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**3M™ Aluminum Conductor Composite Reinforced (3M ACCR)
Installation Guidelines and Maintenance**



Installation Guidelines and Maintenance for 3M ACCR



High-Type 37-Strand Core Conductors & Long Span/River Crossing Applications

This Installation Guidelines and Maintenance document does NOT apply to 3M ACCR conductors that are constructed with a 37-strand core configuration. 3M ACCR conductors that are constructed with a 37-strand core configuration are considered high type conductors and require special stringing procedures and specialized equipment to successfully install them. High-type conductors are typically used for long span or river crossing applications. 3M ACCR conductor sizes that fall under this category include but are not limited to the following: **558-T73, 558-T73-L1, 668-T61, 1033TW-T28, 1085-T37, 1230TW-T24**. See section #7 for more information on high-type cable constructions.

If questions arise concerning the size, type and application of the 3M ACCR that is intended to be installed, consult 3M before proceeding with the installation.

For detailed information on the proper installation guidelines for high-type 3M ACCR conductors, please refer to 3M’s instructional document entitled, *3M™ Aluminum Conductor Composite Reinforced (3M ACCR) Long Spans Using High-Type Cable Constructions Installation Guidelines and Maintenance.*

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1. Safety Instructions

Please read, understand, and follow all safety information contained in these instructions prior to the use of this Aluminum Conductor Composite Reinforced (ACCR). Retain these instructions for future reference.

Intended Use

The 3M™ Aluminum Conductor Composite Reinforced (ACCR) is a conductor for overhead electrical power which is available in different sizes and material ratios. 3M ACCR can be operated continuously at a temperature of 210°C and is reinforced with a highly anisotropic material in its core. 3M ACCR requires special equipment and accessories for installation and operation in an overhead power-line system. Accessories and installation equipment selected for use with any 3M ACCR must adhere to 3M guidelines.

This product is intended for, and shall only be used by, authorized professionals trained in its proper handling, use, operation, installation, and safety.

Do not use 3M ACCR outside it's intended use, as this could cause unsafe or dangerous situations.

Explanation of Signal Word Consequences	
 DANGER:	Indicates a potentially hazardous situation which, if not avoided, will result in serious injury, death and/or property damage.
 WARNING:	Indicates a potentially hazardous situation which, if not avoided, could result in serious injury, death and/or property damage.
 CAUTION:	Indicates a potentially hazardous situation which, if not avoided, could result in minor or moderate injury and/or property damage.
NOTICE:	Indicates a situation which could result in altered product appearance.
	Attention: Read Accompanying Documentation

 **DANGER**

To reduce the risks associated with hazardous voltage, mechanical impact, and working at heights which, if not avoided, will result in serious injury, death and/or property damage:

- If there is possible conductor core damage due to failure to follow the **⚠ WARNING** safety instructions in this document, personnel shall not climb out on the conductor, use a conductor cart, trolley, spacer cart or any other equipment that relies on the 3M ACCR as a single means of personal fall protection safety until it is determined that the conductor or conductor core is not damaged.
- If there is outside aluminum strand or core damage, personnel shall not climb out on the conductor, use a conductor cart, trolley, spacer cart or any other equipment that relies on the 3M ACCR as a single means of personal fall protection safety until it is determined that the conductor or conductor core is not damaged.

 **WARNING**

To reduce the risks associated with hazardous voltage, mechanical impact, and working at heights which, if not avoided, could result in serious injury, death and/or property damage:

