

Shielded vs. Non-Shielded – Changes in the NEC

Presenter:

Michael Hammons
Applications Engineer
AmerCable Inc.

Changes to Article 310.6 for the 2005 National Electrical Code

For the 2005 edition of the NEC, the members of CMP-6 voted to change the voltage rating for non-shielded cables from a maximum of 8000V to 2400V.

Article 310.6 – 2002 NEC

310.6 Shielding. Solid dielectric insulated conductors operated above 2000 volts in permanent installations shall have ozone-resistant insulation and shall be shielded. All metallic insulation shields shall be grounded through an effective grounding path meeting the requirements of 250.4(A)(5) or 250.4(B)(4). Shielding shall be for the purpose of confining the voltage stresses to the insulation.

Exception: Nonshielded insulated conductors listed by a qualified testing laboratory shall be permitted for use up to 8000 volts under the following conditions:

- (a) Conductors shall have insulation resistant to electric discharge and surface tracking, or the insulated conductor(s) shall be covered with a material resistant to ozone, electric discharge, and surface tracking.*
- (b) Where used in wet locations, the insulated conductor(s) shall have an overall nonmetallic jacket or a continuous metallic sheath.*
- (c) Where operated at 5001 to 8000 volts, the insulated conductor(s) shall have a nonmetallic jacket over the insulation. The insulation shall have a specific inductive capacity not greater than 3.6, and the jacket shall have a specific inductive capacity not greater than 10 and not less than 6.*
- (d) Insulation and jacket thicknesses shall be in accordance with Table 310.63.*

Article 310.6 – 2005 NEC

310.6 Shielding. Solid dielectric insulated conductors operated above 2000 volts in permanent installations shall have ozone-resistant insulation and shall be shielded. All metallic insulation shields shall be grounded through an effective grounding path meeting the requirements of 250.4(A)(5) or 250.4(B)(4). Shielding shall be for the purpose of confining the voltage stresses to the insulation.

Exception: Nonshielded insulated conductors listed by a qualified testing laboratory shall be permitted for use up to 2400 volts under the following conditions:

(a) Conductors shall have insulation resistant to electric discharge and surface tracking, or the insulated conductor(s) shall be covered with a material resistant to ozone, electric discharge, and surface tracking.

(b) Where used in wet locations, the insulated conductor(s) shall have an overall nonmetallic jacket or a continuous metallic sheath.

(c) Insulation and jacket thicknesses shall be in accordance with Table 310.63.

Reasons for The Change

Primarily due to safety concerns

- a. Non-shielded cables are susceptible to surface tracking and deterioration
- b. Potential problems with standing line voltages
- c. Potential problems during a fault condition

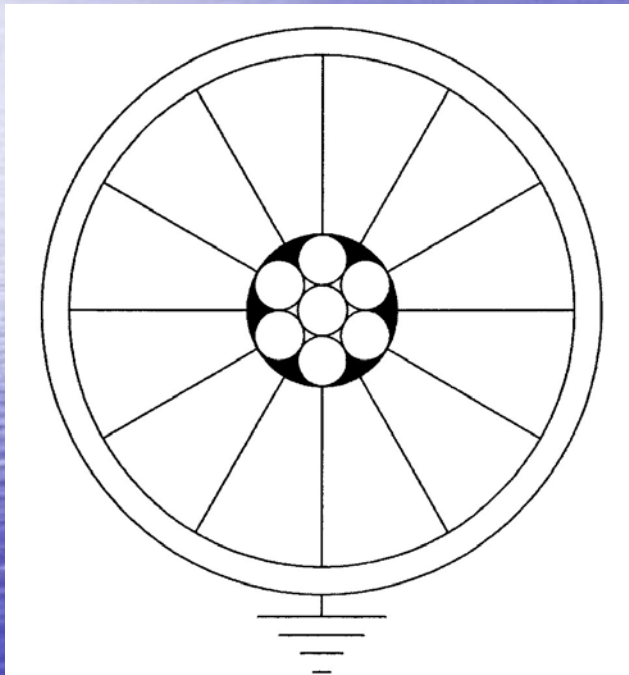
Advantages of Shielded Cables

1. Confines the electric field within the cable
2. Obtains symmetrical distribution of voltage stress within the insulation
3. Protects cable subject to induced potentials
4. Limits radio interference (EMI)
5. Reduces the hazard of shock

