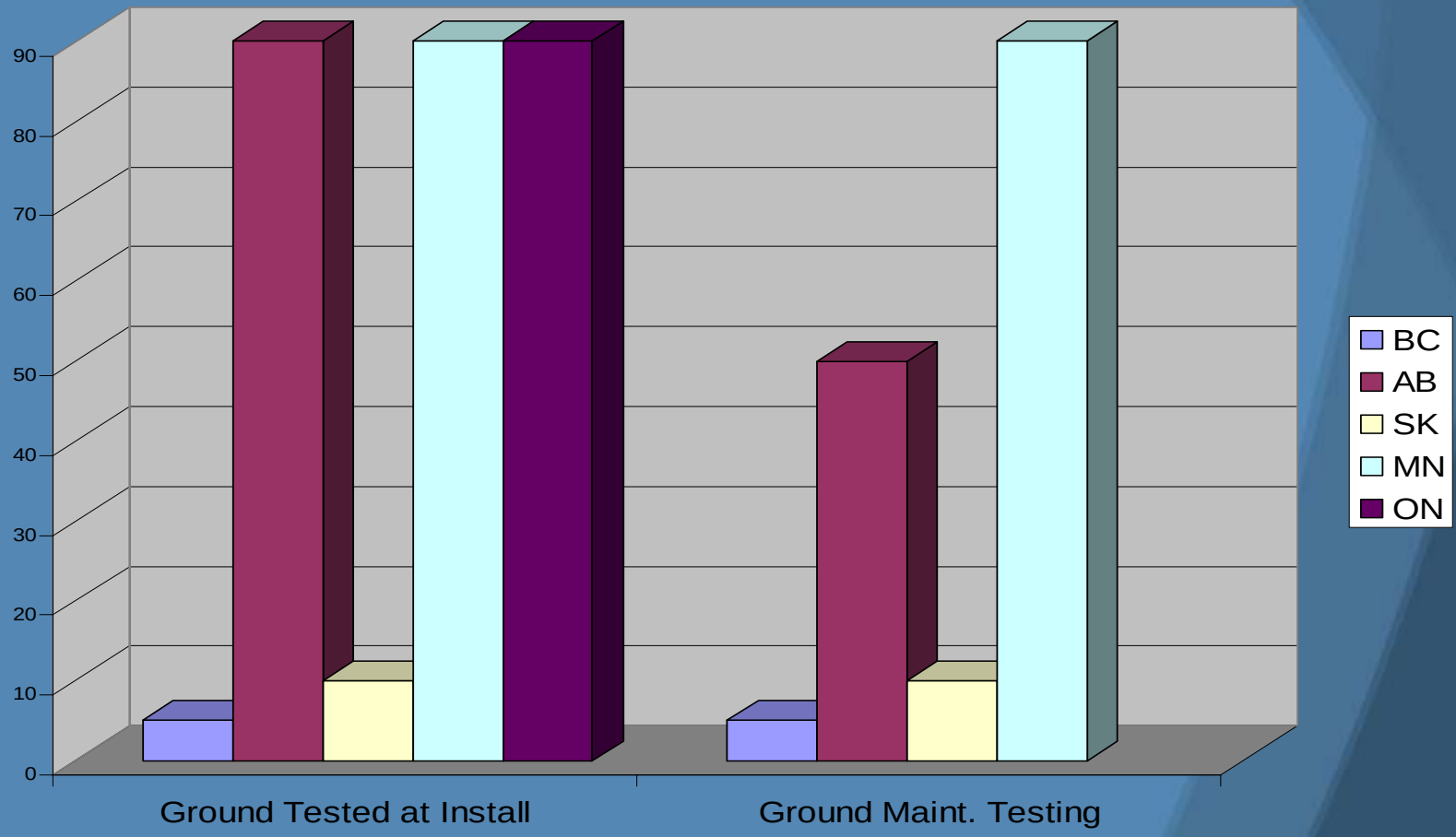
Canadian Electrical Code 2006
Rule 10-500

- *How little impedance is sufficiently low?*
- Before 1987, CEC resistance to ground must be 10 ohms or less
- If 10 ohm ground, when short circuit:
  - I = 120 volts / 10 ohms = 12 amps
- What happens if the resistance to ground is 25 ohms?
  - I = 120/25 = 4.8 amps

Ground Electrodes
Reducing Resistance - Chemical Treatment



Ground System Testing Trends



Ground Resistance Testers

- AEMC Instruments - www.aemc.com
  - Fall of Potential Testers
  - Clamp on Testers
- Extech Intsruments – www.extech.com
  - Fall of Potential Tester
  - Clamp on Tester
- Amprobe – www.amprobe.com
- Fluke- http://ca.fluke.com
- Meggar – www.meggar.com

Ontario MoT & IMSA Study

- MoT Ontario spending $50K per year due to damage from lightning
- Study done in conjunction with IMSA Ontario and McCormick Rankin & Assoc.
- What should be grounded?
- When and where to ground?
- How to design adequate grounding to protect man and equipment?

