Medium Voltage Cables

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Agenda

- Okonite Overview
- MV Cable Components and Their Functions
- Cable Handling and Installation
- End Preparation

The Okonite Company

- Founded 1878 – Oldest Independent Wire and Cable Company in North America
- 100% Employee Owned (ESOT)
- Six Manufacturing Facilities
- Five Customer Service Centers
- Direct Sales Force with Twenty-Four District Offices
- Technical assistance: the best in the wire and cable industry

The Okonite Company

Typical Constructions

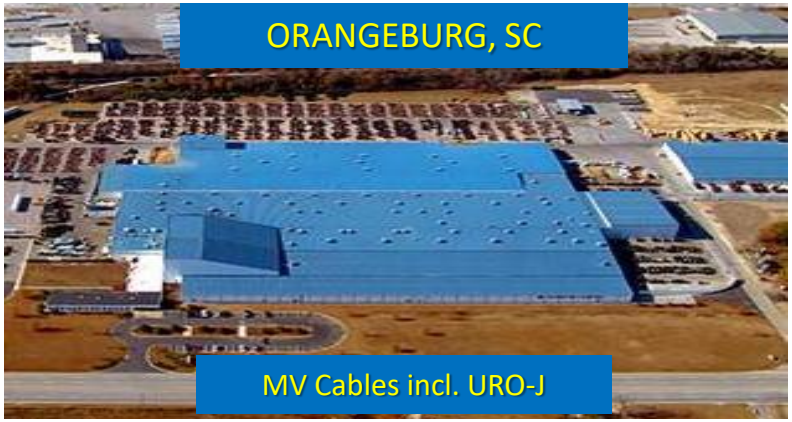
- Low Voltage Power & Control 600V
- Medium Voltage (EPR) 2.4kV – 35kV (UL) and 45kV
- Instrumentation 150V/ITC, 300V/PLTC & 600V/TC
- High Voltage Transmission (EPR) 69kV - 138kV
  (Oil Impregnated Paper) 69kV – 345kV


CUMBERLAND, RI
LV & Instrument Cables - 3 CLX Machines


RICHMOND, KY
LV, MV, HV Cables – 2 CLX Machines


ORANGEBURG COMPOUND


SANTA MARIA, CA
MV Cables – 1 CLX Machine


ORANGEBURG, SC
MV Cables incl. URO-J


PATERSON, NJ
PILC/Pipe Type Cables

Okonite Service Centers

Pittsburgh

Houston

Kansas City

New Orleans

Portland

Application Engineering Services

- **Pulling calculations**: Pulling Tension, Bending Radius and Sidewall Pressure; and equipment type and placement
- **On-site cable installation presence:** Especially for difficult pulls
- **Technical data:** Resistance, Reactance, Capacitance, Inductance
- **Ampacity calculations:** For installations not covered by published tables
- **Custom cable designs**
- **Termination, splicing and repair recommendations**
- **Presentations and on-site training**

Okoguard® URO-J

15kV Underground Primary Distribution Cable-Jacketed

Red Identification Stripes

Filled Strand Aluminum Conductor/105°C Rating

100% and 133% Insulation Levels

A Conductor-Stranded Aluminum with Filled Strand
B Strand Screen - Extruded Semiconducting EPR
C Insulation-Okoguard EPR
D Insulation Screen - Extruded Semiconducting EPR
E Concentric Conductor-Bare Copper Wires
F Encapsulating Jacket-Okolene with Extruded ID Stripes & NESC lightning bolt

Insulation

Okoguard is Okonite's registered trade name for its exclusive ethylene-propylene rubber (EPR) based, thermosetting compound, whose optimum balance of electrical and physical properties is unequaled in other solid dielectrics. Okoguard insulation, with the distinctive red color and a totally integrated EPR system, provides the optimum balance of electrical and physical properties for long, problem free service.

The triple tandem extrusion of the screens with the insulation provides optimum electrical characteristics.

The compressed conductors are filled with a water swellable agent. This construction slows the migration of water through the strands in the event of a mechanical dig-in followed by external exposure to water.

An insulation screen of ethylene-propylene rubber is extruded over the insulation. The copper concentric wires are uniformly spaced around the insulation screen. The overall polyethylene jacket provides protection against mechanical damage and corrosion.

Product identification is provided through the use of three red stripes placed 120° apart in the black jacket, with an NESC lightning bolt.

Applications

Okoguard URO-J cables provide maximum circuit longevity in underground residential distribution systems. They can be buried directly or installed in underground ducts or conduits.

Specifications

Central Conductor: Aluminum per ASTM B-609, Class B stranded per B-231.

Filled Strand: Water swellable agent meets or exceeds ICEA T-31-610 water penetration resistance and ANSI/NEMA class A connectorability requirements.

Conductor Screen: Extruded semiconucting ethylene-propylene rubber meets or exceeds the requirements of ICEA S-94-649, AEIC CS8, and CSA C68.5.

Insulation: Extruded Okoguard meets or exceeds the requirements of ICEA S-94-649, AEIC CS8, and C68.5.

Insulation Screen: Extruded semiconducting ethylene-propylene rubber meets or exceeds the requirements of ICEA S-94-649, AEIC CS8, and CSA C68.5.

Concentric Conductor: Bare copper wires.

Jacket: Black Okolene with red extruded stripes meets or exceeds the requirements of ICEA S-94-649, AEIC CS8, and CSA C68.5 for polyethylene jackets.

Product Features

- Triple tandem extruded, all EPR system.
- Okoguard cables meet or exceed ICEA standards.
- Meets RUS 1728.204 for cables with filled strand or solid conductor and 133% insulation level.
- 105°C continuous operating temperature.
- 140°C emergency rating.
- 250°C short circuit rating.
- Excellent corona resistance.
- Low dielectric constant and power factor.
- Screens are clean stripping.
- Exceptional resistance to "treeing".
- Filled strand conductor.
- Moisture resistant.
- Overall jacket provides extended life.
- Excellent resistance to most chemicals.
- Can be listed by UL as Type MV-90 on Special Orders.
- CSA C68.5 listed, LTGG (-40°C), SR.
- Design Options:
  - Additional conductor sizes
  - Copper central conductor
  - Copper flat strap concentric neutral
  - Product identification via colored jackets.
  - Semiconducting jackets.
- Improved Temperature Rating.

Okoguard insulation system has been tested and qualified for operation at 105°C continuous and 140°C emergency operating temperature.

- Minimum installation temperature of -40°C.

Industry Standards Organizations

ICEA S-94-649: Standard For Concentric Neutral Cable Rated 5000-46,000 Volts

AEIC CS8: Specification for Extruded Dielectric, Shielded Power Cables Rated 5 through 46kV

ASTM B-609, B-231: Aluminum 1350 Round Wire, Concentric-Lay Stranded Aluminum 1350 Conductors

RUS 1728.204: Electric Standards and Specifications for Materials and Constructions

Customer Specifications

Medium Voltage Cable- Components

A Conductor
B Conductor Shield
C Insulation
D Insulation Shield
E Metallic Shield
F Jacket

Ampacity

- The maximum ampacity of a cable depends on the ability of the surrounding environment to dissipate heat generated by its losses.
- Maximum conductor temperature is limited by the temperature rating of the insulation i.e. 60, 75, 90, and 105°C.
- Since heat rises:
  - the more THERMAL insulation surrounding the cable
  - the hotter the conductor runs.

Ampacity

Note:

- There isn’t just one ampacity value for a cable.
- The installation and operational parameters determine the ampacity.
- If an ampacity cannot be determined from tables, a calculation is required.

Basic Component – All Cables

- Conductor

To provide a low resistance path for the flow of current sized such that the:

(1) cable temperature ratings are not exceeded, and
(2) voltage regulation (voltage drop) is within acceptable limits

Conductors – ASTM Standards

Aluminum Standards

- B 230 Aluminum 1350-H19 Wire for Electrical Purposes
- B 233 Aluminum 1350 Drawing Stock for Electrical Purposes
- B 231 Concentric-Lay-Stranded Aluminum 1350 Conductors
- B 609 Aluminum 1350 Round Wire, Annealed and Intermediate Tempers, for Electrical Purposes
- B 800 8000 Series Aluminum Alloy Wire for Electrical Purposes – Annealed and Intermediate Tempers
- B 400 Compact Round Concentric-Lay-Stranded Copper Conductors

Conductor

- Typically Aluminum
- Size specified in AWG or KCMIL
- Stranding – Class B most common
- Stranding Construction – Concentric Round (Bare Conductors), Compressed, and Compact

Conductors - Classes

The number of wires change for the same conductor size.

500 kcmil

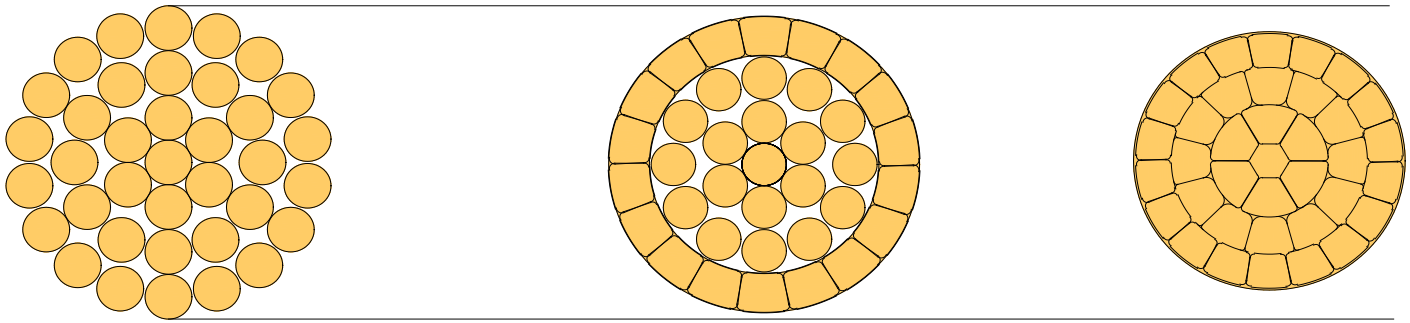
Class B – 37 wires

Class C – 61 wires

Class H – 427 wires

Class K – 5054 wires

Class B Conductor Stranding Types



37 Strands Concentric | 37 Strands Compressed | 37 Strands Compact

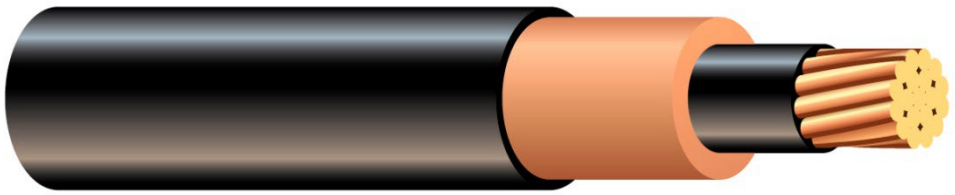
500 kcmil (37 strand) Diameter Differences

0.813”	0.788” (-3%)	0.736” (-10%)

Filled Strand/Water Block

Shields

- There are two non-metallic shields in a medium voltage cable.
  - Conductor shield on the inside of the insulation
  - Insulation shield on the outside of the insulation.
  - Shields also referred to as screens



Conductor Shield

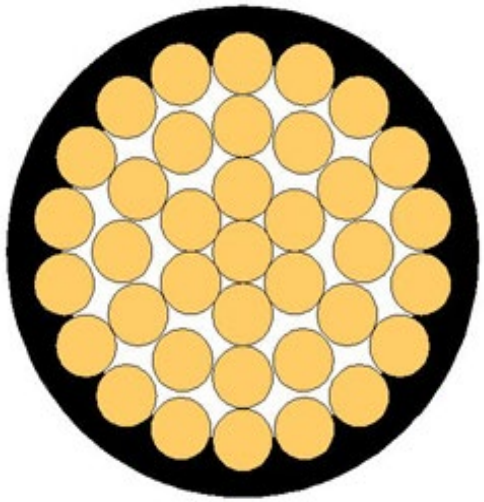
Cables rated 2.4 kV and above

Purpose: To reduce voltage stress at the interface between the conducting and insulating components

A cylindrical, smooth surface between the conductor and insulation

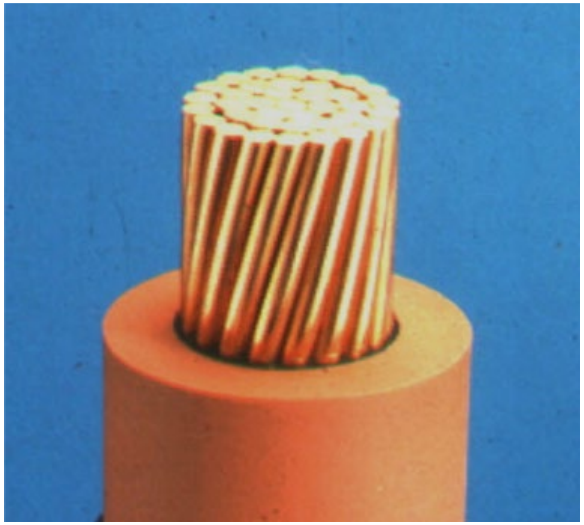
Semiconducting, not insulating

Compatible with the insulation



Insulation – All Cables

Purpose: To withstand the electrical field applied to the cable for its design life in its intended installed environment



- Normal and Emergency Voltage and Current
- Should be homogeneous; free from voids, protrusions and contaminants
- Needs to be bonded to conductor screen
- Thicker insulation = higher voltage rating

Insulation Types

Thermoset

- Heat cured; Cannot be reheated and reshaped
- EPR
- XLPE
- TS-CPE
- XLPO (LSZH)

or Thermoplastic

- Cold cured; Can be reheated and take on another shape
- PVC
- PE
- TP-CPE
- TPPO (LSZH)

AS OTHER INSULATION SYSTEMS CHANGE OVER TIME - OKOGUARD EPR HAS CONSISTENTLY OUTPERFORMED FOR OVER 40 YEARS

SEMICONS

?

