Science.
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# Power Cable Splicing and Terminating Guide

## Quality Workmanship that Lasts

# Innovative solutions, technology and reliability are vital to your business.

To be successful, you depend on both quality products and effective installations.

That's why the contributions of 3M scientists and engineers extend beyond developing products to sharing best practices on how to use them.

With a solid understanding of your industry and the technology that drives it, we strive to help make your work easier and more reliable.

Turn the pages to discover cable splicing and termination techniques that can help reduce the risk of errors that could cause premature electrical failures – and help make you look like a hero.

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# The Technology

**Tape Technology**
Our durable tapes are designed with various materials to insulate across a wide range of electrical applications.

**Connecting Technology**
Our full line of high-performing connectors are UL Listed for many crimping tools to provide a reliable connection and improve installer convenience.

**Rubber Technology**
Our cold shrink tubing is engineered from strong, adaptable rubber that installs easily and fits securely around splices and terminations.

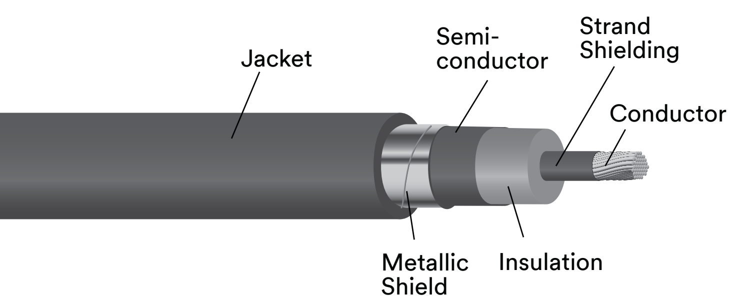
**Resin Technology**
Our liquid resins provide an extra layer of insulation that protects electrical components and assemblies from natural elements.

# The Human Factor

Products are only as good as the people who create them. Teams of 3M scientists, chemists, engineers, electricians and technicians work together with manufacturing, quality control, sales and distribution to deliver high quality products – products that resolve complex problems and are easy to use.

That's why 3M products include "human engineering." Not only are our products long-lasting and cost effective but they also work smoothly and efficiently in installers' hands. "Human engineering" combines the human factor with technology, developing products that work for people.

# Medium/ High Voltage Power Cable




## Medium/High Voltage Cable Types

Of the nearly limitless variety of cables in use today, five of the most common are:

- Tape shielded
- Drain wire shielded
- General Cable UniShield®
- Concentric Neutral (CN)
- Jacketed Concentric Neutral (JCN)

Beyond cable shield types, two common configurations are used:

- Single conductor - consisting of one conductor per cable or three cables for a three-phase system.
- Three conductor - consisting of three cables sharing a common jacket.

Despite these visible differences, all power cables are essentially the same, consisting of:

- Conductor
- Strand shield
- Insulation
- Insulation shield system (semi-conductive and metallic)
- Jacket

Each component is vital to an optimally performing power cable and must be understood in order to make a dependable splice or termination.

# Medium/High Voltage Cable Components

## Conductor

The current carrying components are made of copper or aluminum. (Aluminum is less expensive but less efficient, requiring a larger conductor diameter to carry an equal electrical load when compared to a copper conductor.)

Conductors used with modern solid dielectric cables come in four basic configurations:

## Concentric Stranding

(Class B)
Concentric stranding is not commonly used in modern shielded power cables. The penetration of the extruded strand shielding between the conductor strands makes the strand shield difficult to remove during field cable preparation.

## Compressed Stranding

Compressed stranding is a commonly used conductor configuration. Compressed to 97 percent of concentric conductor diameters, the compressed strands block the penetration of an extruded strand shield, making it easily removable in the field. For sizing lugs and connectors, the sizes remain the same as with the concentric stranding.

## Compact Stranding

Compacted to 90 percent of concentric conductor diameters, the reduced conductor size results in all of the cable's layers being proportionally reduced in a diameter, an important consideration when sizing for molded rubber products. Although this conductor has full ampacity ratings, the general rule for sizing is to consider it one conductor size smaller than concentric or compressed.

## Solid Wire

This conductor is not commonly used in industrial shielded power cables.

## Strand Shielding

Strand shielding is the semi-conductive layer between conductor and insulation, which compensates for air voids that exist between conductor and insulation.

Air is a poor insulator, having a nominal dielectric strength of only 76 volts per mil, while most cable insulation have dielectric strengths over 700 volts per mil. Without strand shielding, an electrical potential exists that will over-stress these air voids.

As air breaks down or ionizes, it goes into corona (partial discharges). This forms ozone, which chemically deteriorates cable insulation. The semi-conductive strand shielding eliminates this potential by simply "shorting out" the air.

Modern cables are generally constructed with an extruded strand shield.

(Reference: AEIC NO. 5, D. Semi-conducting Shielding.)