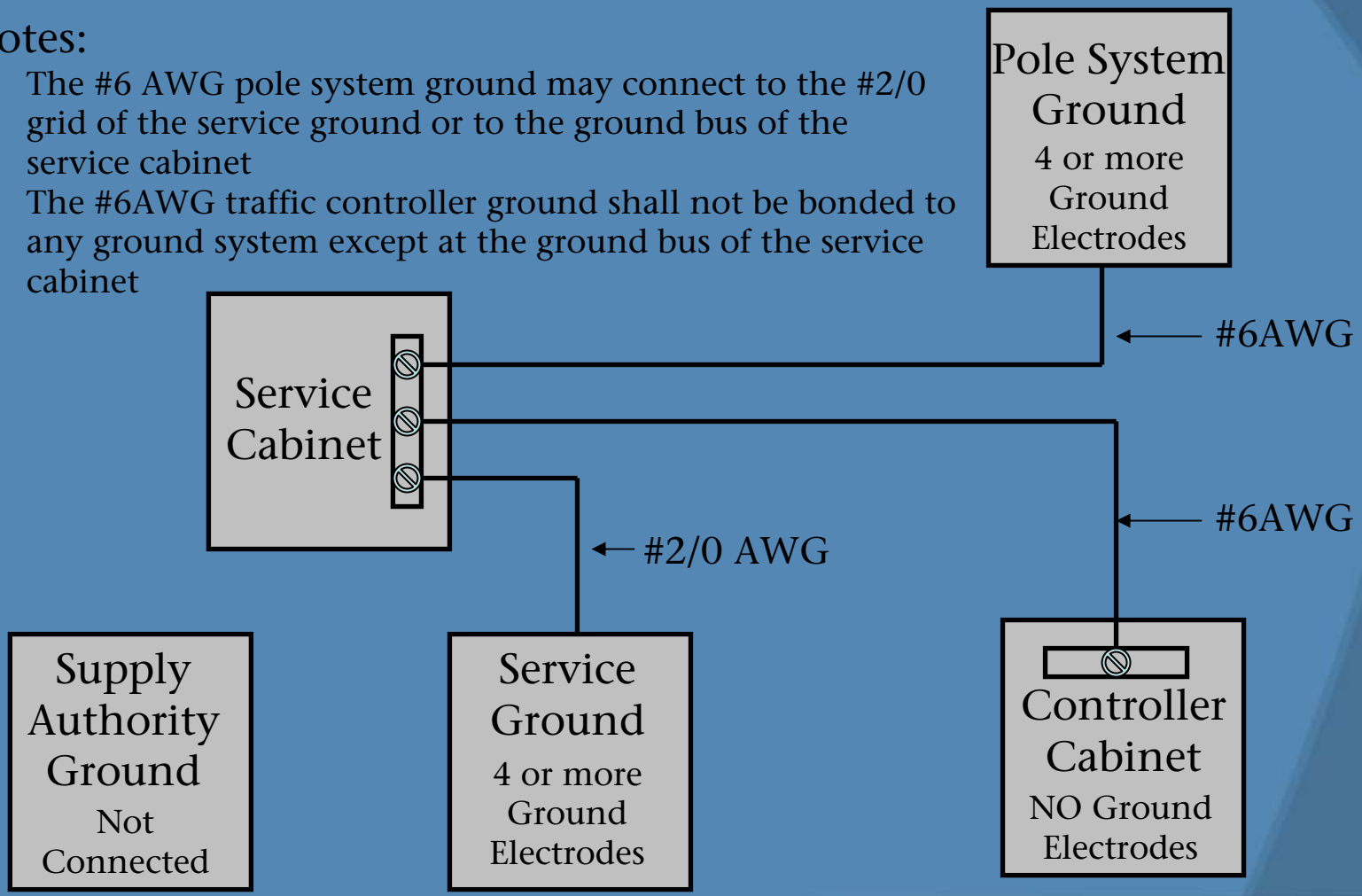
Ground Electrode Recommendations

- Do not install a ground electrode at the controller cabinet
- Install at least 4 ground rods (2 plates) at the service location.
- Install at least 1 ground electrode at each corner of the intersection.