Improved I/S HFDA 0692A, 0692B, 0692C, 0692D

Super smooth s/s Semi cons HFDA 0800 HFDA 0801

HFDA 0691 strippable 1/S

HFDA 0581 XLPE s/s for cu

DFDA 7702 Thermo Plastic PE 1) Over XLPE 2) s/s for HMW PE 1/S for HMW PE

HFDA 0580 XLPE s/s (stuck to cu)

INSULATION

?

HFDC4202 EC (New Version)

Next Generation UC 8202 EBR/PE

TRXLPE HFDB 4202 (New Version)

TR-XLPE FLEXEMEV UC 4203

TR-XLPE HFDA 4202

HFDE 4201 (Non Blooming)

HFDB 4201 (Non-Staining)

90° C XLPE Ins. HFDA 4201 (Staining A.O.)

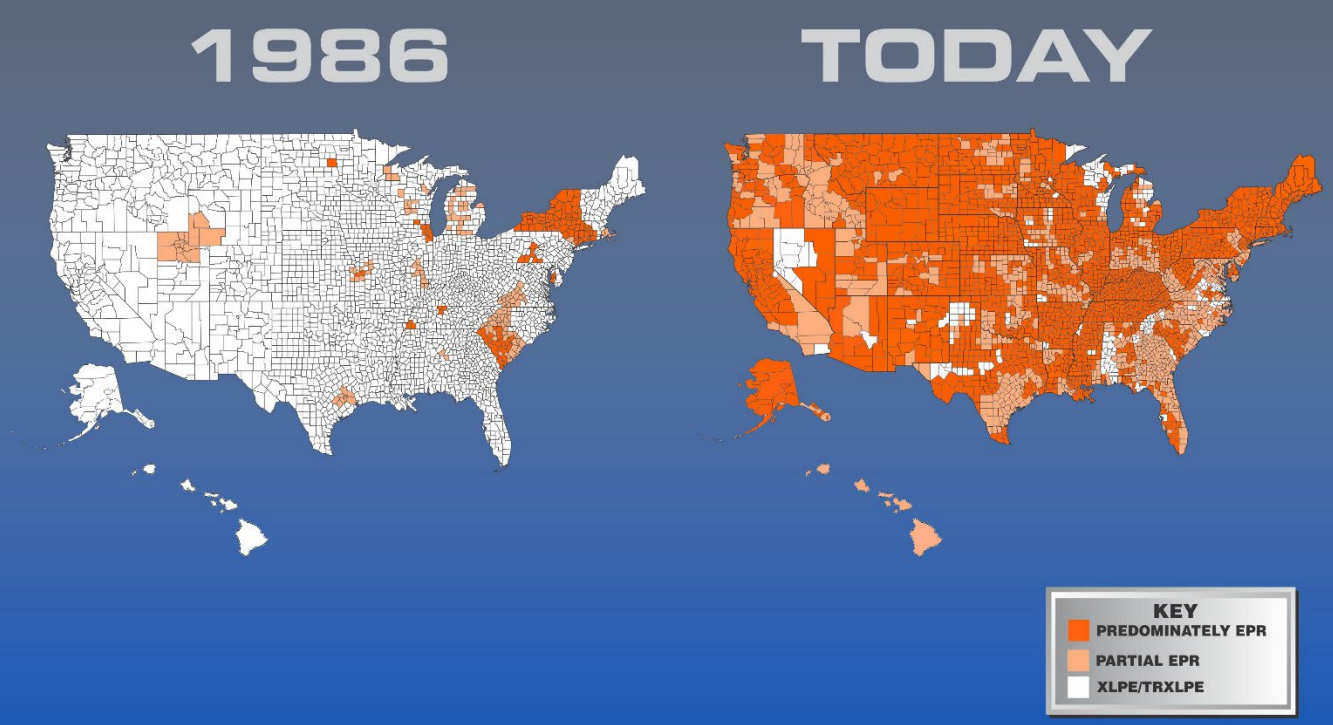
75° C HMWPE DFDA 6201

NO CHANGE

Comparisons

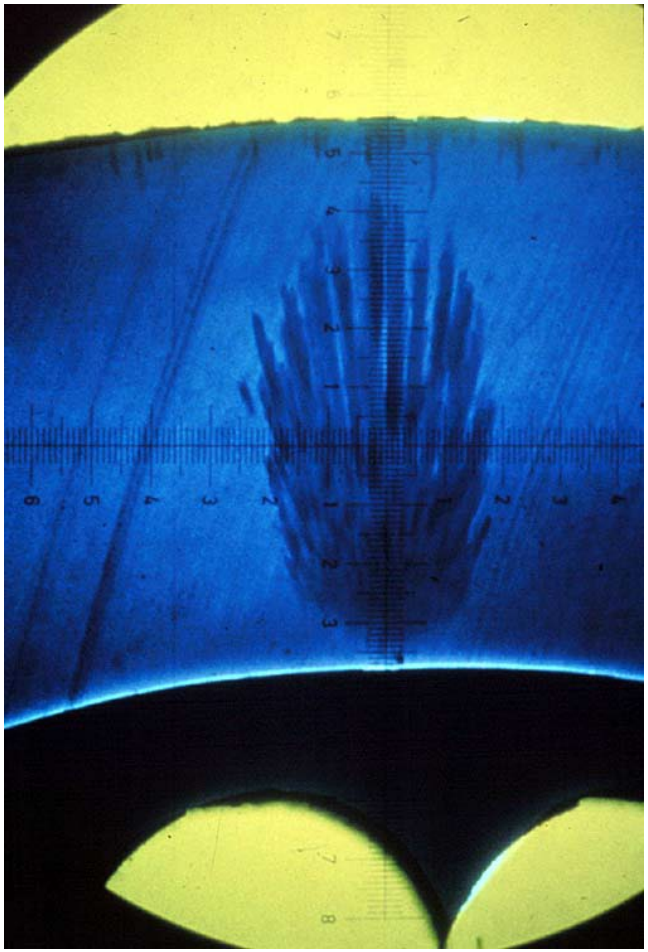
- EPR
  - 105°C Normal Operating Temp
  - Flexible
  - Water Tree Retardant
  - Better Thermal Stability
- XLPE
  - 90°C Normal Operating Temp
  - Stiff
  - Susceptible to Water Trees
  - Greater Thermal Expansion

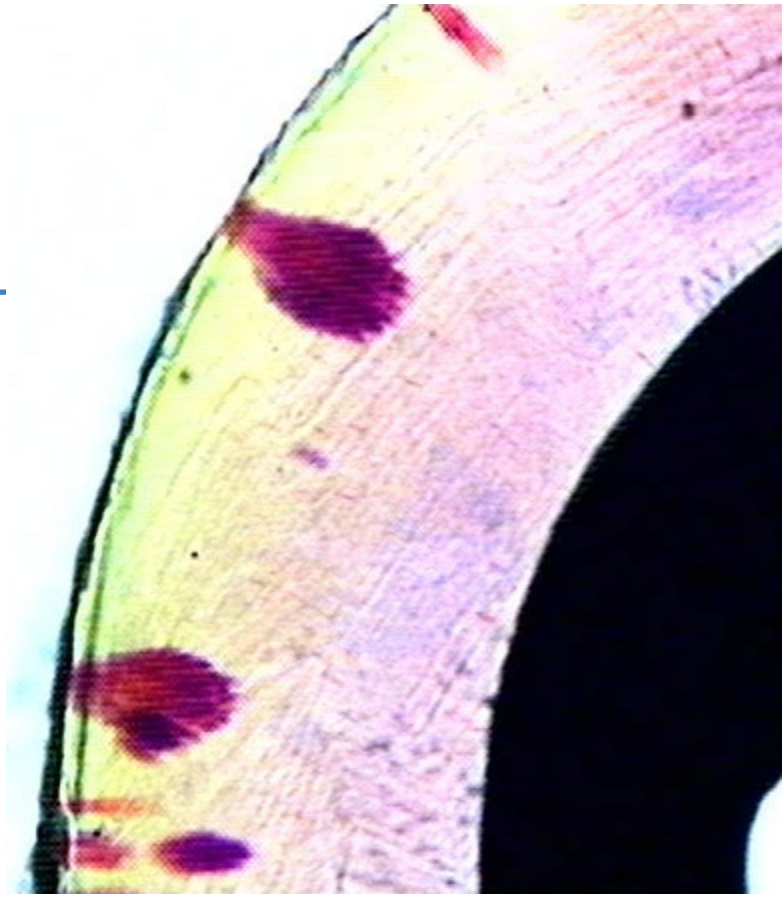
MEDIUM VOLTAGE URD EPR USAGE BY UTILITIES



Source: Cable Specifications of Utility Organizations - January, 2023

Water Tree





Water trees localized in TR-XLPE

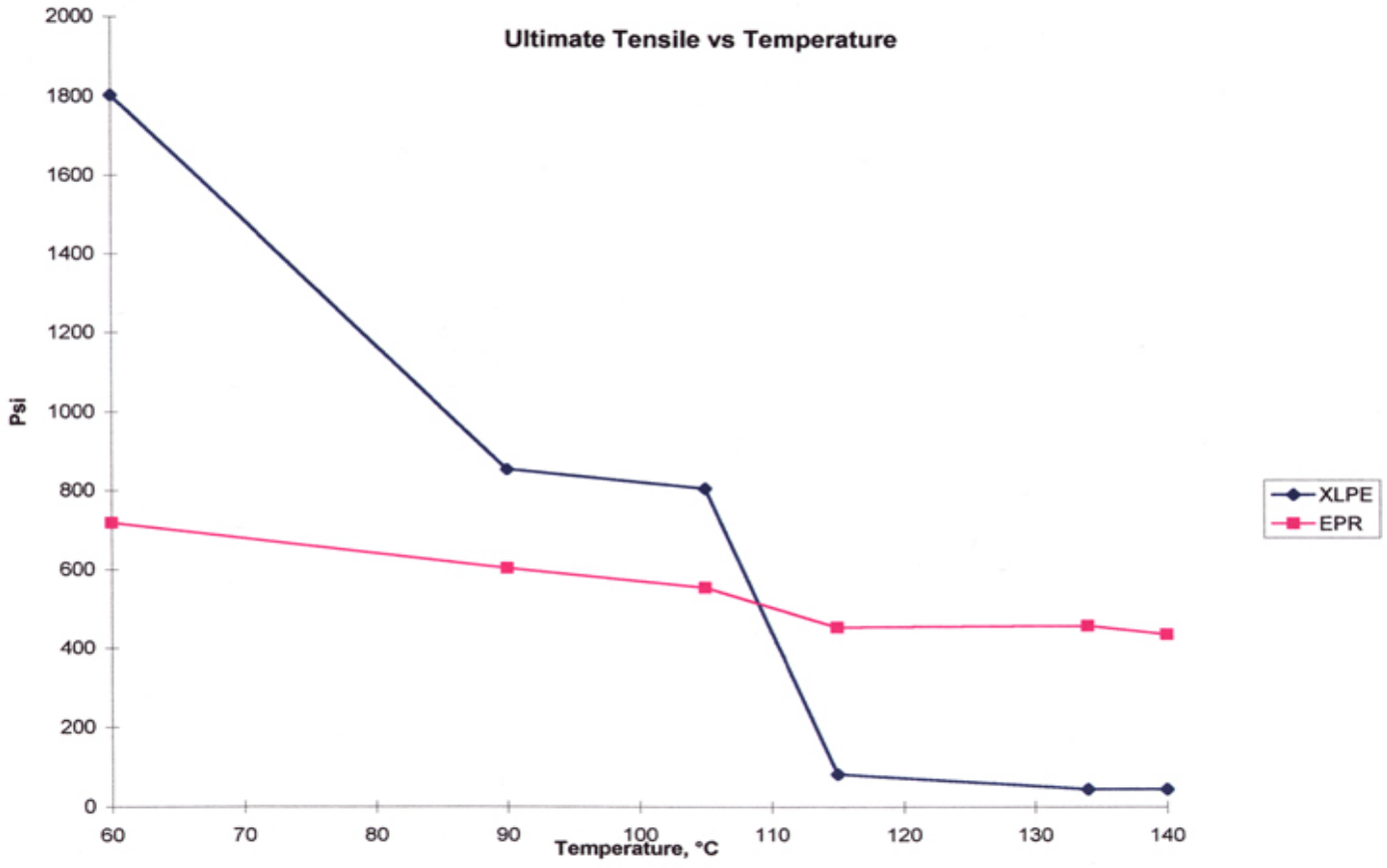
from "*Comparison of AC and Impulse Breakdown of Model EPR and TR-XLPE Cables as a Function of Wet Electrical Aging*" DiLorenzo et al, PES ICC, April 2002