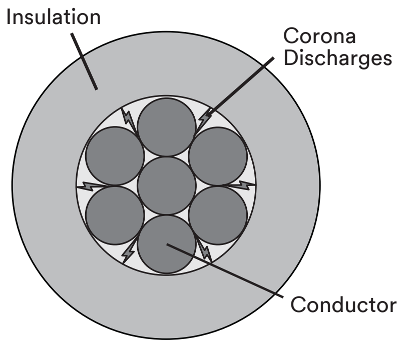



**Figure 1**

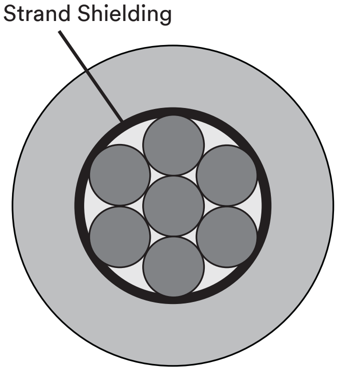



**Figure 2**

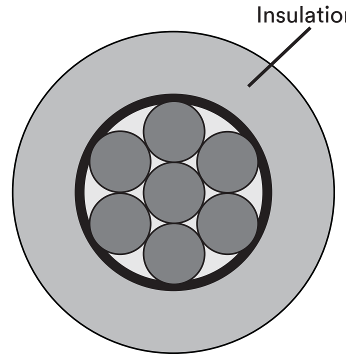



**Figure 3**

## Insulation

A third layer consisting of many different variations such as extruded solid dielectric or laminar (oil paper or varnish cambric). Its function is to contain the voltage within the cable system. The most common solid dielectric insulations in industrial use today are:

- Cross-linked polyethylene (XLP)
- Ethylene propylene rubber (EPR)
- Polyethylene

Each is preferred for different properties such as superior strength, flexibility, temperature resistance, etc., depending upon the cable characteristics required. The selection of the cable insulation level to be used in a particular installation shall be made on the basis of the applicable phase-to-phase voltage and the general system category as outlined below.

**100 percent Level** - Cables in this category may be applied where the system is provided with relay protection such that ground faults will be cleared as rapidly as possible, but in any case within one minute. These cables are applicable to the great majority of the cable installations, which are on grounded systems. They may be used also on other systems for which the application of cable is acceptable, provided the above clearing requirements are met in completely deenergizing the faulted section.

**133 percent Level** - This insulation level corresponds to that formerly designated for ungrounded systems. Cables in this category may be applied in situations where the clearing time requirements of the 100 percent level category cannot be met, and yet there is adequate assurance that the faulted section will be de-energized in a time not exceeding one hour. Also, they may be used when additional insulation strength over the 100 percent level category is desirable.

**173 percent Level** - Cables in this category should be applied on systems where the time required to de-energize a grounded section is indefinite. Their use is recommended also for resonant grounded systems. Consult the manufacturer for insulation thicknesses.

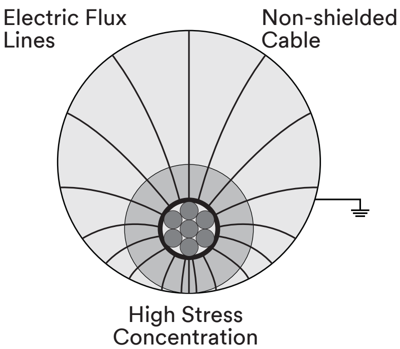



Figure 4

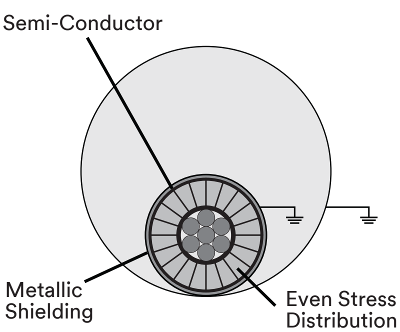



Figure 5

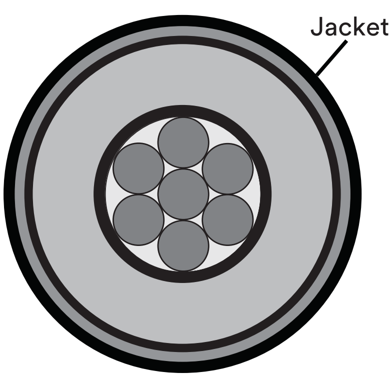



Figure 6

## Insulation Shield System

The outer shielding which is comprised of two conductive components: a semi-conductive layer (semi-con) under a metallic layer. (See cable types for common shield varieties.) The principal functions of the insulation shield system are to:

- Confine the dielectric field within the cable
- Obtain a symmetrical radial distribution of voltage stress within the dielectric
- Protect the cable from induced potentials
- Limit radio interference
- Reduce the hazard of shock
- Provide a ground path for leakage and fault currents

The **shield must be grounded** for the cable to perform these functions.

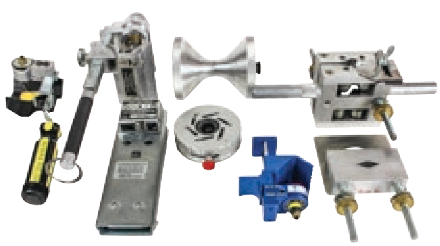
The semi-conductive component is available either as a tape or as an extruded layer. (Some cables have an additional layer painted between the semi-con and the cable insulation.) Its function is similar to strand shielding: to eliminate the problem of air voids between the insulation and metallic component (in this case, the metallic shielding). In effect, it “shorts out” the air that underlies the metallic shield, preventing corona and its resultant ozone damage.

The metallic shield is the current carrying component that allows the insulation shield system to perform the functions mentioned earlier. This is the layer where various cable types differ most. For that reason, most cables are named after their metallic shield (e.g., tape shielded, drain wire shielded, UniShield®, etc.).

As a result, shield type (cable identification) becomes important information to know when selecting products for splicing and terminating.

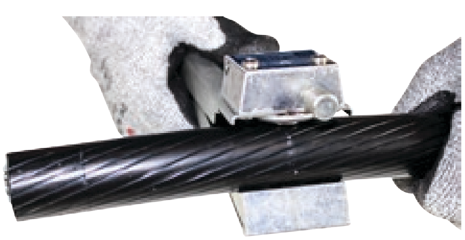
## Jacket

The jacket is the tough outer covering for mechanical protection as well as moisture barrier. Often, the jacket serves as both an outer covering and the semi-conductive component of the insulation shield system, combining two cable layers into one: the semi-conductive jacket. Typical materials used for cable jackets are PVC, neoprene, lead, etc. Frequently, industrial three conductor cables have additional protection in the form of an armor layer.