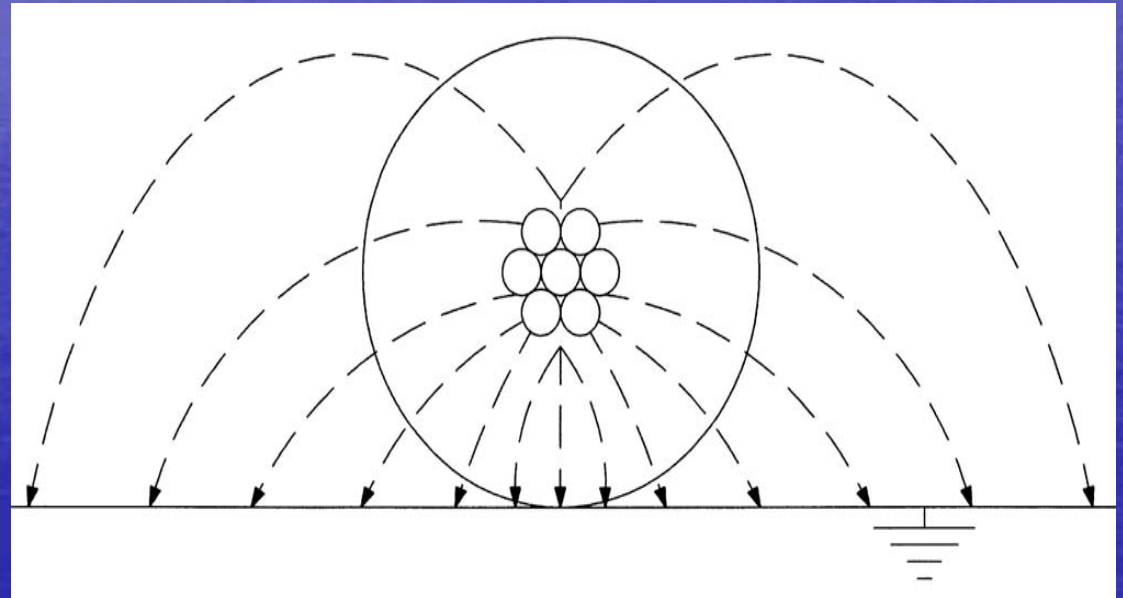
Disadvantages of Shielded Cables

- Shielding requires that the cable have a larger bend radius
- Are typically less flexible than the non-shielded cables
- Terminations require a stress cone
- All of these present problems when installing into areas where space is limited

Field Lines in Shielded vs. Non-Shielded Cables



Shielded Cable



Non-Shielded Cable

Advantages of Non-shielded Cables

- Absence of shielding allows for a very small bending radius
- Cable is very flexible
- Terminations only require the insulation to be tapered back and a lug attached
- Easier to install in areas where space is limited provided proper care is taken to insure adequate spacing between the cables and any grounded metallic objects.