TYPICAL TREEING OF POLYETHEYLENE FAMILY OF INSULATIONS

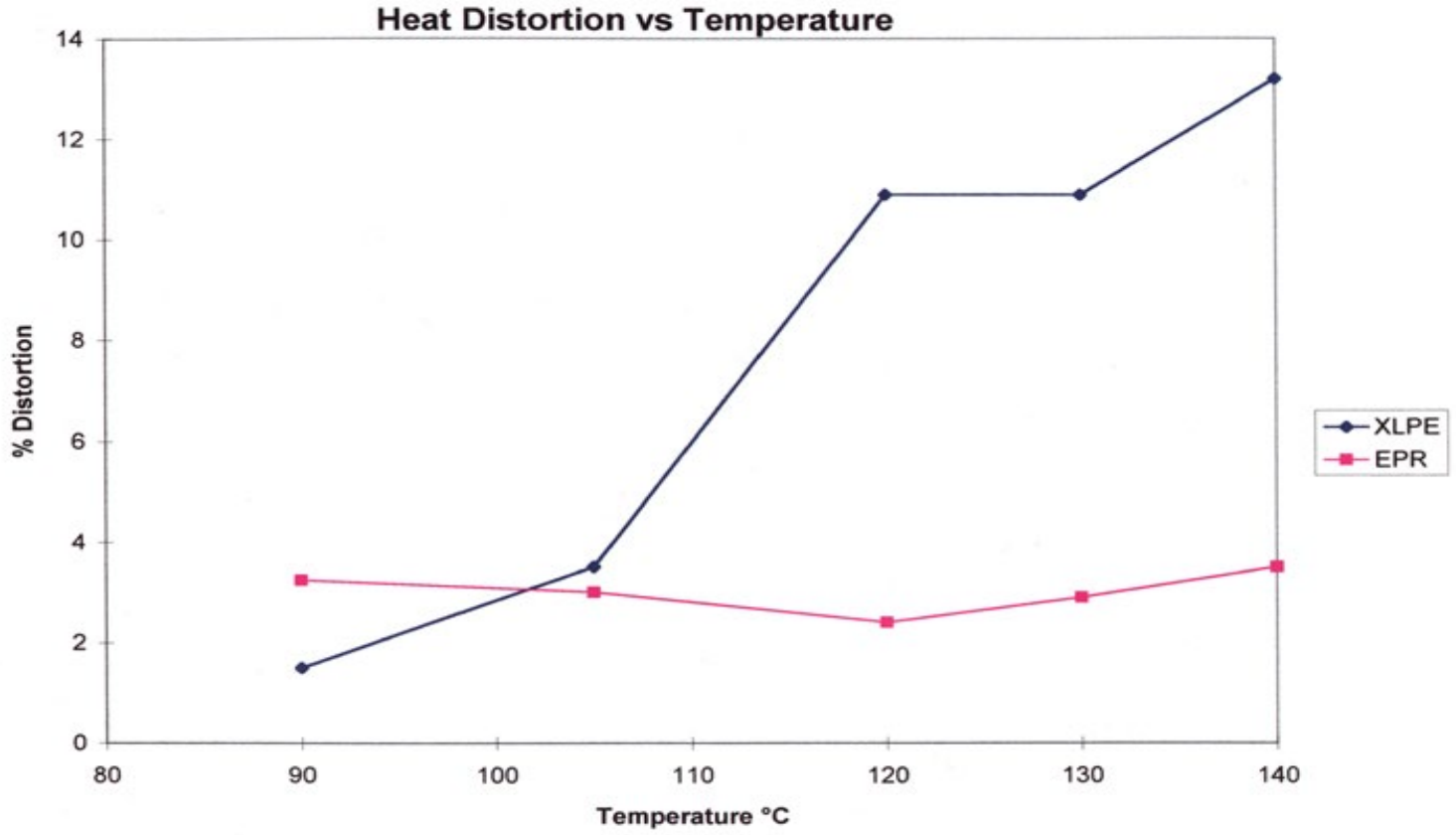
Causes of Water Trees in XLPE

- Why do cables with XLPE insulations suffer from water trees?
- What conditions are necessary for water trees to occur?
  - Water vapor
  - Electrical stress (volts/mil)
  - Time, typically 10 to 15 years

Tensile Strength Comparison



Heat Distortion Comparison



ACCELERATED CABLE LIFE TESTS

Sample: 1/0 A/175 Wall - unjacketed

- AC Test Voltage - 4X Voltage to Ground
- Water Temperature - 60-70°C
- Conductor Temperature - 90°C
- Water in Strand
- Days to Fail 50% of the Samples*

XLPE.....46
TR XLPE.....186
TR XLPE w/Super Smooth Semi-Con...360
XLPE w/Super Smooth Semi-Con.....375
OKOGUARD.....

TEST TERMINATED AFTER
1415
DAYS
(3.87 YEARS)

Insulation Thickness - % Insulation Level
MV Cables only

WALL THICKNESSES

	15 Kv	25 kV	35 kV
100 %	175 mils	260 mils	345 mils
133 %	220 mils	320 mils	420 mils
173 %	260 mils	460 mils	650 mils

Insulation Thickness - % Insulation Level

100%	133%	173%
Relay Clearing Time ≤ 1 minute	Relay Clearing Time ≤ 1 hour	Relay Clearing Time Indefinite
Typical for a 3-Phase System	Typical for a 3-Phase System	Typically for delta systems where 1-phase may be indefinitely grounded

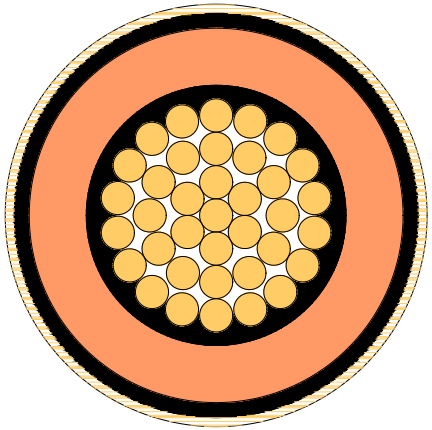
Insulation Shield

Non-metallic Shielding Layer

A cylindrical, smooth surface between the insulation and metallic shield

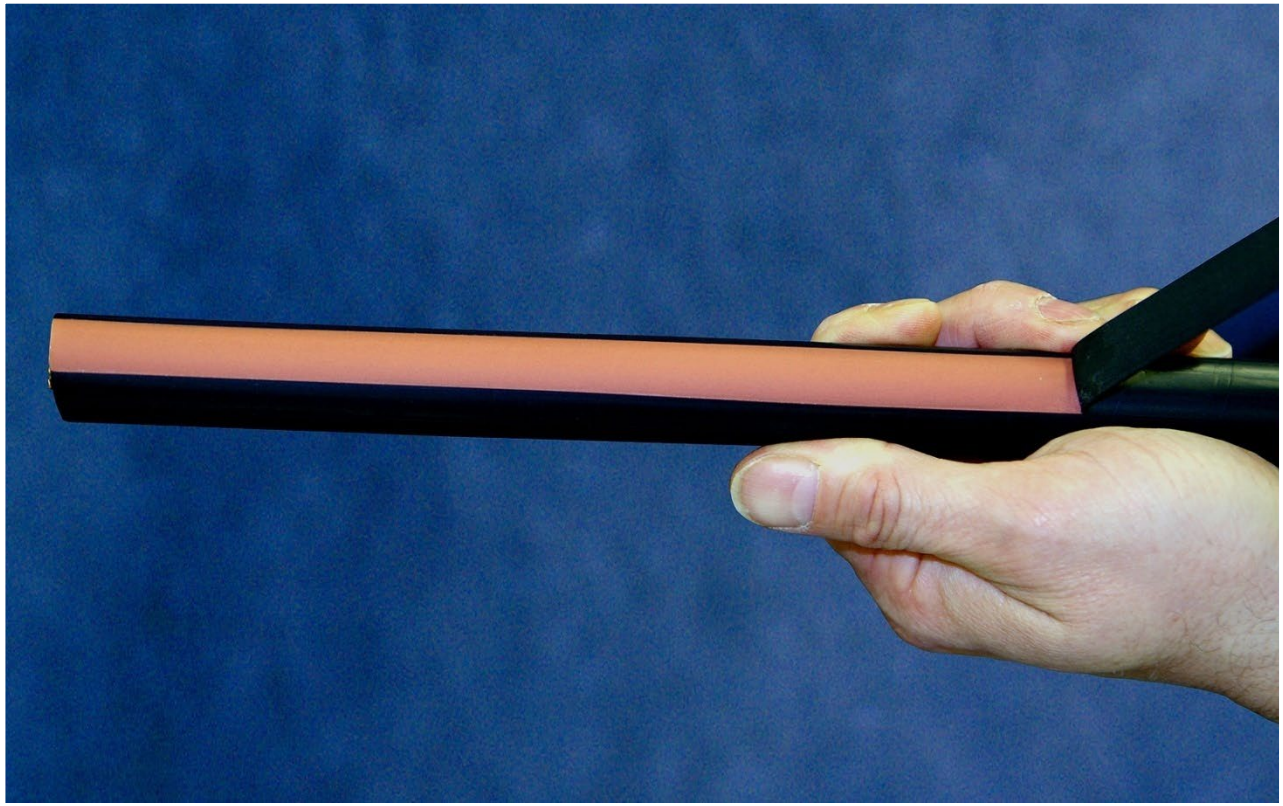
Purpose: To reduce voltage stress at the interface between the conducting and insulating component

Compatible with the insulation



Strippability

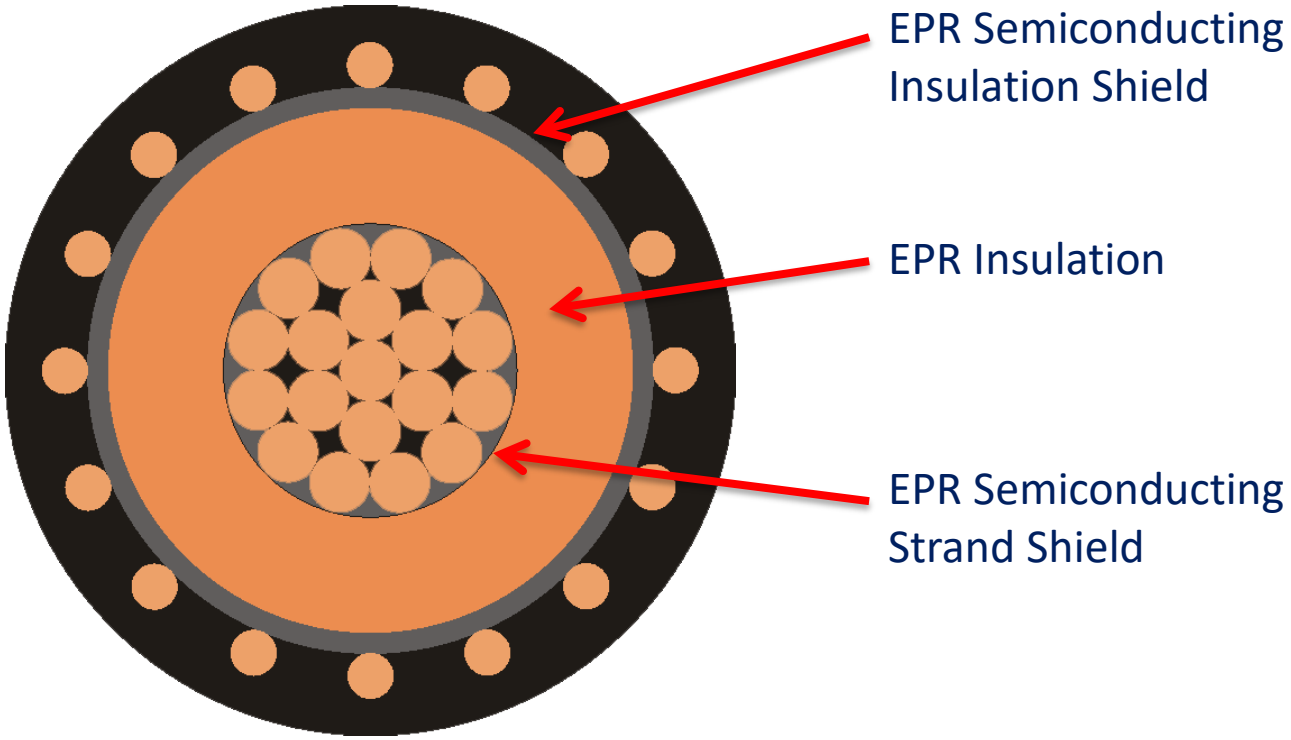
The formulation and manufacture of Okoguard and the all-EPR insulation system yields a free stripping insulation shield