# Medium/High Voltage Cable Preparation

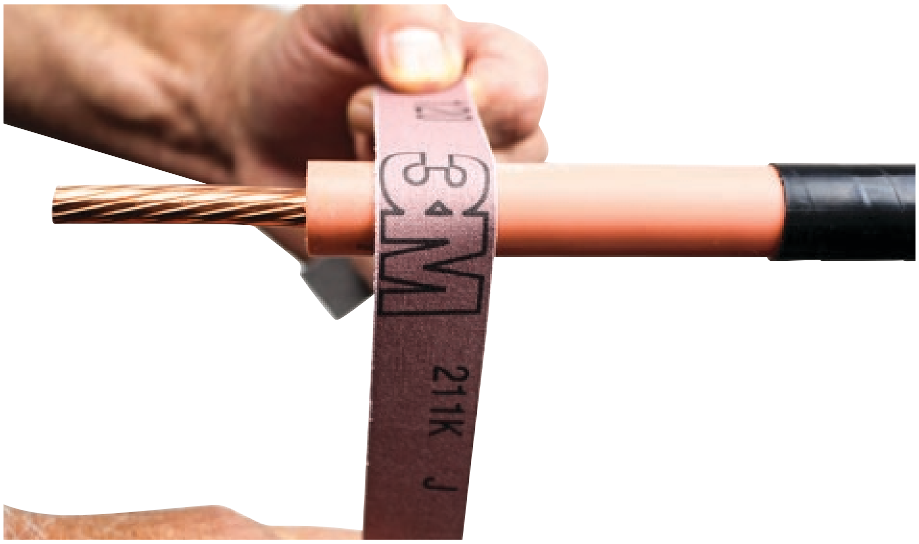
It is necessary to begin with a good cable end. For this reason, it is common practice to cut off a portion of cable after pulling to assure an undamaged end. A key to good cable preparation is the use of sharp, high quality tools.



When the various layers are removed, cuts should extend only partially through the layer. For example, when removing cable insulation, the installer must be careful not to cut completely through and damage the conductor strands. Specialized tools are available to aid in the removal of the various cable layers.

Another good technique for removing cross-linked polyethylene (XLP) cable insulation is to use a string as the cutting tool.

When penciling is required (not normally needed for molded rubber products), a full, smooth taper is needed to eliminate the possibility of air voids. The semi-conductive layer(s) and the resulting residue must be completely removed. Two methods are commonly used to remove the residue: abrasives and solvents.




## Abrasives

Research has proven 120 grit to be optimum: fine enough for the medium/high voltage interface and yet coarse enough to remove semi-con residue without "loading up" the abrasive cloth.

The abrasive must have a non-conducting grit. **Do not** use emery cloth or any other abrasive that contains conductive particles since these could embed themselves into the cable insulation. When using an insulation diameter dependent product (e.g., molded rubber products), care must be taken not to abrade the insulation below the minimum specification for the product.


## Solvents

It is recommended that a non-flammable cable cleaning solvent be used. Any solvent that leaves a residue should be avoided. **Do not** use excessive amounts of solvent as this can saturate the semi-con layer and render it non-conductive. Know your solvent. Avoid toxic solvents that are hazardous to health.


# Splicing

Cable preparation materials are available that contain solvent saturated, non-woven pads or rags appropriately filled with the proper quantity of non-flammable, non-toxic cable cleaning solvent.

These kits also contain a 120-grit, non-conductive abrasive cloth.

After the cable surfaces have been cleaned, the recommended practice is to reverse wrap (adhesive side out) a layer of vinyl tape to maintain the cleanliness of the cable.

## Definition

A splice may be considered as two or more conductors joined with a suitable connector, then reinsulated, reshielded and rejacketed with compatible materials and applied over a properly prepared surface.

Whenever possible, splicing is normally avoided. However, splicing is often an economic necessity. There can be many reasons for building splices, such as:

- The supplied length of cable is not sufficient to perform the intended job, e.g., only so much cable can be wound on a reel (the reel ends), or only so much cable can be pulled through so much conduit, around so many bends, etc.
- Cable failures
- Cables damaged after installation
- A tap into an existing cable (tee or wye splices)

In all the above cases, the option is to either splice the cable or replace the entire length. The economy of modern splicing products, in many cases, makes splicing an optimal choice.

Whatever the reason to splice, good practice dictates that splices have the same rating as the cable. In this way, the splice does not derate the cable and become the weak link in the system.

# Splicing Steps

The previous definition accurately identifies the need for splicing, which leads into the five common steps for building a splice:

1. Prepare the surface
2. Join conductors with connector(s)
3. Reinsulate
4. Reshield
5. Rejacket

The greatest assurance against splice failure starts with the person who makes the splice. Adequate cable preparation, proper installation of all components and good workmanship require trained skills performed by people adept at them. Much has been done in the last few years to develop products and systems that make splicing easier. Yet the expertise, skills and care of the installer are still necessary to make a dependable splice.

## 1. Prepare the surface

High-quality products usually include detailed installation instructions. These instructions should be followed. A suggested technique is to check off steps as they are completed.

Good instructions alone do not qualify a person as a “cable splicer.” Certain manufacturers offer hands-on training programs designed to teach proper installation of their products. It is highly recommended that inexperienced splice and termination installers take advantage of these programs where available.