Ontario MoT & IMSA Study

Notes:

1. The #6 AWG pole system ground may connect to the #2/0 grid of the service ground or to the ground bus of the service cabinet
2. The #6AWG traffic controller ground shall not be bonded to any ground system except at the ground bus of the service cabinet



NEMA TS2 Cabinet Grounding

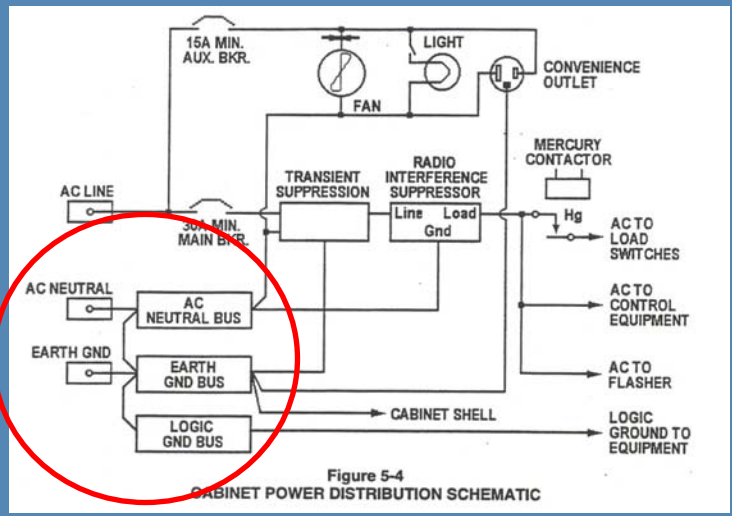


Figure 5-4
CABINET POWER DISTRIBUTION SCHEMATIC

- 5.4.2.1 Grounding System – the grounding system shall be divided into three separate and distinct circuits connected together at a single point.

NEMA TS2 Cabinet Grounding

- SDLC communication cables shall be shielded, and the shield shall be connected to earth ground at the connector end only
- All panels within the cabinet assembly should be directly connected to the ground bus in a manner that minimizes the length of the conducting path

NEMA TS2 Surge Protection

- 5.4.2.4 AC Service Transient Suppression
  - Transient Suppression must withstand a 20,000 amp surge current
  - Output voltage must not exceed 500 volts at any time

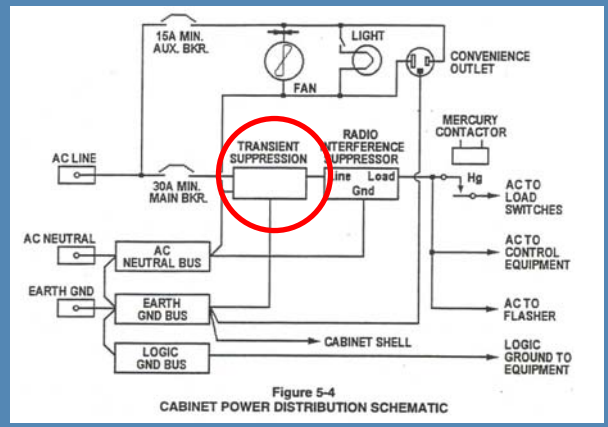


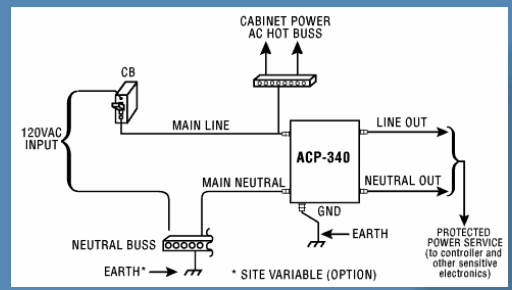
Figure 5-4
CABINET POWER DISTRIBUTION SCHEMATIC

Surge Protection Devices (SPD's)

- What do they do?
  - Attenuate transient voltage levels and noise
  - Shunt current to ground (20,000+ amps)
  - Clamp voltages (250 volts typical)
  - Filter certain frequencies
- What technologies are used?
  - Metal oxide varistors
  - Silicon avalanche diodes
  - Gas tubes
  - LCR filters

Surge Protection Recommendations

- Use a hybrid surge arrestor capable of providing quick response as well as dissipating high energy faults
- Use a Transient Voltage Suppressor to limit the transient voltages on the 24 VDC line to 28 volts
- Provide surge protection for all circuits entering the controller cabinet
  - Communication lines
  - Cameras
  - Loops
  - Antennas