All EPR Construction

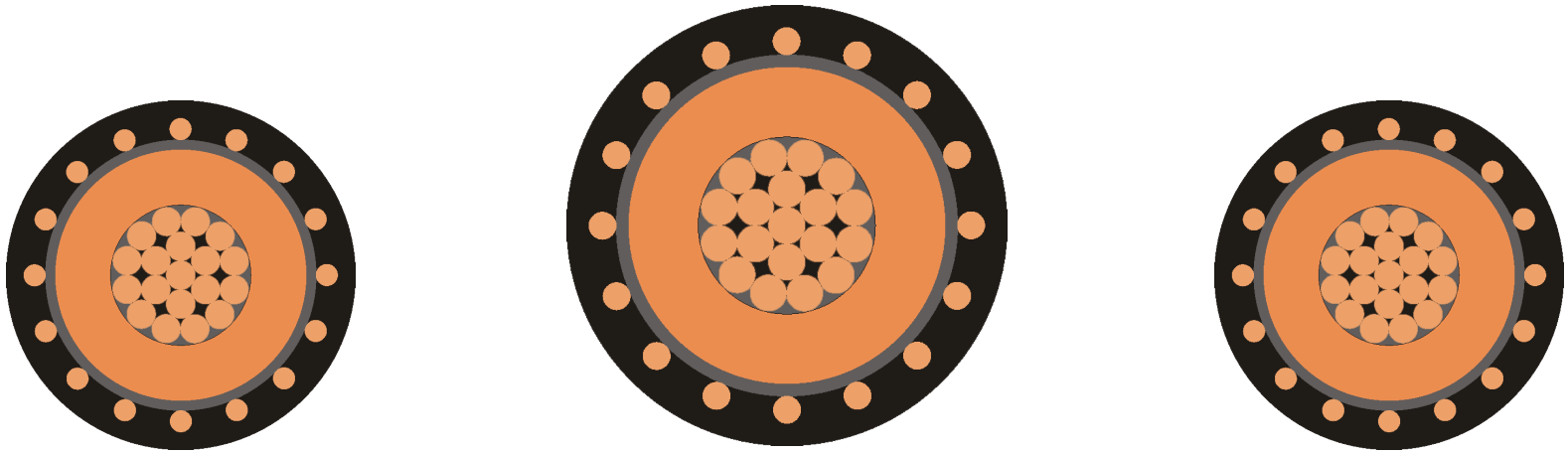
Okoguard Cables Utilize An All EPR Insulation System

All components assure chemical & thermal compatibility



Advantages

- The same coefficient of expansion
- The same thermal characteristics
- The same physical and electrical characteristics
- The same aging characteristics



The Difference

- The composition and mixture of insulation is carried out by Okonite at its own plant exclusively dedicated to the manufacture of Okoguard

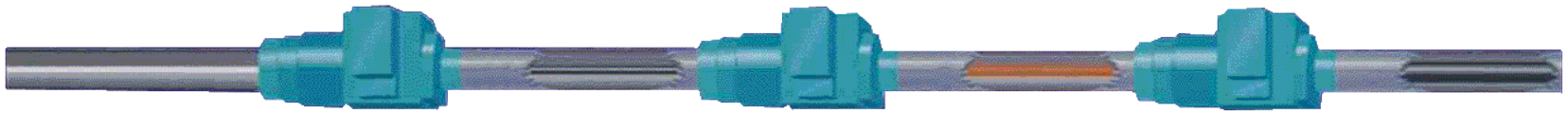
The Advantage

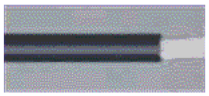
- Complete control of quality of the ingredients, formulation, and the process

THE OKONITE COMPANY

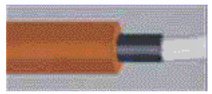
Triple Tandem Extrusion

- Okoguard Cables are manufactured on a continuous vulcanization machine (CV) with three tandem extruders
- A closed system that applies all three EPR components in one process
- Damage of critical interfaces and contamination are eliminated
- Employs laser micrometers to measure and control dimensions
- Triple Tandem is superior to the common head process which is limited to the measurement of the combined insulation and insulation shields

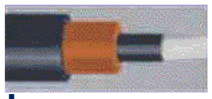




1st extruder applies the conductor shield, a black semiconducting, EPR thermosetting compound



2nd extruder immediately applies red Okoguard EPR insulation



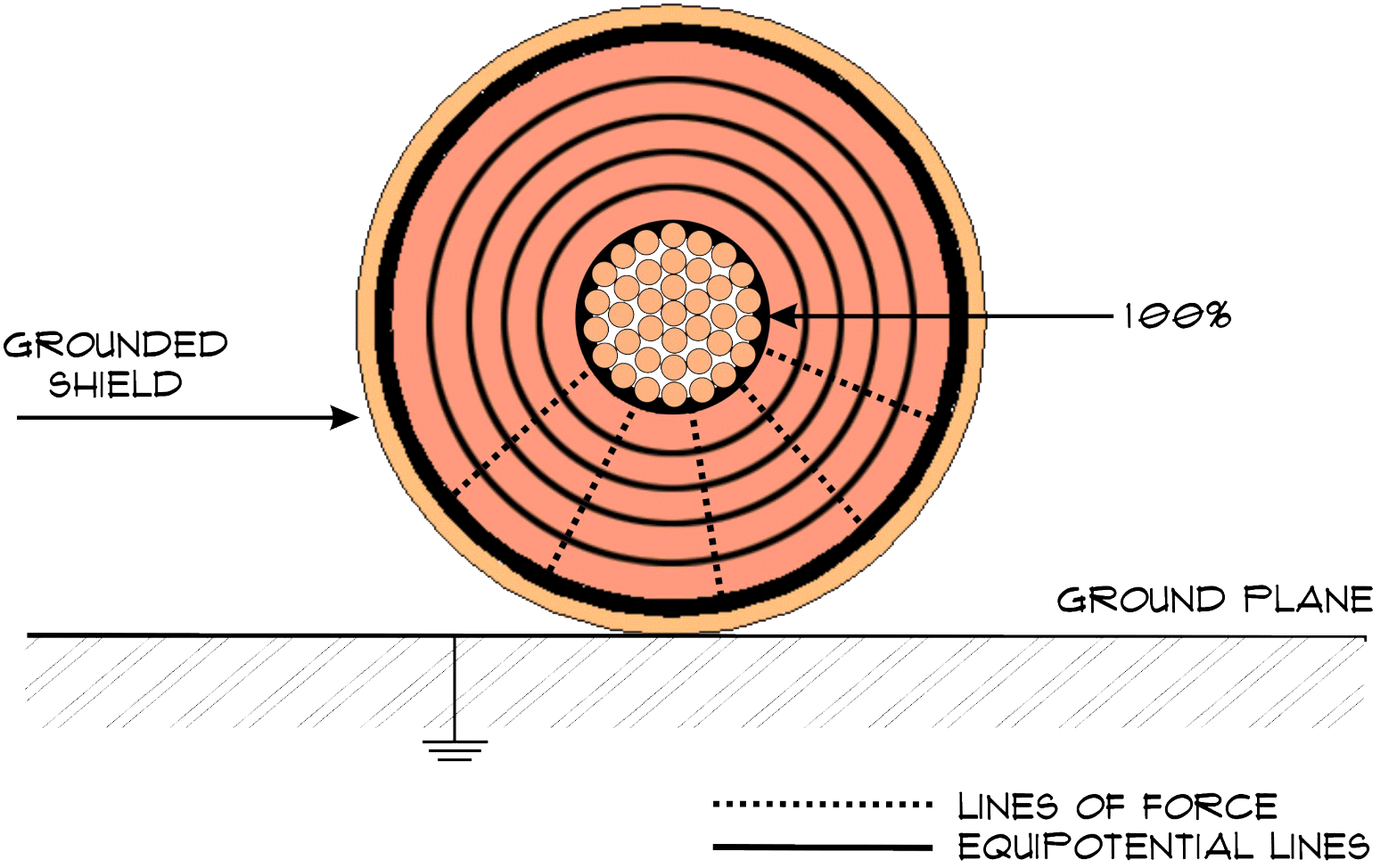
3rd extruder applies the insulation shield, a black semiconducting, EPR thermosetting compound

Metallic Shield Functions

(when properly grounded)

- Confine the electrical field within the insulation.
- Reduce the chance of electrical shock.
- Provide a symmetrical distribution of voltage stress
- Prevent surface discharge
- Reduce electrical interference
- Provide a fault current path to ground
- Neutral current return for URD cables

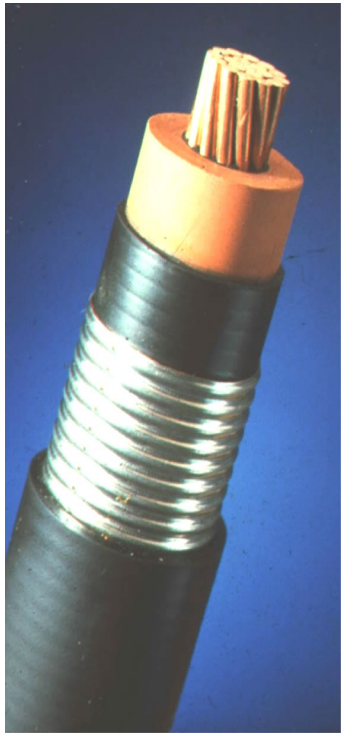
SHIELDED CABLE

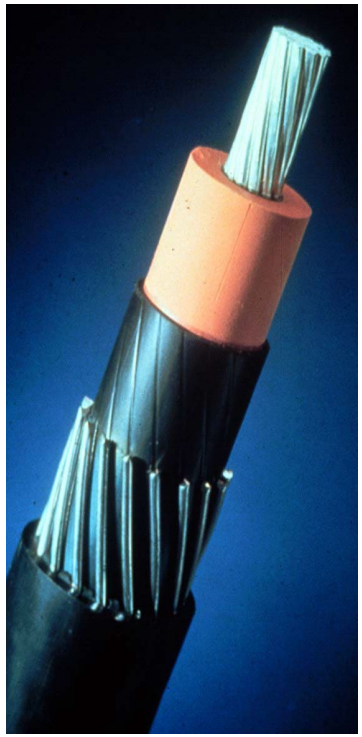


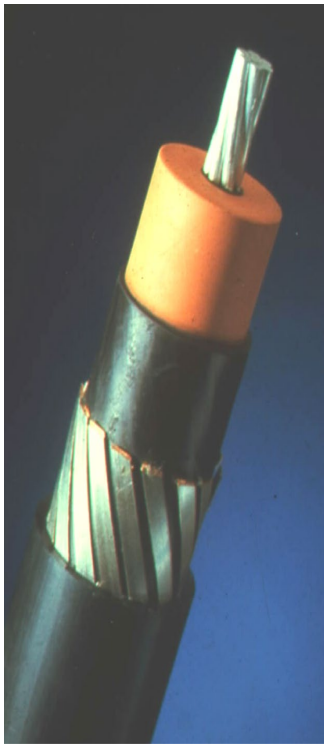
Metallic Shield - Types

- Flat copper tape
- Corrugated copper tape
- Concentric applied copper wires
- Concentric applied flat copper straps

Shielding Examples







Effect of Fault Current in Shield on Jacket

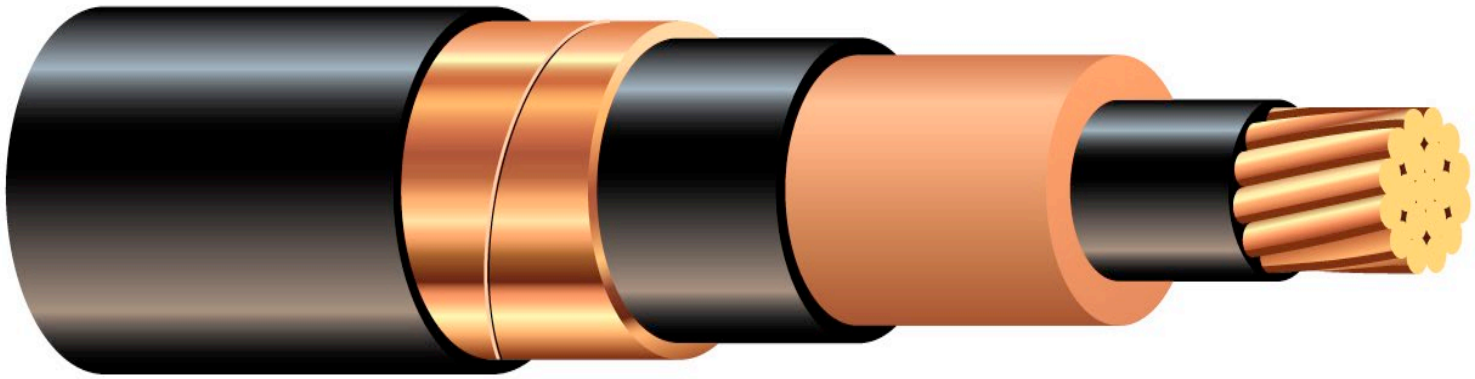
- Fault current returning to ground on the shield will produce higher than normal heat.
- Excessive heat can melt the overlying jacket.
- The higher the shield resistance (e.g. CU Tape) the more heat is generated.
- A lower shield resistance produces less heat.
- Adding more copper (wires, tapes, armor) lowers the shield resistance.