# 2. Join conductors with connector(s)

After the cables are completely prepared, the rebuilding process begins. If a cold shrink or premolded splice is being installed, the appropriate splice components must be slid onto the cable(s) before the connection is made. The first step is reconstructing the conductor with a suitable connector. A suitable connector for medium/high voltage cable splices is a compression or shearbolt connector.

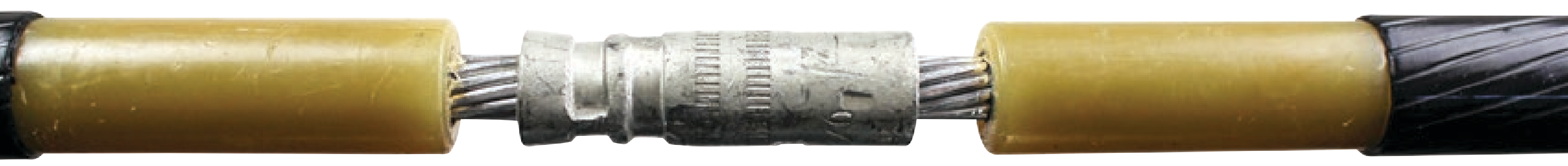
**Do not use** mechanical type connectors (such as split-bolt connectors.). Connector selection is based on conductor material: aluminum or copper.

## Aluminum conductor

Connect with aluminum-bodied connector (marked CU/AL). These must come pre-loaded with contact aid (antioxidant paste) to break down the insulating aluminum oxide coating on both the connector and conductor surfaces.

## Copper conductor

Connect with either copper or aluminum bodied connectors. A UL listed connector that can be applied with any common crimping tool is recommended. This connector should be tested and approved for use at medium or high voltage. In this way, the choice of the medium or high voltage connector is at the discretion of the installer and is not limited by the tools available.



## 3. Reinsulate

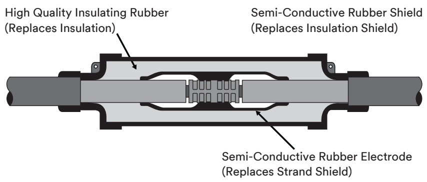
Perhaps the most commonly recognized method for reinsulating is the traditional tape method. Tape has a history of dependable service and is generally available. Since tape does not depend on cable types and dimensions, it is the most versatile approach. However, wrapping tape on a medium/ high voltage cable can be time consuming and error prone since the careful build-up of tape requires accurate half-lapping and constant tension in order to reduce built-in air voids.

Linerless splicing tapes reduce both application time and error. Studies have shown time savings of 30-to-50 percent since there is no need to stop during taping to tear off liner. This also allows the installer to maintain a constant tape tension, reducing the possibility of taped-in voids. Tape splice kits can be useful since they contain all the necessary tapes along with proper instructions. They ensure the proper materials are available on the job, which is ideal in an emergency.

Another method for reinsulating utilizes molded rubber technology. These factory-made splices are engineered for the convenience of the installer. In many cases, these splices are also factory tested and designed to be installed without the use of special installation tools.

Most molded rubber splices use ethylene propylene rubber (EPR) as the reinsulation material. This EPR must be cured during the molding process. Either a peroxide cure or a sulfur cure can be used. Peroxide cures develop a rubber with maximum flexibility for easy installation on a wide range of cable, and most importantly, provide an excellent long-term, live memory for lasting, more reliable splices.

(Reference: IEEE paper Cat. 76 CH 119-7-PWR "Effect of Curing Agents on Long term Permanent Set of Molded Rubber Devices" by R.D. Erickson and P.N. Nelson, 3M Company.)

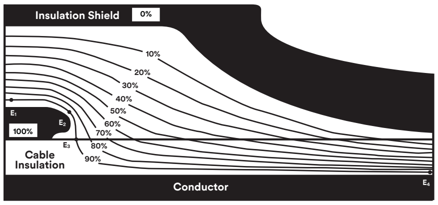




Figure 7

# 4. Reshield

The cable's two shielding systems (strand shield and insulation shield) must be rebuilt when constructing a splice. The same two methods are used as outlined in the reinsulation process: tape and molded rubber.

For a tape splice, the cable strand shielding is replaced by a semi-conductive tape. This tape is wrapped over the connector area to smooth the crimp indents and connector edges.

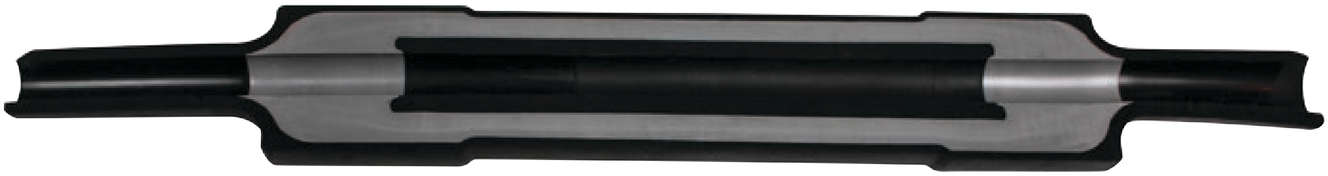
The insulation shielding system is replaced by a combination of tapes. Semi-con is replaced with the same semi-conducting tape used to replace the strand shield.

The cable's metallic shield is generally replaced with a flexible woven mesh of tin-plated copper braid. This braid is for electrostatic shielding only and is not designed to carry shield currents. For conducting shield currents, a jumper braid is installed to connect the cables' metallic shields. This jumper must have an ampacity rating equal to that of the cables' shields.