Cabinet Assembly Surge Protection

Sanderson & Willingdon, Burnaby

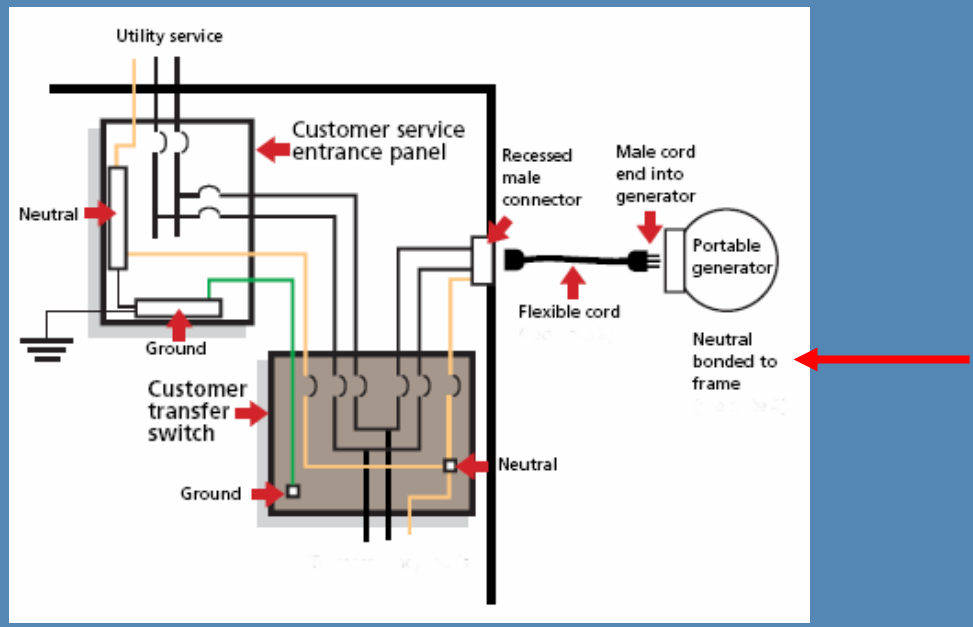
- 25KV line touches video camera on street light

Cabinet Assembly Surge Protection

200th Street & Logan Avenue, Langley

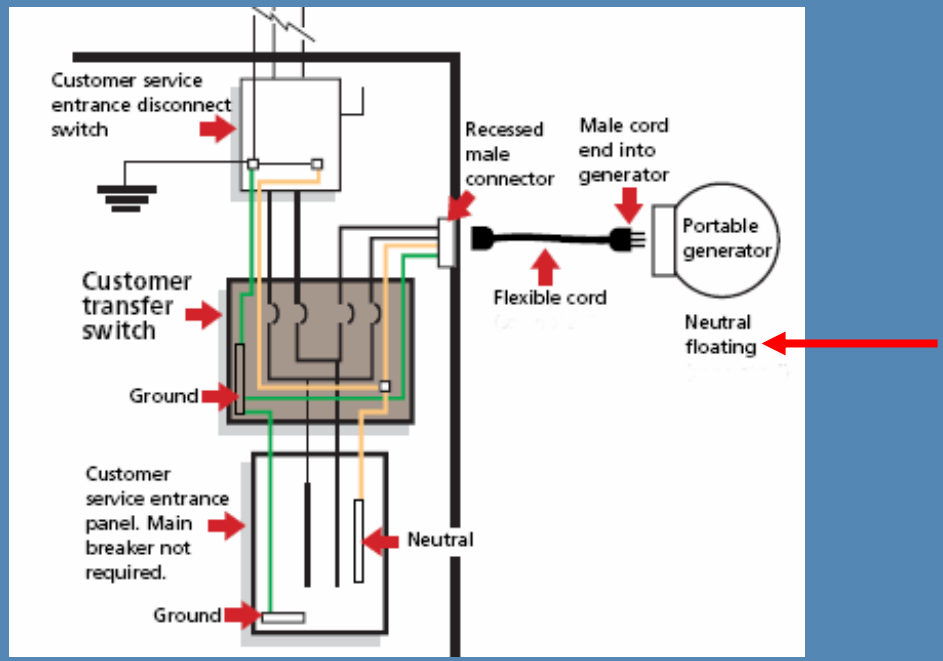
- 25KV line breaks and lands over inductive loops

Portable Generator Connections



- A separate ground is not required because the generator neutral is bonded to the frame
- A transfer switch must be used that switches the neutral conductor

Portable Generator Connections



- The neutral conductor must be solidly connected if the generator neutral is floating

Can Improvements be Made?
In the Cabinet…

- Reduce size of over-current devices to better match cabinet loads
- Keep bonding wires as short as possible and directly connected to the ground bus
- Verify bonding wires are large enough
- Test existing surge protection equipment regularly

Can Improvements be Made?

Outside the Cabinet…

- Review existing grounding systems and upgrade if not 10 ohms
- Install supplemental grounding
- Test grounding systems as part of your regular signal maintenance
- Separate the controller cabinet location from power service location
- Make a 2 ft diameter coil with 6 turns in the line and neutral feeders at a nearby pull box.