- Do not place large side angle loading on the Preformed Grip assembly when gripping the 3M ACCR. Large side loading angles placed on the Preformed Grip can cause conductor core damage to the 3M ACCR or Preformed Grip failure (commonly known as “peel-out”). The maximum side loading on a Preformed Grip assembly shall not be greater than 10° from the center line of the 3M ACCR conductor that is being gripped.
- After a Preformed Grip is placed on the 3M ACCR, do not allow the unloaded section, or jumper tail, for example, of the 3M ACCR to become unsecured resulting in this section of conductor falling and/or swinging towards the Preformed Grip. This can cause conductor core damage to the 3M ACCR.
- After a steel forging of the compression dead end is installed onto the 3M ACCR, do not allow the forging to become unsecured resulting in this section of conductor falling and/or swinging towards the Preformed Grip. This can cause conductor core damage to the 3M ACCR.
- After a compression dead end assembly is installed onto the 3M ACCR, do not allow the assembly to become unsecured resulting in this section of conductor falling and/or swinging towards the Preformed Grip. This can cause conductor core damage to the 3M ACCR.
- After a THERMOLIGN dead end assembly is installed onto the 3M ACCR, do not allow the assembly to become unsecured resulting in this section of conductor falling and/or swinging towards the Preformed Grip. This can cause conductor core damage to the 3M ACCR.
- It is required that the inner reinforcement rod layer of the THERMOLIGN suspension assembly is to be installed over the 3M ACCR prior to picking (lifting) the 3M ACCR out of the stringing block to complete the suspension installation. The picking strap or conductor hook must be installed over this reinforcement rod layer. Conductor core damage to the 3M ACCR can be caused if the picking (lifting) strap or conductor hook is placed directly on the 3M ACCR without the reinforcement rod layer.
- Chicago grips or pocket-book grips are NOT to be used in any way to hold, grip or tension 3M ACCR conductors. Tests done with these types of grips have shown that the offset gripping action induces a sharp bend to the conductor and causes damage to the composite core wires, even at low tensions.

 **WARNING**

To reduce the risks associated with hazardous voltage, mechanical impact, and working at heights which, if not avoided, could result in serious injury, death and/or property damage:

- Do not use the ‘slack stringing’ method for installation as it may cause unknown damage to the 3M ACCR.
- Avoid elevated back tensions combined with small bend radiuses, such as small diameter stringing blocks, as this may cause damage to the inner composite core wires.

 **WARNING**

To reduce the risks associated with hazardous voltage, mechanical impact, and working at heights which, if not avoided, could result in serious injury, death and/or property damage:

- This product is intended for, and should only be used by, authorized professionals trained in its proper handling, use, operation, installation and safety.

 **WARNING**

To reduce the risks associated with hazardous voltage, mechanical impact, and working at heights which, if not avoided, could result in serious injury, death and/or property damage:

- Handle the ACCR and components carefully. For proper performance and personal safety, do not substitute for the 3M selected system accessories.
- During assembly and installation, protect the devices and components against damages and contamination. Ensure all necessary parts are received and undamaged. Only use undamaged parts for assembly and operation.
- Only use a lifting tool with sufficient lifting capacity for unloading conductor and accessories upon delivery. Unloading shall be by skilled workers. After unloading, check the ACCR and components for damage.
- When working under live overhead transmission lines, avoid accidental electric contact.

 **WARNING**

To reduce the risks associated with hazardous voltage, mechanical impact, and working at heights which, if not avoided, could result in serious injury, death and/or property damage:

- Do not use these 3M safety instruction procedures to supersede your company construction procedures or safety standards. Nonobservance of this or other instructions could result in serious injury or death.
- Read, understand, and follow all safety statements for each system part in the appropriate installation instruction and refer to the applicable Safety Data Sheets for the compounds.

 **WARNING**

To reduce the risks associated with hazardous voltage, mechanical impact, and working at heights which, if not avoided, could result in serious injury, death and/or property damage:

- Ensure that the minimum size sheaves on the hold-down block are 14" (355 mm) each when being used on any size 3M ACCR conductor hold-down or let-up procedure.
- Do not use bands when pulling sock splices through stringing blocks.
- Always use a 28" (700mm) minimum stringing block between the reel stand and the tensioner if the incline angle over the fairlead roller is greater than 20°.

 **WARNING**

To reduce the risks associated with hazardous voltage, mechanical impact, and working at heights which, if not avoided, could result in serious injury, death and/or property damage:

- During installation, operation, and maintenance of the ACCR and components, consider all applicable rules and regulations for installation, use and maintenance of overhead transmission lines, including any related national safety and accident prevention regulations, any guidelines (working and standards operation procedures) of your company, any other applicable local/national regulations, as well as requirements of any applicable accident prevention and insurance association.

 **WARNING**

To reduce the risks associated with hazardous voltage, mechanical impact, and working at heights which, if not avoided, could result in serious injury, death and/or property damage:

- The system components are intended for a single use (one time) for the specified application, except as otherwise specified in this installation and maintenance guide. Do not modify these components under any circumstances. Tensioning Grips (‘TG-Grips’) from PLP* can be applied up to 3 times. (*TG-Grips Grips can be applied up to 3 times on a single conductor for the tensioning or final sagging of the conductor. The reapplication is acceptable for the purpose of re-positioning the TG-Grip for adjusting the sag on that single conductor only. TG-Grips are not to be re-used after 3 applications or the final use on that single conductor. The TG-Grip has a rated holding strength of 40% of the conductor rated breaking strength (RBS).)