For a cold shrink or rubber molded splice, conductive rubber is used to replace the cable's strand shielding and the semi-conductive portion of the insulation shield system. Again, the metallic shield portion must be jumpered with a metallic component of equal ampacity.

A desirable design parameter of a molded rubber splice is that it be installable without special installation tools. To accomplish this, very short electrical interfaces are required. These interfaces are attained through proper design shapes of the conductive rubber electrodes.

Laboratory field plotting techniques show that the optimum design can be obtained using a combination of logarithmic and radial shapes.



## 5. Rejacket

Rejacketing is accomplished in a tape splice by using a combination of the rubber splicing tape overwrapped with a vinyl tape.

In molded rubber splice, rejacketing is accomplished by proper design of the outer semi-conductive rubber, effectively resulting in a semi-conductive jacket.

When a molded rubber splice is used on internally shielded cable (such as tape shield, drain wire shield or UniShield® cables), a shield adapter is used to seal the opening that results between the splice and cable jacket.

In general, for the versatility to handle practically any splicing emergency, in situations where only a few splices need to be made, or when little detail is known about the cable, tape or a tape kit make the most effective splice.

When cable size, insulation diameter and shielding type are known and when numerous splices will be made, molded rubber splices are simple, dependable, and quick to apply.

# Terminations

Referencing and quoting IEEE Std 48-1975 with permission as follows:

“This standard supersedes IEEE Std 48-1962 Standard for Potheads. (Note: Current standard is IEEE Std. 48-1990)

“The superseded document encompassed only the pothead, a cable termination designed primarily for cables having laminated insulation, and which sealed the end of a cable and provided insulation egress for the conductor or conductors.

“A considerable increase in the use of cables having extruded insulation has occurred since the issuance of IEEE Std 48-1962 and has encouraged the development of new types of cable terminations. As a consequence, there are available today many types of cable termination designed primarily for cables having extruded insulation which perform some, or all, of the functions of a pothead but which cannot be classified as such.

“This standard encompasses all (with one exception) terminations for alternating-current, high-voltage cables having laminated or extruded insulation: conventional potheads, factory reassembled terminations, hand-wound tape and pennant stress cones, slip-on terminations and stress cones, resistance graded terminations, etc. The only exception is separable insulated connectors, a special type of high-voltage cable termination which is covered by another standard.

“In order to categorize the various types of terminations so that distinctions may be made, the terminations have been classified according to what they provide.

“**A Class I High-Voltage Cable Termination** (or more simply, a Class I Termination) provides: (1) some form of electric stress control for the cable insulation shield terminus, (2) complete external leakage insulation between the high-voltage conductor(s) and ground, and (3) a seal to prevent the entrance of the external environment into the cable and to maintain the pressure, if any, within the cable system. This classification encompasses the conventional potheads for which the original IEEE Std 48-1962 was written. With this new classification or designation, the term pothead is henceforth dropped from usage in favor of Class 1 Termination.

“**A Class 2 Termination** is one that provides only (1) and (2): some form of electric stress control for the cable insulation shield terminus and complete external leakage insulation, but no seal against external elements.

Terminations that fall into this classification would be, for example, stress cones with rain shields or special outdoor insulation added to give complete leakage insulation, but no seal against external elements. Terminations falling into this classification would be, for example stress cones with rain shields or special outdoor insulation added to give complete leakage insulation, and slip-on terminations for cables having extruded insulation when not providing a seal as in Class 1.

“**A Class 3 Termination** is one that provides only: (1) some form of electric stress control for the cable insulation shield terminus. This class of terminations would be for use primarily indoors. Typically, this would include hand-wrapped stress cones (tapes or pennants), and the slip-on stress cones.

“Some Class 1 and Class 2 Terminations have external leakage insulation made of polymeric material. It is recognized that there is some concern about the ability of such insulation to withstand weathering, ultraviolet radiation, contamination and leakage currents, and that a test capable of evaluating the various materials would be desirable. There are available today a number of test procedures for this purpose. However, none of them has been recognized and adopted by the industry as a standard. Consequently, this standard cannot and does not include such a test.”

These IEEE Classes make no provision for indoor or outdoor environments. This is because contamination and moisture can be highly prevalent inside most industrial facilities (such as paper plants, steel mills, petrochemical plants, etc.).

As a general recommendation, if there are airborne contaminates, or fail-safe power requirements are critical, use a Class 1 termination.

# Stress Control

In a continuous shielded cable, the electric field is uniform along the cable axis, and there is variation in the field only in a radial section. Figures 8 and 9 show the field distribution over such a radial section. The spacing of the electric flux lines and the corresponding equipotential lines is closer in the vicinity of the conductor than at the shield, indicating a higher electric stress on the insulation near the conductor. This stress increase, or concentration, is a direct result of the geometry of the conductor and shield in the cable section and is accommodated in practical cables by insulation thickness sufficient to keep the stress on the insulation near the cable's outside diameter within acceptable values.

In terminating a shielded cable, it is necessary to remove the shield to a point some distance from the exposed conductor as shown in Figure 10. This is to secure a sufficient length of insulation surface to prevent breakdown along the interface between the cable insulation and the insulating material to be applied in the termination. The particular length required is determined by the operating voltage and the properties of the insulating materials. This removal of a portion of the shield results in a discontinuity in the axial geometry of the cable, with the result being that the electrical field is no longer uniform axially along the cable, but exhibits variations in three dimensions.