Shielding – Types
Listed from High Resistance to Low

- Flat copper tape (High R)
- Longitudinally corrugated tape (LCS) copper tape
- Concentric copper wires
- Concentric copper flat straps (Low R)

Shielding Resistance dictates the amount of circulating current that flows.

Cable Jackets



Cable Jackets

- Cable Jacket – Nonmetallic Outer Covering of a Cable
- Two Broad Categories: Thermoset and Thermoplastic
- For each application, the operating temperature and environment must be considered

Types of Cable Jackets

- Thermoplastic
  - PE (LLDPE)
  - PVC
  - TP-CPE
- Thermoset
  - TS-CPE
  - XLPE

Jacket - Purposes

- To Protect Cable Insulation, Screens, and Ground Wires From Physical Damage
- To Prevent Shield Corrosion
- To Provide Heat, Chemical, and Water Resistance
- To Provide Flame Retardance (CT/non-CT rated)
- To Provide Identification

OKONITE MV URD CABLE

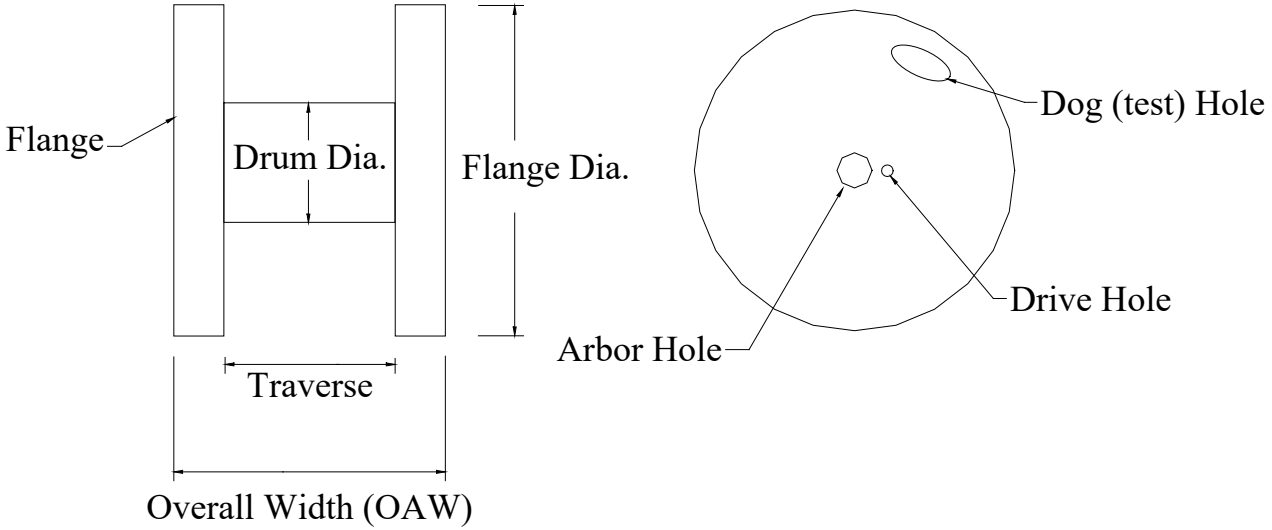
- EPR (Okoguard)
- Full or 1/3 Neutral
- 100 & 133% Insulation
- 5KV - 35KV
- Aluminum Compressed Conductor – Filled Strand
- LLDPE Jacket (Okolene)

Cable Handling and Installation

Mark Thiele, PE - Regional Application Engineer

Wood or Steel Reel

Reel Anatomy



Flange Diameter x Traverse Width x Drum Diameter x Overall Width

Triplexed (twisted) Cable on Reel

Paralleled (side-by-side) Cable on One Reel

Do not pick up a reel by the flange (unless cable is removed). This can damage the cable and/or the flange.

Spreader Bar

No Ropes or Slings on the Cable

Reel Handling

Reel Handling

- An example of git-r-done but not the best, or safest, way to do it.

Recommendation

Don’t use devices that support the reel from the arbor hole in a sideways position.

- Do not store reels on their side.
- Can damage cable, particularly larger sizes.
- Encourages wrong picking technique

Do Not Lay Flat

Recommended Handling & Storage Instructions

1.) **DO NOT** accept reels lying flat or showing evidence of having been laid flat in transit.
2.) **DO NOT** accept reels exhibiting damage to flanges or covering.
3.) **INDOOR STORAGE** is recommended for bare aluminum sheathed cables.
4.) **KEEP** cable ends sealed during storage.
5.) **FOLLOW ALL** recommended installation procedures outlined in the Okonite Engineering Manual.

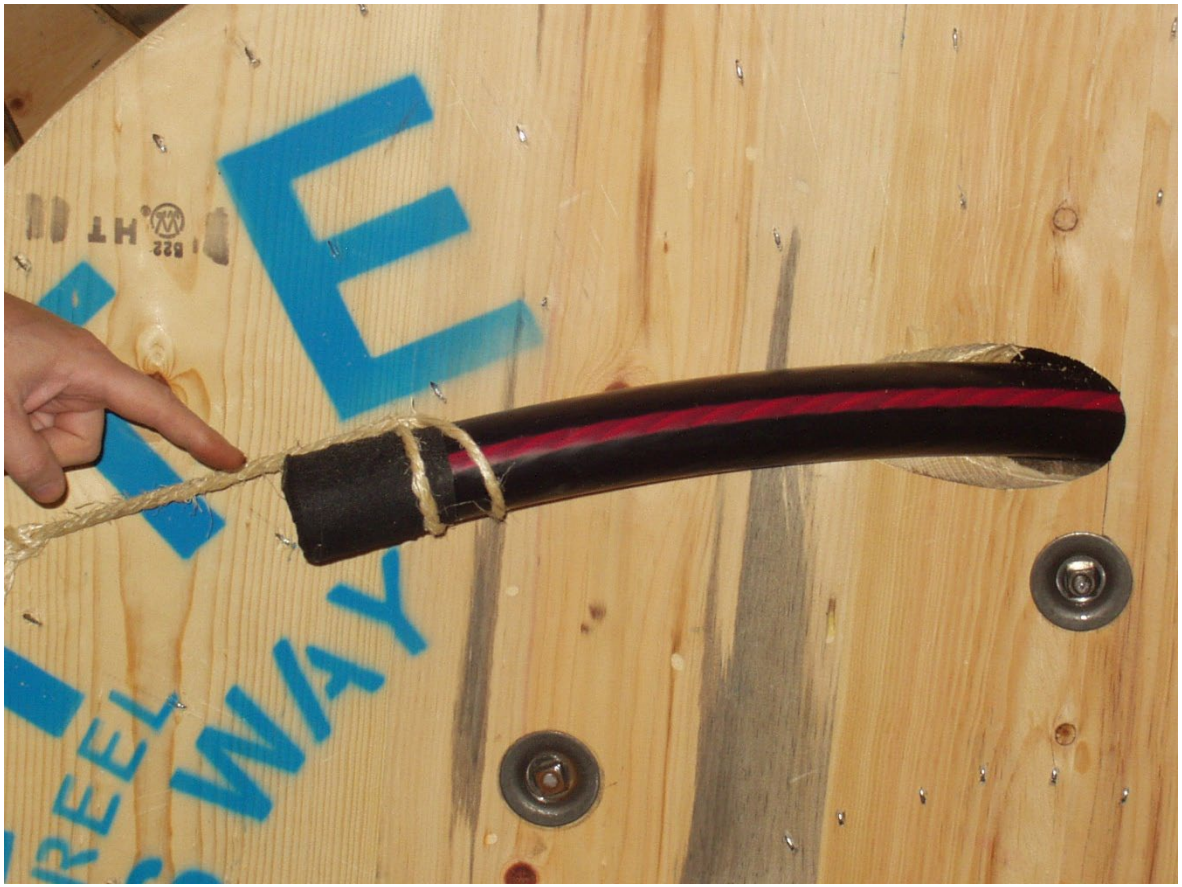
Do Not Lay Reels on Their Sides

Inspect the Wrapper

- The wrapper can indicate if damage has occurred.