Disadvantages of Non-Shielded Cables

1. Electric field is partly in the insulation and partly in whatever lies between the insulation and ground (usually air)
2. When improperly installed, discharges can occur which result in ozone formation and deterioration of the jacket.
3. These problems increase when installed in contaminated areas (i.e. where the cable is exposed to moisture, soot, grease, or other conducting films)

Improper Installation Resulting in Discharge



Proper Installation



Grounding Shielded Cables

- In general, cable shields should be grounded at each end of the cable run to improve the safety of the circuit
- Cables grounded at only one point will have a voltage built up in the sheath
- Preferred method is to use both a soldered and mechanical connection to provide a permanent low resistance bond

Effects of Grounding Shields at Multiple Points

- Can have circulating currents flowing through the shield due to mutual inductance
- Result is that the shield will be heated and current carrying capacity may be reduced
- Commonly referred to as a “Closed Circuit” shield

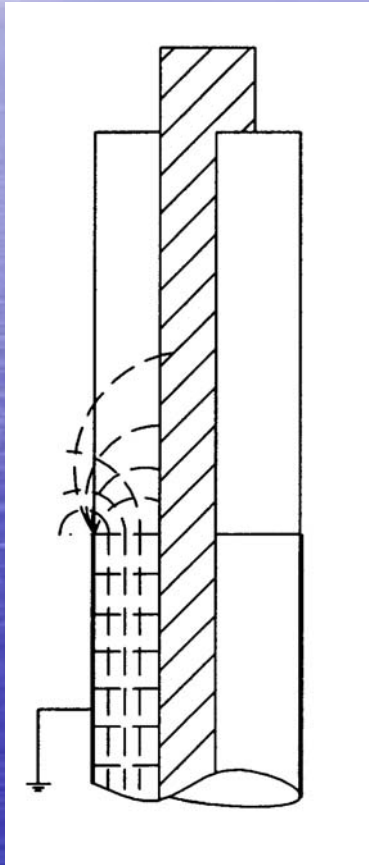
Effects of Grounding Shields at One Point

- Cable will have a voltage built up on the shield due to mutual inductance
- Magnitude will depend on installation and length of cable run
- May cause unsafe conditions for workers due to unwanted discharges
- Safe potential is considered to be 25V
- Commonly referred to as an "Open Circuit" Shield

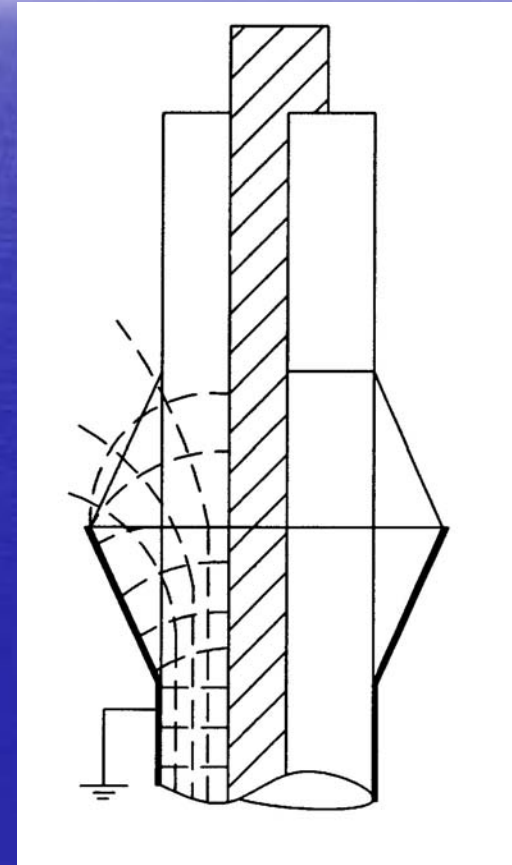
Terminating Shielded Cables

- When terminating a shielded cable, the shield must be removed for a certain distance to prevent flashover
- This results in a distortion of the electric fields in the cable and creates a stress point which must be relieved.
- The common method of achieving this is to apply a stress cone.