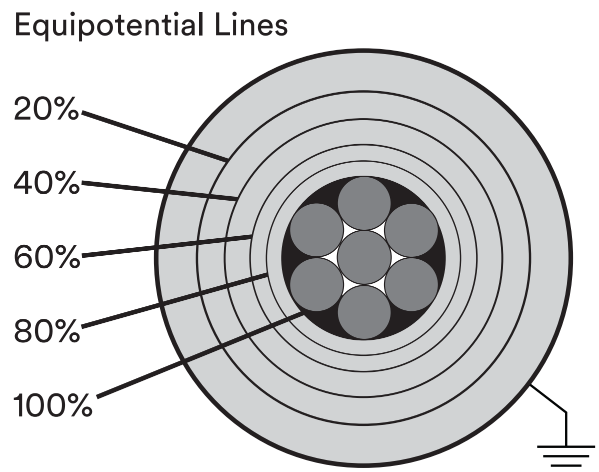



**Figure 8**

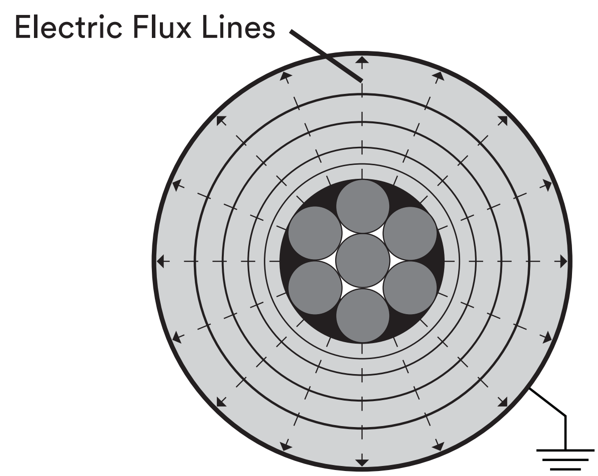



**Figure 9**

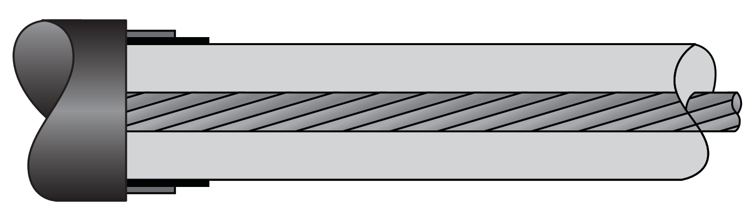


**Figure 10**

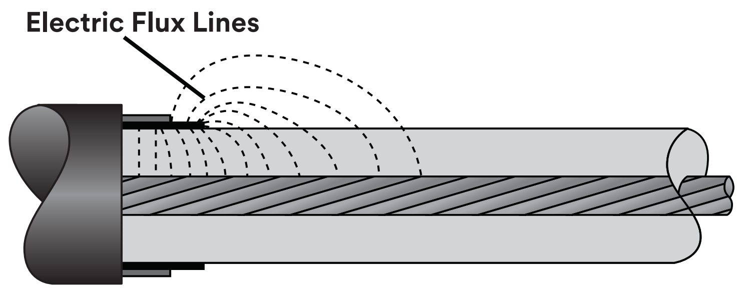



**Figure 11**

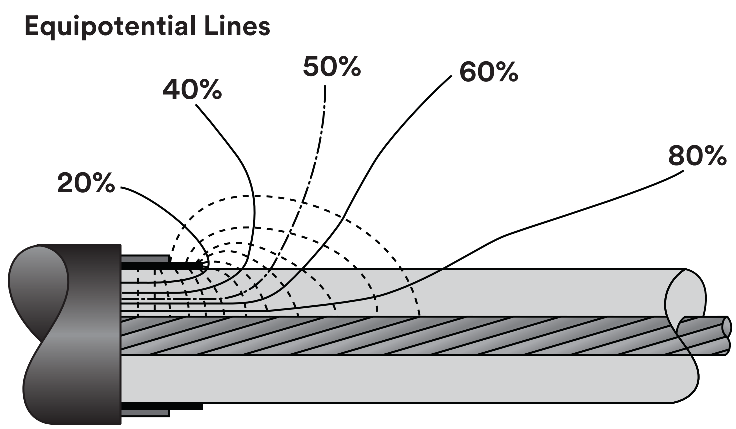



**Figure 12**

Figure 11 shows the electric field in the vicinity of the shield discontinuity. The electric flux lines originating along the conductor are seen to converge on the end of the shield with the attendant close spacing of the equipotential lines signifying the presence of high electric stresses in this area. This stress concentration is of much greater magnitude than that occurring near the conductor in the continuous cable, and as a result, steps must be taken to reduce the stresses occurring near the end of the shield if cable insulation failure is to be avoided.

All terminations must at least provide stress control. This stress control may be accomplished by two commonly used methods:

1. Geometric stress control
2. Capacitive stress control

# 1. Geometric stress control

This method involves an extension of the shielding (Figure 13), which expands the diameter at which the terminating discontinuity occurs and, as a result, reduces the stress at the discontinuity. It also reduces stresses by enlarging the radius of the shield end at the discontinuity. (Figures 14 and 15)