Do Not Lay Flat
OKONITE
www.okonite.com

Cable End Seal and Tie Down Rope



Acceptable

Heat Shrink End Cap

Cold Shrink End Cap

Rubber Tape or Mastic

Unacceptable

Plastic (#33/35) Tape

Duct Tape and Garbage Bag

Wood Reels Outdoors = Limited Life

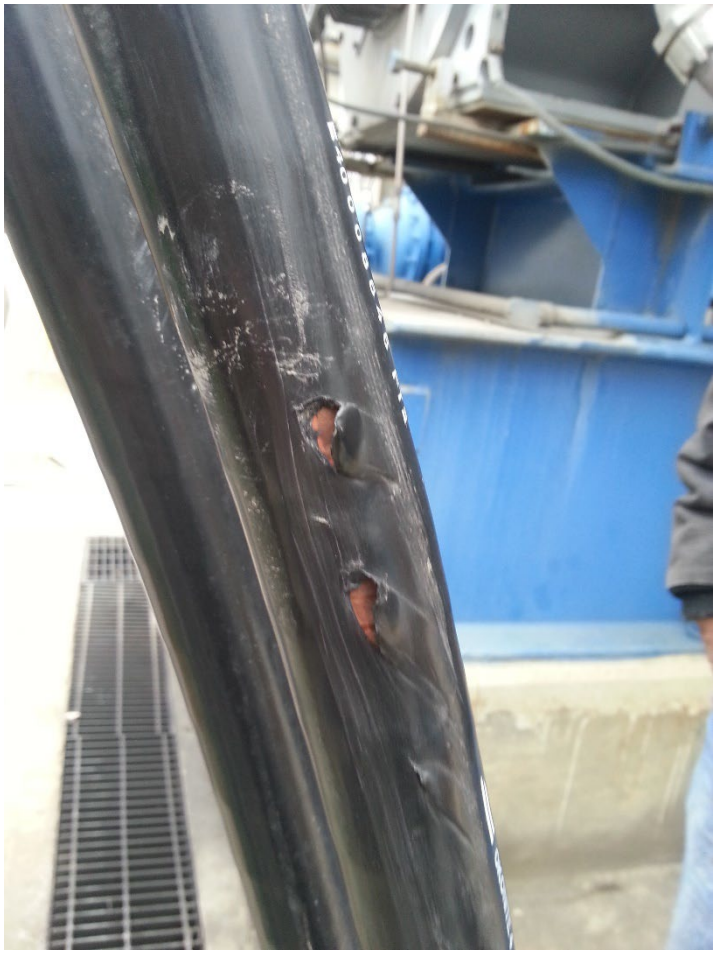
“Roll This Way” – See Arrow

The Correct Approach

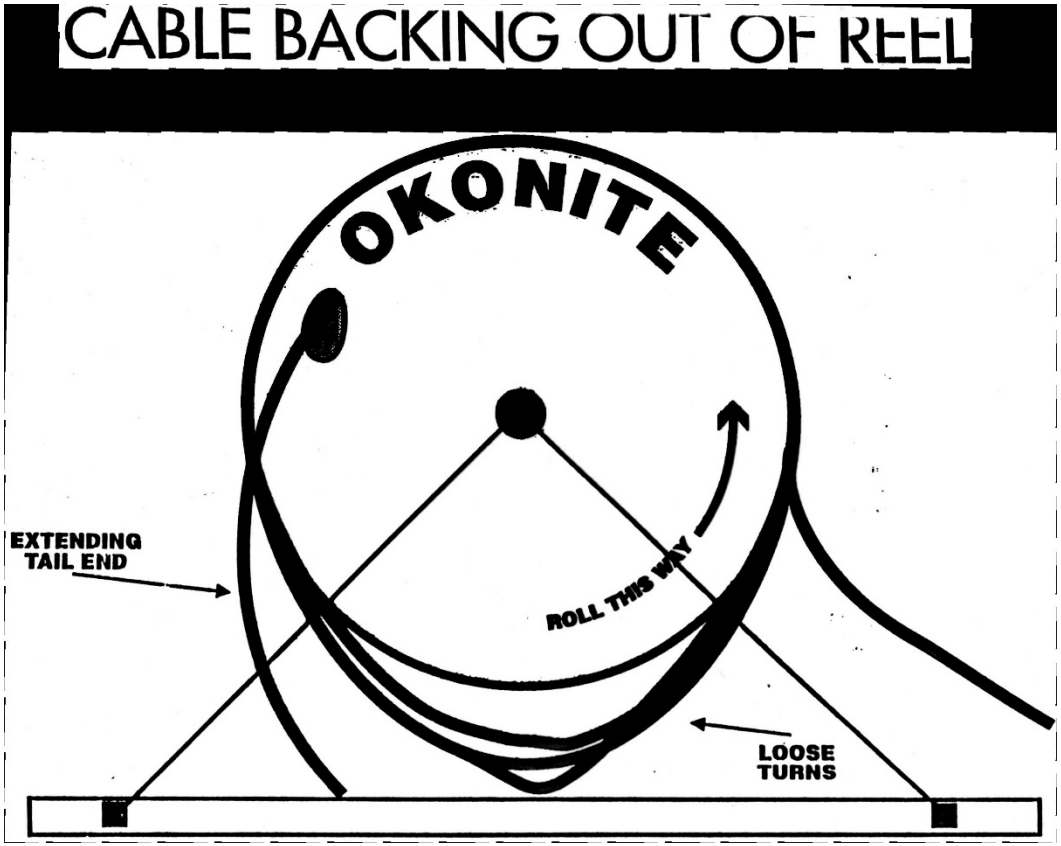
Fork Damage


I Am Safety!
Not Lay Flat

Nail Snag



When Reel Speed ≠ Cable Speed



Do not try to stop cable from coming out of test hole

Eliminate the loose turns and reduce cable loss

Cable “Backing Out” of the Reel


16 5:18 PM

Loose Wraps

Reels have overspun and the free end will back out of the test hole as pulling tension is re-applied.

What If I Nail Down the Loose End?

Z-ing on URD

Are Cable Pulling Considerations Important?

"....90% of all cable failures can be traced back to mechanical damage during installation."

Cable Installation Design Parameters

- Maximum Pulling Tension
- Maximum Sidewall Pressure
- Minimum Bending Radius
- Conduit Fill
- Jamming

Maximum Pulling Tension

This is the maximum tension that can be exerted on the pulling eye. The limiting factor is the yield strength of the conductor strands at the pulling eye. If exceeded, the strands may elongate and disrupt the insulation system, pull out of the eye or break.

Maximum Sidewall Pressure

SWP = T/R

SWP is equal to the tension in the bend divided by the radius of the bend in feet and is expressed in pounds per foot of radius. It is the pressure that exists between the conductor and the outside surface of a cable for each foot in contact with the bend.

SWP is usually the limiting factor in a cable pull, but can be modified in the design and construction stage by increasing the bend radius.

If SWP is exceeded for shielded cable, damage to the shield may occur or the shield material may damage insulation or jacket.

Minimum Bending Radius

Minimum Bending Radius as a Multiple of Cable Diameter	
Armored, corrugated sheath or	
interlocked type	7
with shielded single conductor	12
with shielded multi-conductor	7*
with non-shielded multi-conductor	7
Non-armored, flat or corrugated	
tape shielded single conductor	12
tape shielded multi-conductor	7*
LCS with PVC jacket	15
Non-armored, wire or flat strap	8
Non-armored, triplexed, shielded	8

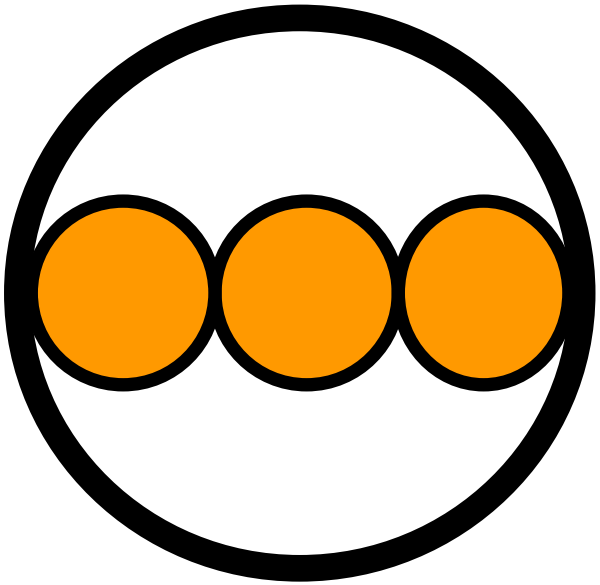
*12 times single conductor diameter or 7 times overall cable diameter-whichever is greater

Minimum Bending Radius

- Violations?

Jamming

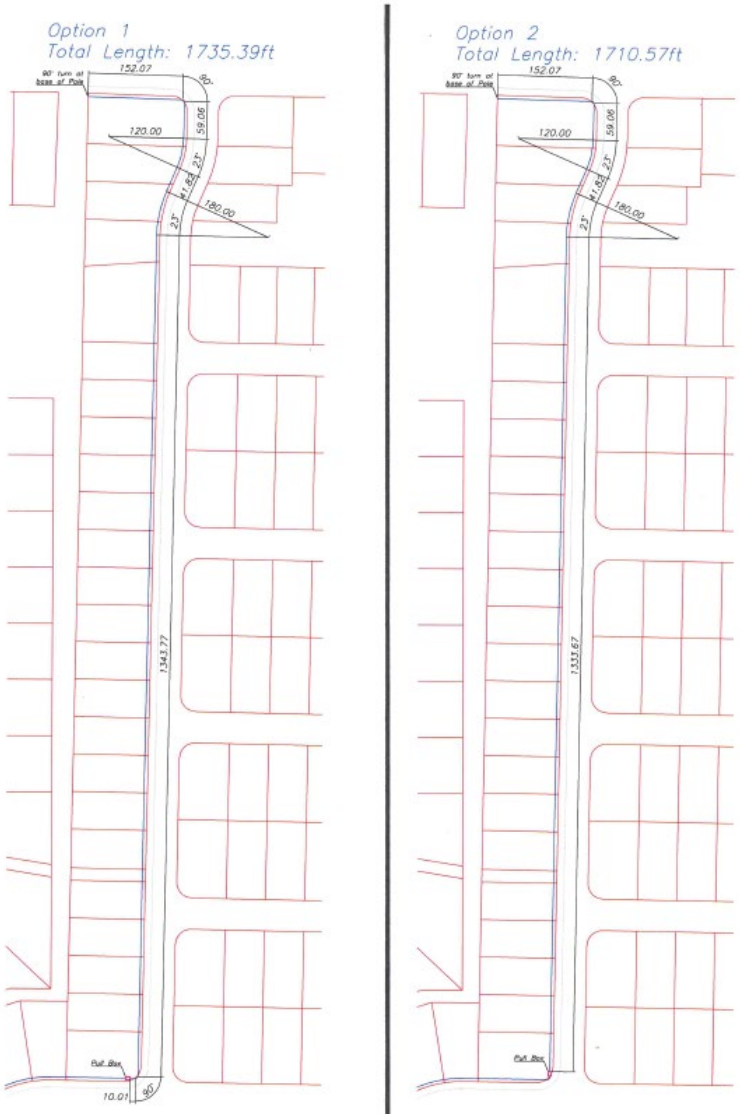
Jamming may occur when the sum of the diameters of the cables being pulled approximately equal the ID of the conduit or duct.



Pulling Calculations

- Horizontal pull
- Horizontal bend
- Sidewall pressure
- Vertical pull
- Vertical bend
- Incline
- Back tension
- Coefficient of friction (COF)

Pulling Calculations



Pulling Calculations

8/31/2023

Pull Description : Revised Install, 25kV 750 kcmil AL 1/3 neutral URD, Option 1

Okonite Cat. No.: 162-23-4096
Conduit ID: 4.03 inches Conduit Fill : 25.4%
Total of 1 cable(s) of 1 different type(s) being pulled.
Total cable weight : 2.365 (lbs/ft)
Calculated weight correction factor : 1.00
Configuration : Single Cable
Jam/Clearance Analysis : Jamming Not Possible
Incoming Tension : 60 lbs
COF : 0.35

Pull Detail Summary

Total (Cumulative) Bend : 316.0 degrees
Total Length Including Bends : 1741.6 feet
Max. Pulling Tension: 6,000 lbs
Max. Sidewall Pressure: 2,000 lbs/foot of radius
Minimum Bend Radius: 16.25 inches
Conduit Condition : Good

Cables

Cable Type	Cable Outer Diameter (inches)	Number of Cables	Cable Weight (lbs/ft)
1	2.030	1	2.365

Segments

Seg #	Straight Section Slope (°)	Slope Direction	Straight Section Length (ft)	Straight Section COF	Tension (lbs)	Bend Type	Bend Direction	Bend Radius (ft)	Bend Angle (°)	Bend Length (ft)	Bend COF	Tension (lbs)	Sidewall Pressure (lbs/ft)
1	0.0	--	152.0	0.35	186	Horizontal	--	3.00	90.0	4.7	0.35	322	107
2	0.0	--	59.0	0.35	371	Horizontal	--	120.00	23.0	48.2	0.35	440	4
3	0.0	--	42.0	0.35	475	Horizontal	--	180.00	23.0	72.3	0.35	569	3
4	0.0	--	1344.0	0.35	1681	Horizontal	--	3.00	90.0	4.7	0.35	2914	971
5	0.0		10.0	0.35	2922	Vertical Up	Up	3.00	90.0	4.7	0.35	5069	1690

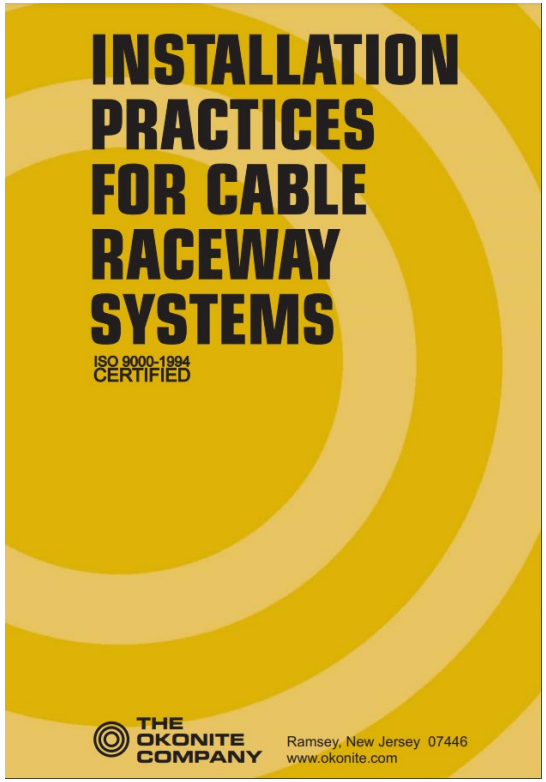
The Pull-Planner™ 4.0 Software uses the cable pulling (tension estimation) equations common in technical studies and included in a number of industry standards.