Voltage Stresses in a Shielded Cable Termination

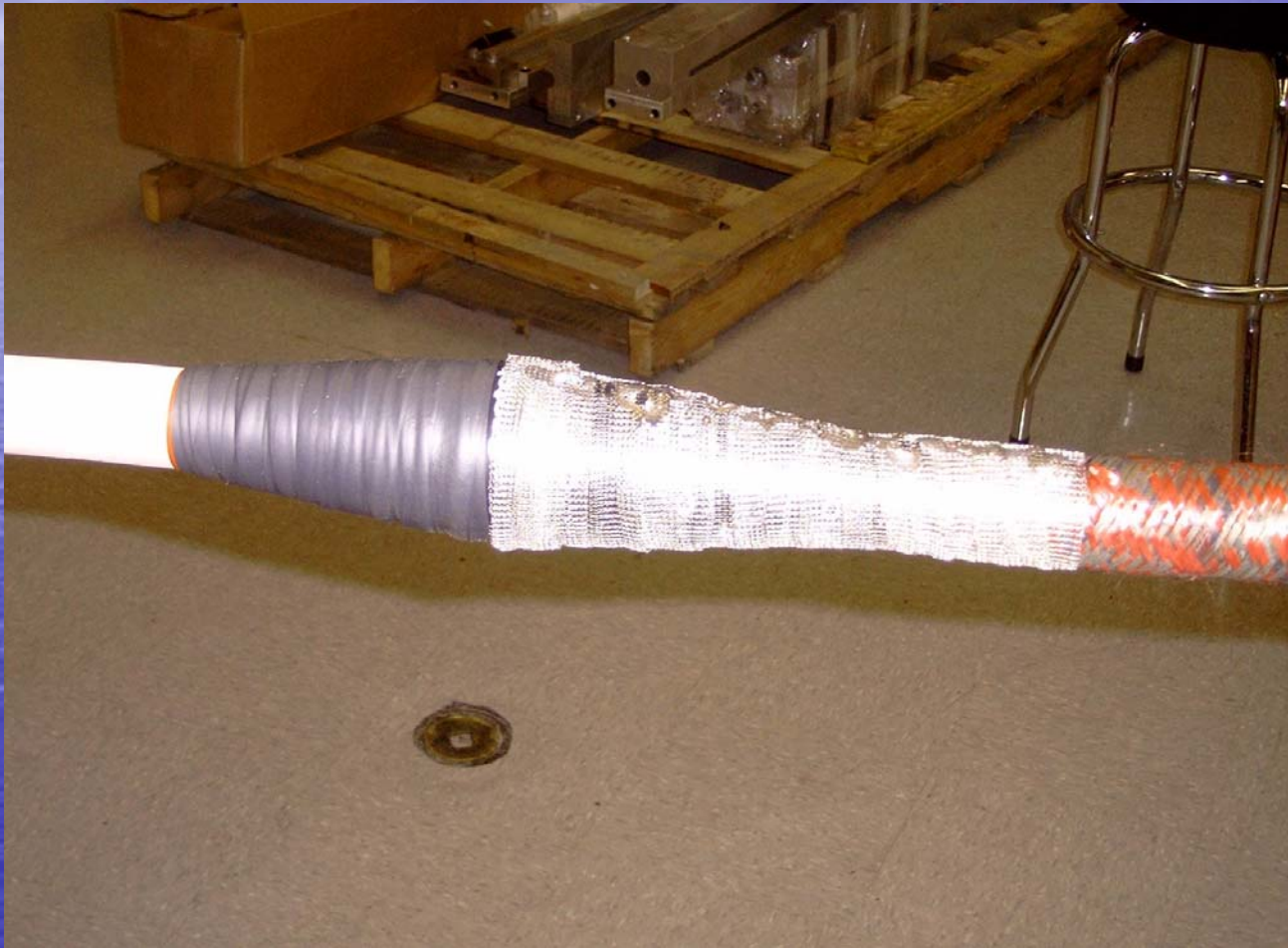


No Stress Cone



Stress Cone

Stress Cone



Terminating Non-Shielded Cable

- Primary concern is compatibility of the connector with the conductor material
- Typical installations involve tapering the Jacket/Insulation back to prevent a flashover from the conductor to the jacket and applying a lug
- Care should be taken to insure adequate spacing between phases and between the conductor and any grounded metallic objects.



Questions?