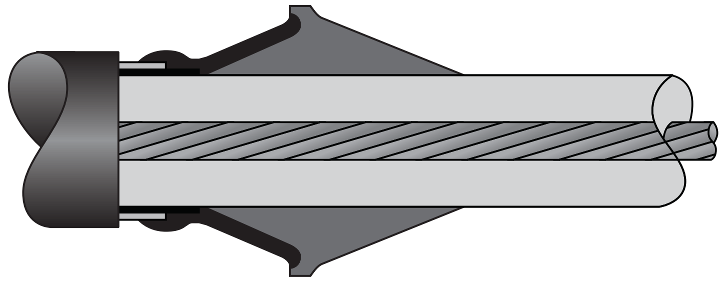


Figure 13

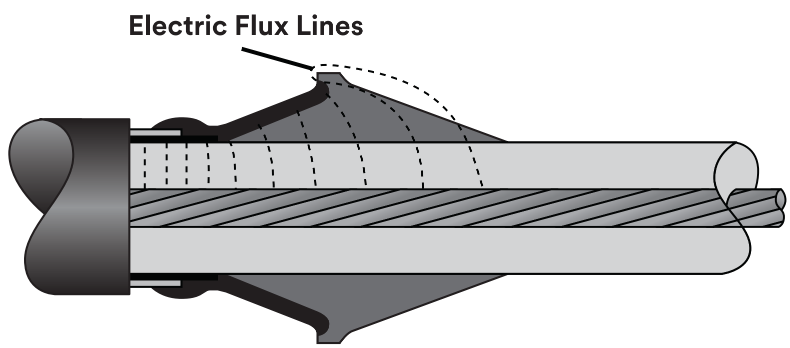



Figure 14

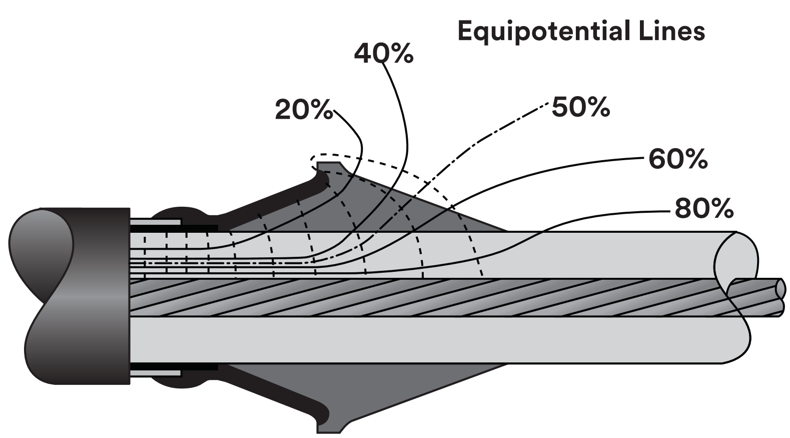



Figure 15

# 2. Capacitive stress control

This method consists of a material possessing a high dielectric constant (K), generally in the range of K30, and also a high dielectric strength.

Dielectric Constant = K:
A measurement of the ability of a material to store a charge.

| Material | K |
|---|---|
| Air | 1 |
| Cable Insulation | 3 |
| 130 C Tape | 3 |
| High K Material | 30 |

This K is generally an order of magnitude higher than the cable insulation. Located at the end of the shield cut-back, the material capacitively changes the voltage distribution in the electrical field surrounding the shield terminus. Lines of electrical flux are regulated to equalize the electrical stresses in a controlled manner along the entire area where the shielding has been removed. (Figures 16 and 17)

By changing the electrical field surrounding the termination, the stress concentration is reduced from several hundred volts per mil to values found in continuous cable — usually less than 50 volts per mil at rated cable voltage. (For a detailed technical explanation see "High Dielectric Constant Materials for Primary Voltage Cable Termination" by P.N. Nelson and H.C. Hervig, 3M Company.)

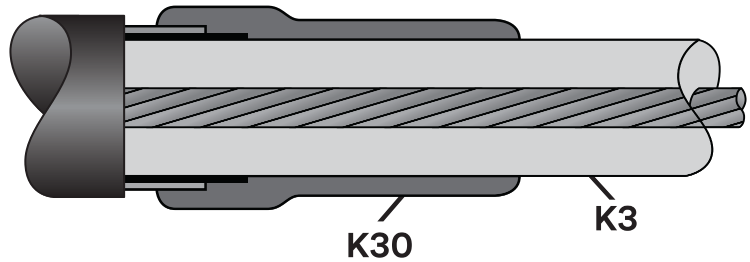



**Figure 16**

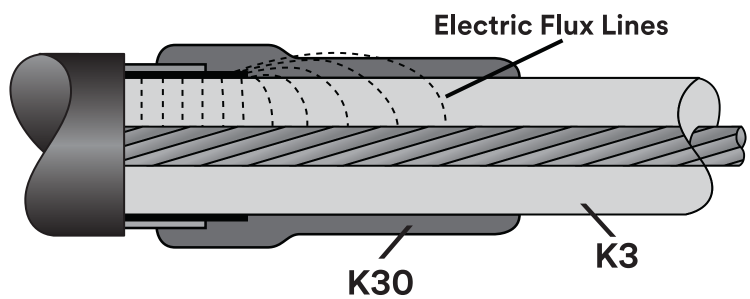



**Figure 17**

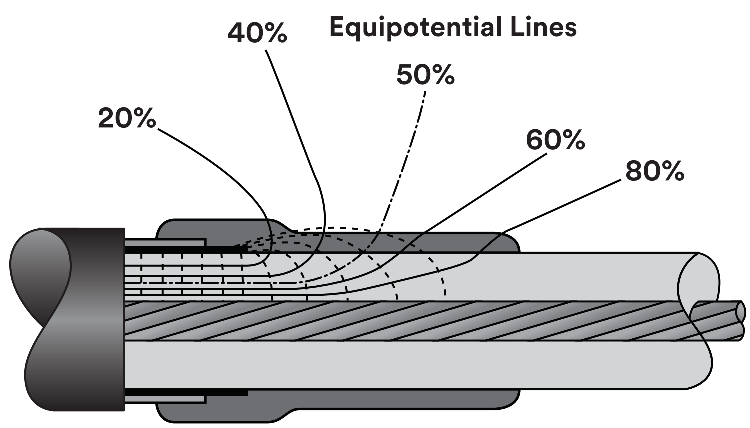



**Figure 18**

# External Leakage Insulation

This insulation must provide two functions: protection from flashover damage and protection from tracking damage.