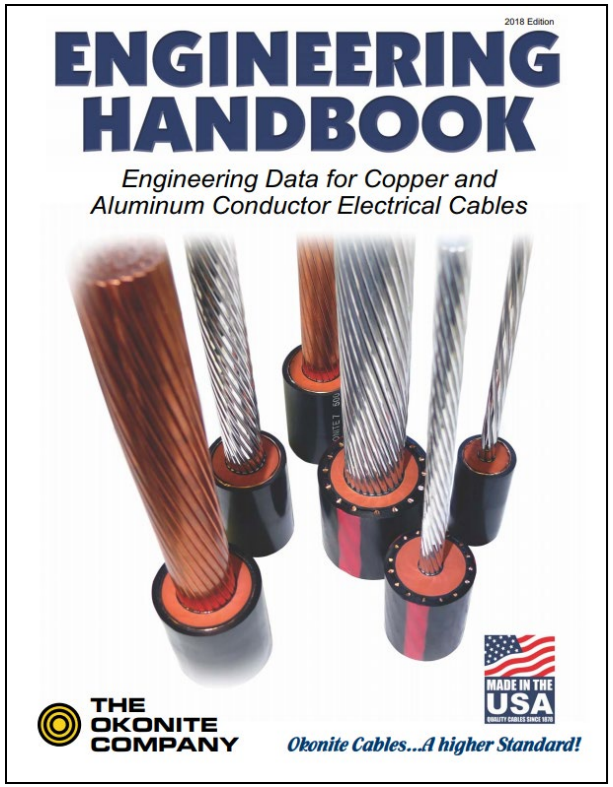
Based on the information provided by Contractor, the calculated pulling tensions and sidewall pressures for this pull are within the maximum limits for this cable type.

The Okonite Company submits the pulling calculations as a product service. These calculations and our 'Cable Installation Practices for Cable Raceway Systems' manual define Okonite's recommendations for cable handling. Okonite's product warranty is directed solely to our cable design and manufacture. Okonite does not warrant the workmanship of others.

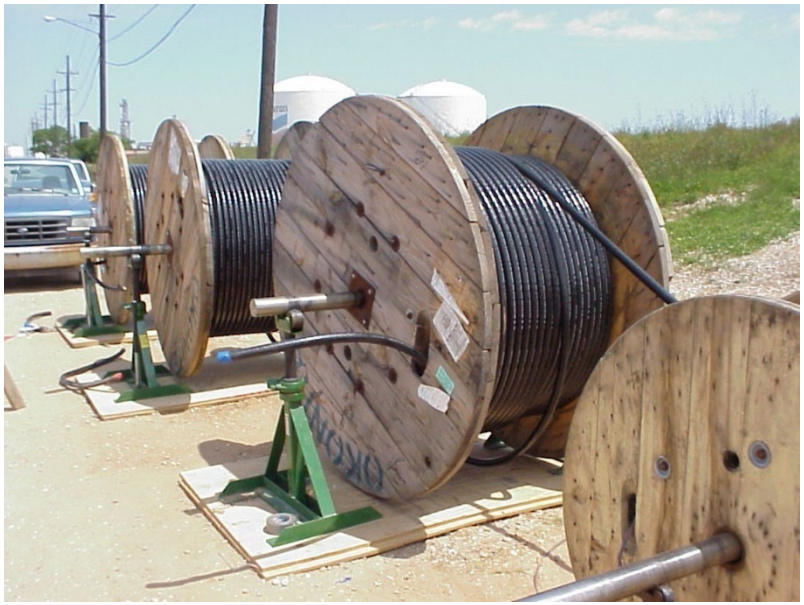
More Information?

- See our Installation and Practices for Cable Raceway Systems manual and Engineering Handbook at
  https://www.okonite.com/media/catalog/product/files/Installation_Practices.pdf
  https://www.okonite.com/media/catalog/product/files/EHB_2022.pdf



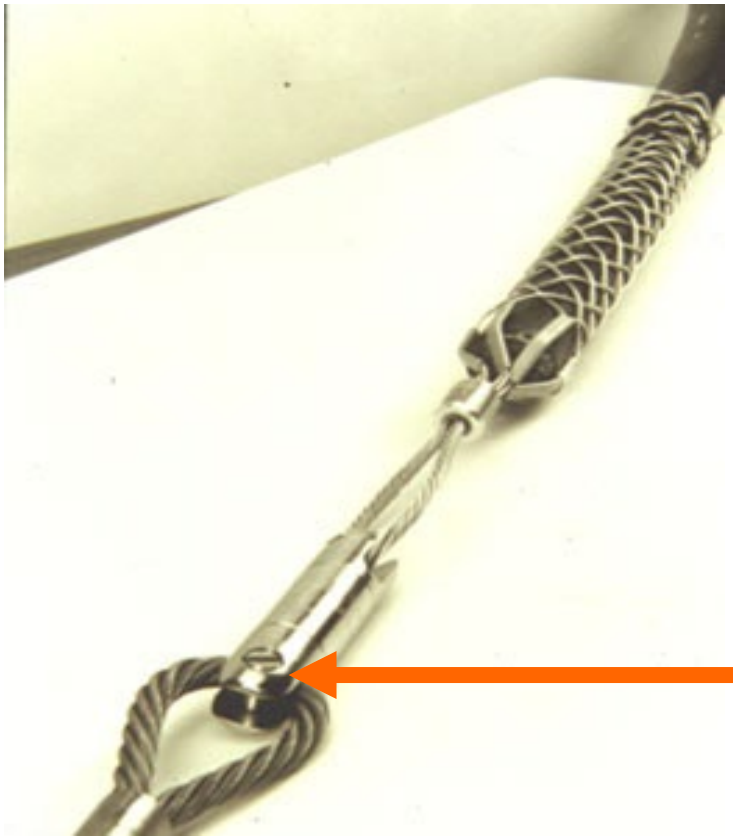


Staggered Reels



Staggered Reels

Equipment



Ball Bearing Type
Preferred

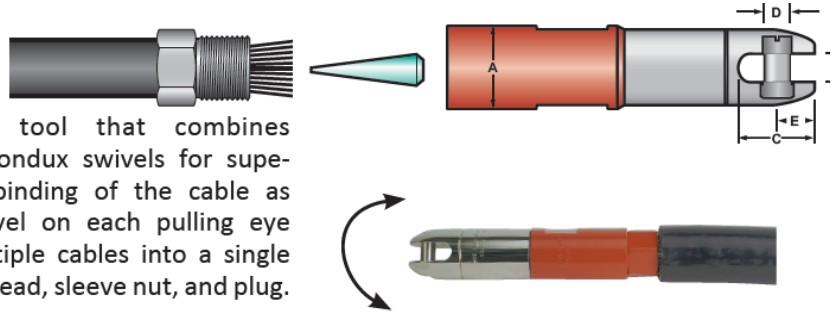
Swivel

Equipment

Pulling Equipment

– Reusable Pulling Eyes System

Reusable Power Pulling Eyes, Swivel Head



The Swivel Head Power Pulling Eye is a hybrid tool that combines features from standard reusable power pulling eyes and Condux swivels for superior performance. A swivel head prevents twisting and binding of the cable as it is installed. It eliminates the need for a separate swivel on each pulling eye when installing single cables into individual conduits or multiple cables into a single conduit. Each Swivel Head Power Pulling Eye includes a swivel head, sleeve nut, and plug.

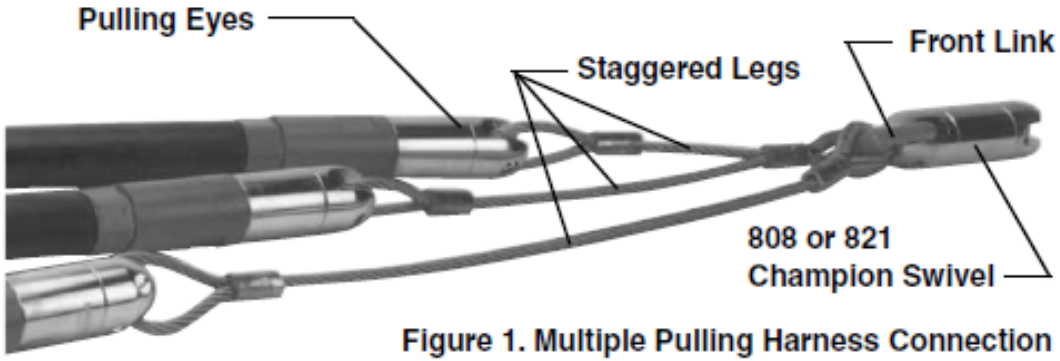
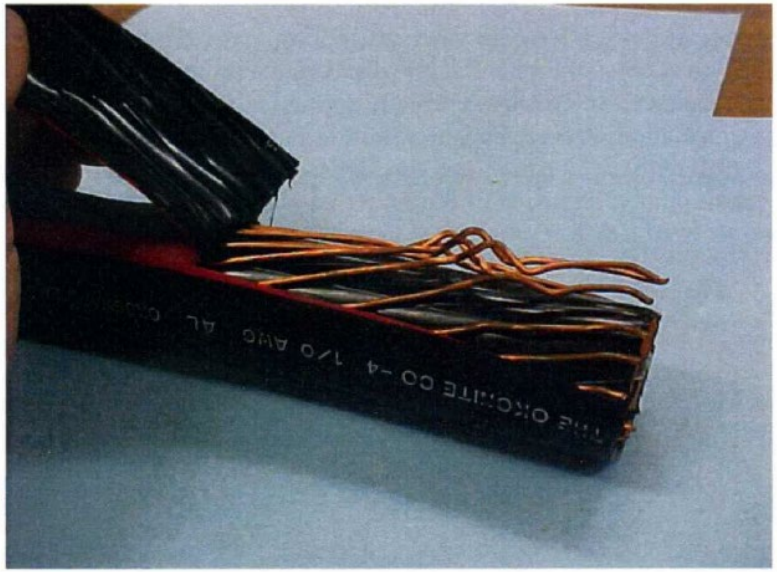


Figure 1. Multiple Pulling Harness Connection

Improper Equipment Damage

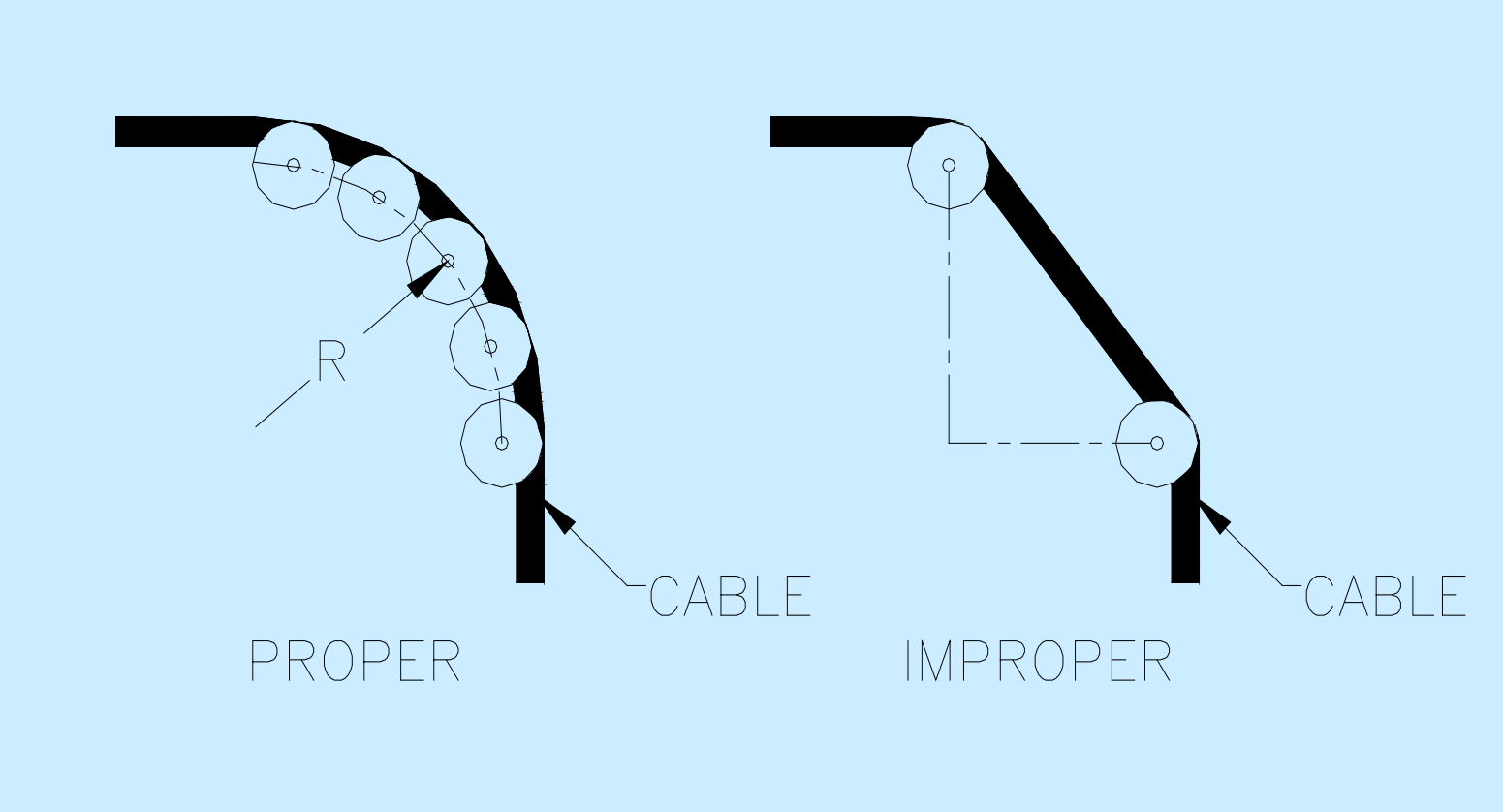
– No Swivel or Damaged Swivel – Torsional twist builds up on the cable and can migrate all the way back to the reel

"It came off the reel that way."