Terminations can be subjected to flashovers such as lightning induced surges or switching surges. A good termination must be designed to survive these surges. Terminations are assigned a BIL (Basic Lightning Impulse Insulation Level) according to their insulation class (see IEEE Std 48). As an example, a 15 kV class termination has a BIL rating of 110 kV crest.

Terminations are also subjected to tracking. Tracking can be defined as the process that produces localized deterioration on the surface of the insulator, resulting in the loss of insulating function by the formation of a conductive path on the surface.

A termination can be considered an insulator, having a voltage drop between the medium/high voltage conductor and shield. As a result, a leakage current develops between these points.

The magnitude of this leakage is inversely proportional to the resistance on the insulation surface. (Figure 19)

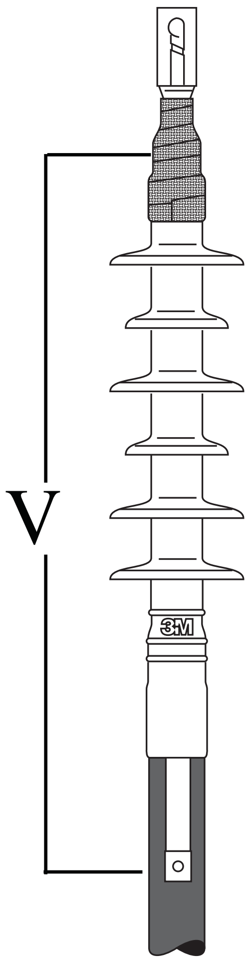



Figure 19

| CLASS (kV) | BIL (kV-crest) |
|---|---|
| 5.0 | 75 |
| 8.7 | 95 |
| 15 | 110 |
| 25 | 150 |
| 34.5 | 200 |
| 46 | 250 |
| 69 | 350 |

Both contamination (dust, salt, airborne particles, etc.) and moisture (humidity, condensation, mist, etc.) will decrease this resistance. This results in surface discharges referred to as tracking. In an industrial environment, it is difficult to prevent these conditions. For that reason, a track resistant insulator must be used to prevent failure.

A high performance Class 1 termination is built with properly designed insulator skirts that are sized and shaped to form breaks in the moisture/contamination path, which reduces the probability of tracking problems. Also, this skirt design can reduce the physical length of a termination by geometrically locating the creepage distance over the convolutions of the insulator, an important factor when space is a consideration.

Good termination design dictates that the insulator be efficiently applied under normal field conditions. This means the product should be applied by hand with a minimum of steps, parts and pieces. Preferably, no special installation tools or heat should be necessary.

Because they are inorganic materials and do not form carbon (conductive) residues, both silicone rubber and porcelain are considered the best in track resistance.

(Reference: IEEE paper Cat. 76-CH 119-7 PWR "Contamination Testing of Distribution Class Cable Terminations" by L.A. Johnson and W.C. Osborn, 3M Company and "Accelerated Environment Testing of Distribution Class Silicone Terminations" by H.C. Hervig, 3M Company.)

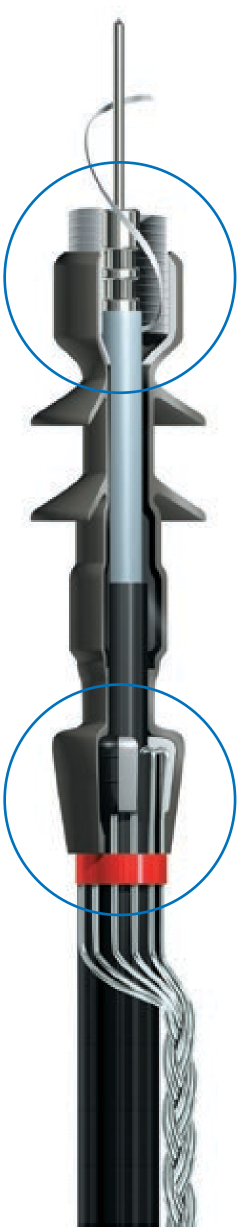


Figure 20

# Seal to the External Environment

In order to qualify as a Class 1 Termination, the termination must provide a seal to the external environment. Both the conductor/lug area and the shielding cut-back area must be sealed. These seals keep moisture out of the cable to prevent degradation of the cable components. Several methods are used to make these seals, such as: factory-made seals, tape seals (silicone tape for a top seal) and compound seals. (Figure 20)

All terminations are normally grounded. However, individual circumstances can exist where it is not desirable to ground both ends of the cable. The cable shield **must be** grounded somewhere in the system. When using solid dielectric cables, it is recommended that solderless ground connections be used (eliminating the danger of over-heating cable insulation when soldering).

As a general summary, for highly contaminated and exposed environments or on extremely critical circuits, silicone rubber or porcelain terminations are preferred.

For potentially contaminated, moisture-prone areas, which is most likely the majority of cases, silicone rubber provides dependable Class 1 terminations.

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## ⚠ Caution

Working around energized medium- and high-voltage systems may cause serious injury or death. Installation should be performed by personnel familiar with good safety practice in handling medium- and high-voltage electrical equipment. De-energize and ground all electrical systems before installing product.



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