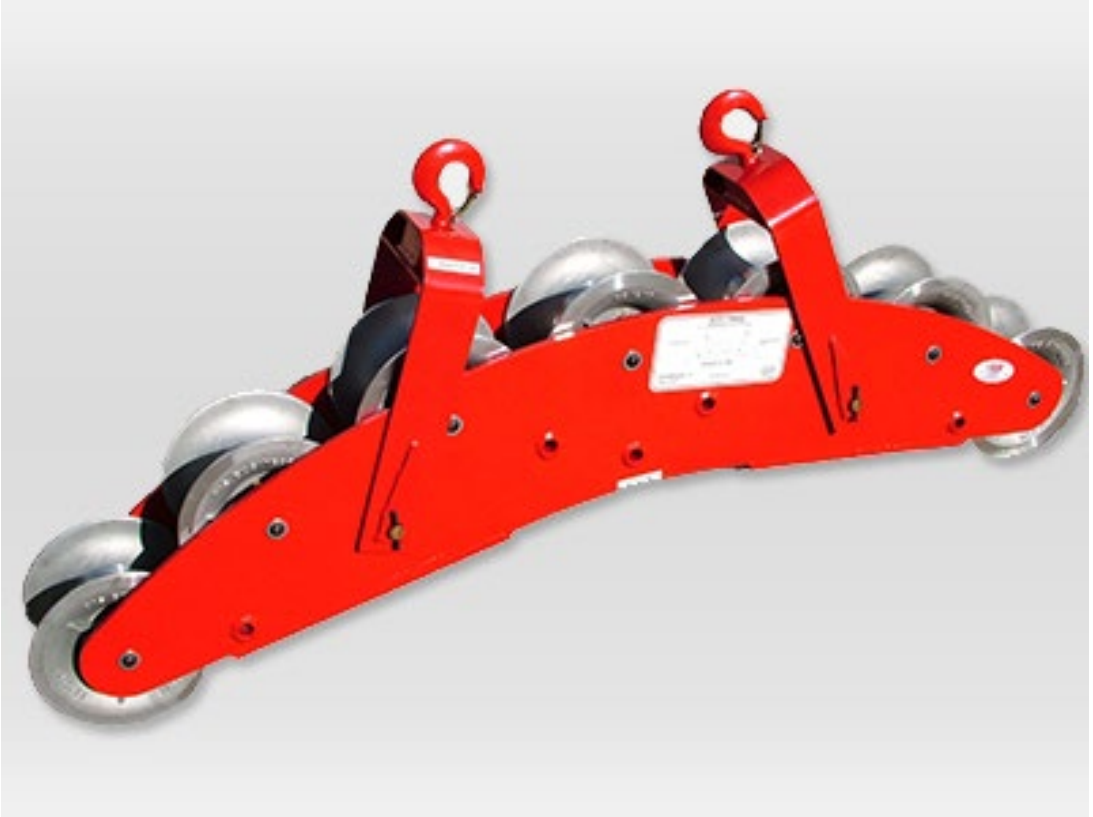
Equipment

- The Proper Sheave to Use



Equipment

- Appropriately Sized Multi-Sheave Radius Roller - Recommended



Equipment

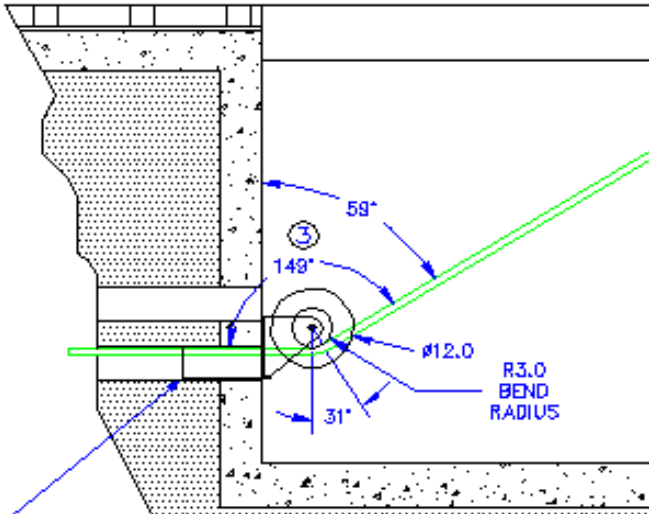
- The Proper Assembly to Use?

Equipment

- Single Wheels
  - Single-Wheel (Sheave) Block – Not Recommended for pulling around corners
  - Exceeding Maximum Sidewall Pressure can result in Damage (Radius too small)

Duct Rollers

- Duct Equipment
  - Duct Rollers – Use only as “Feed-In” Rollers, Never as “Feed-Out”. Excessive Sidewall Pressure (SWP) can damage cable since effective radius can be as smal as 1.5”.



Equipment

- Pulling Equipment
  - Cable Puller (Drum)

Equipment

- Pulling Equipment
  - Tugger

Pulling Lube

Reminders

- Pull thru max number of bends as early as possible (when possible)
- Use sweeps with larger radius on difficult pulls to minimize SWP
- Use plenty of lube
- Use BB swivels
- Dispose of a few feet of cable adjacent to pulling device
- If unsure of pull, perform a pulling tension calculation in both directions

Cable Preparation

- FOLLOW TERMINATION MANUFACTURER'S INSTRUCTIONS!

Jacket Removal

Jacket Removal

- From the Okonite Cable Prep YouTube video

Jacket Removal

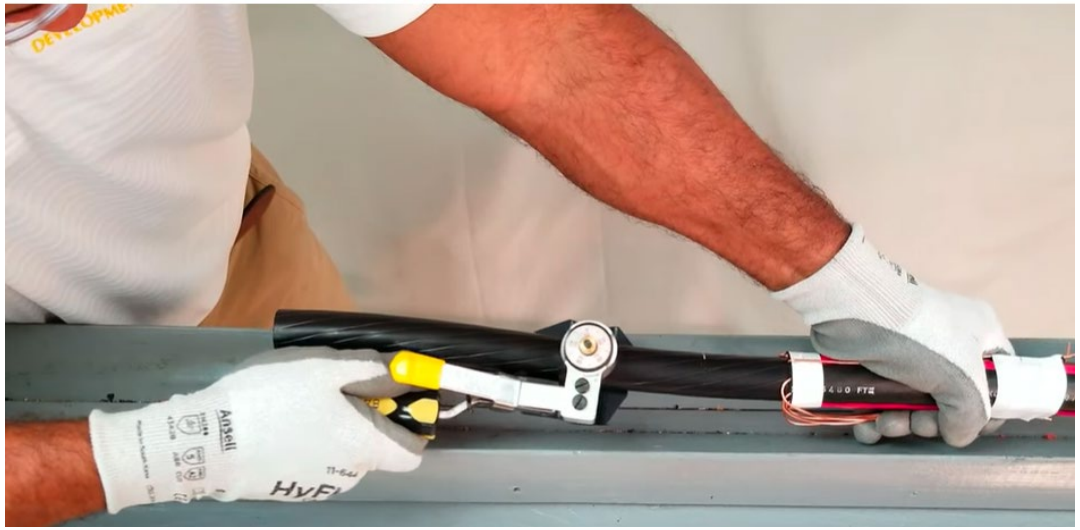
Jacket Removal

Jacket Removal

- The Ripjack

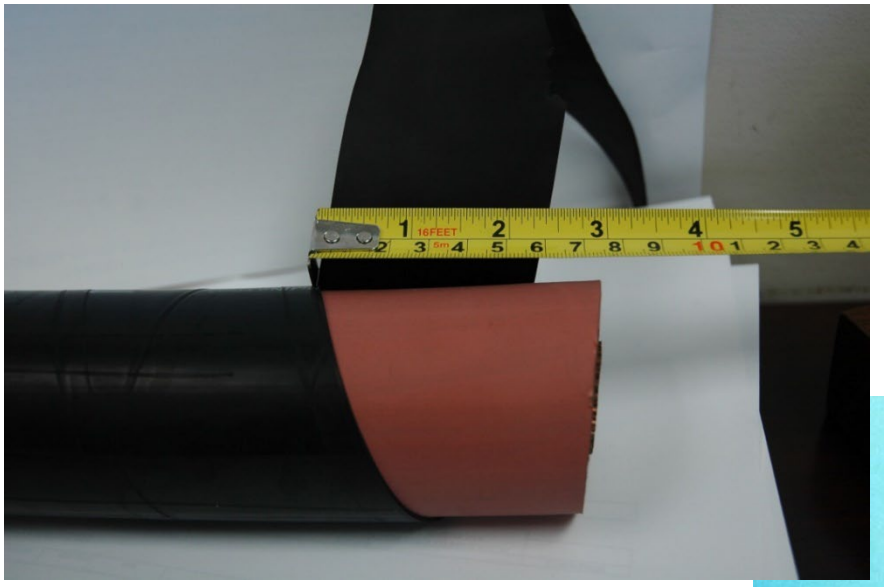
Semicon Removal

Semicon Removal

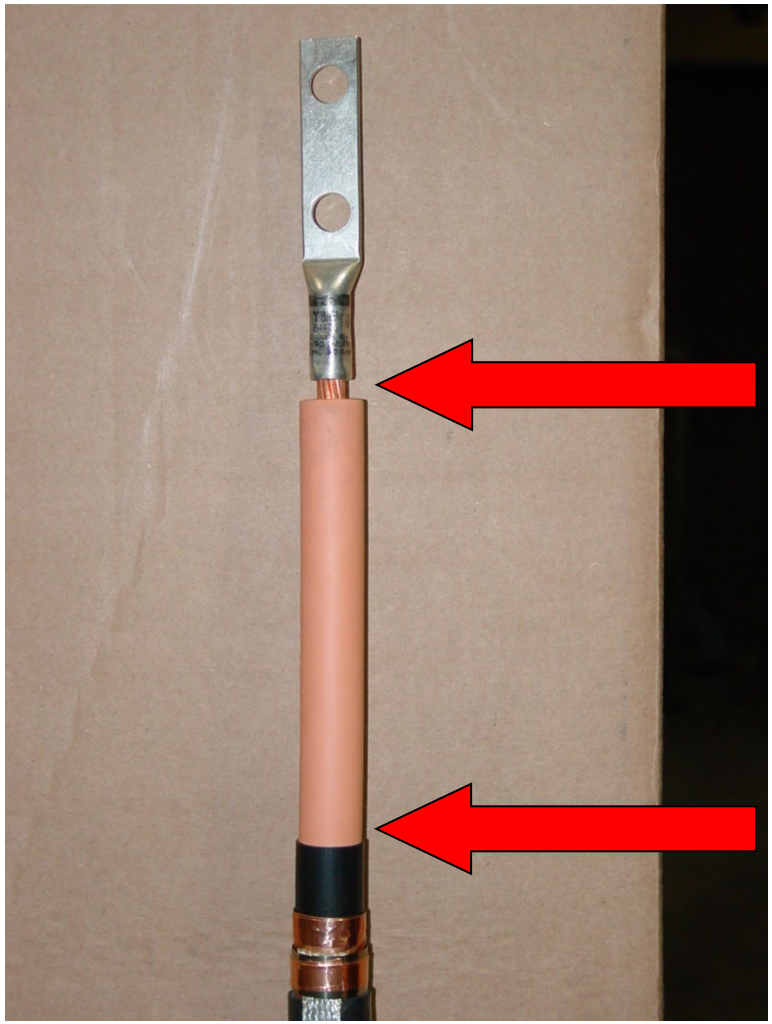


Semicon Removal

Semicon Removal



Semicon Removal



High Voltage but Low Stress

High Stress Area/Near Ground

Semicon Cleaners

- Are cleaners or sanding required once the semicon is removed? No, other than the simple cleaning required by the cable accessory manufacturer, or to remove dirt and grime that may have gotten on the insulation surface during end preparation.
- The results of Okonite's Specific Surface Resistivity (SSR) and Dielectric Strength tests along the exposed insulation surface are indicated in the table below.

Test	No Surface Preparation	Cleaner/Degreaser Wipe Only	Cleaner/Degreaser Wipe and Buffing
SSR	Infinity	Infinity	Infinity
Dielectric Strength	85kV	84kV	83kV

SSR Measurements per UL 1072, Section 47

Dielectric Strength – rapid rise 1kV/sec

Questions?