 **WARNING**

To reduce the risks associated with hazardous voltage, mechanical impact, and working at heights which, if not avoided, could result in serious injury, death and/or property damage:

- Do not use damaged roller array sheaves. Always check tool for damage before use, including the inner surfaces. Sheaves must roll smoothly without impediment.
- Do not change or repair the tool itself. Repair must be performed by the manufacturer only.
- For a specific project, the maximum allowed tension for the ACCR cable guided by the roller array sheave shall not exceed the maximum allowed break over angle specified by 3M.
- Always check the safety mechanism on the roller array block for damage and correct closing after putting the cable through it. Always check whether the safety bolt is secured by the safety ring.

 **WARNING**

To reduce the risks associated with hazardous voltage, mechanical impact, and working at heights which, if not avoided, could result in serious injury, death and/or property damage:

- Always wear appropriate Personal Protective Equipment including eye, skin, body, hand, head, and feet protective equipment.
- Always use appropriate climbing equipment during installation procedures.

 **WARNING**

To reduce the risks associated with hazardous voltage, mechanical impact, and working at heights which, if not avoided, could result in serious injury, death and/or property damage:

- Damaged 3M ACCR must be repaired according to the guidelines set out in this document.

 **CAUTION**

To reduce the risks associated with poisoning or allergic reactions during the work with ALNOX ELECTRICAL JOINT COMPOUND which, if not avoided, could result in minor or moderate injury:

- Always read and follow the instructions contained in the material's SDS.
- Avoid contact of material with water. Risk of flammable gases.
- Avoid eye and skin contact. Wear safety glasses with side guards to avoid eye contact. Wear impervious gloves to prevent any skin contact. In case of contact with eyes, flush with plenty of water or saline for 15 minutes and consult a physician immediately. In case of skin contact wash skin with soap and water for at least 15 minutes. Consult a physician if symptoms do occur.
- Wear respiratory protection mask.
- Keep out of reach of children. For professional use only. Keep containers closed when not in use. Store away from heat, sparks, flames, oxidizers, and other incompatible substances.
- In case of using other, e.g. less toxic electrical joint compounds (e.g. ContactAL HPG), the security information in the appropriate SDSs are to be observed.

 **CAUTION**

Hi Temp Filler Compound

To reduce the risks associated with poisoning during the work with Hi Temp Filler Compound which, if not avoided, could result in minor or moderate injury:

FIRST AID PROCEDURES

- The following first aid recommendations are based on an assumption that appropriate personal and industrial hygiene practices are followed.
- Eye Contact: Flush eyes with large amounts of water. If signs/symptoms persist, get medical attention.
- Skin Contact: Remove contaminated clothing and shoes. Immediately flush skin with large amounts of water. Get medical attention. Wash contaminated clothing and clean shoes before reuse.
- Inhalation: No need for first aid is anticipated.
- If Swallowed: Do not induce vomiting unless instructed to do so by medical personnel. Give victim two glasses of water. Never give anything by mouth to an unconscious person. Get medical attention.

PERSONAL PROTECTIVE EQUIPMENT (PPE)

- Eye/Face Protection: Avoid eye contact. The following eye protection(s) are recommended: Safety Glasses with side shields.
- Skin Protection: Avoid skin contact. Select and use gloves and/or protective clothing to prevent skin contact based on the results of an exposure assessment. Consult with your glove and/or protective clothing manufacturer for selection of appropriate compatible materials.
- Respiratory Protection: An exposure assessment may be needed to decide if a respirator is required.
- If a respirator is needed, use respirators as part of a full respiratory protection program. Based on the results of the exposure assessment, select from the following respirator type(s) to reduce inhalation exposure: Half facepiece or full facepiece air-purifying respirator suitable for particulates. For questions about suitability for a specific application, consult with your respirator manufacturer.
- Prevention of Swallowing: Do not eat, drink or smoke when using this product. Wash exposed areas thoroughly with soap and water.

 **CAUTION**

To reduce the risks associated with environmental contamination which, if not avoided, could result in minor or moderate injury:

- Dispose of all system components in accordance with applicable local laws and regulations.

NOTICE

- To avoid potential conductor staining due to water and/or condensation, the plastic wrap that is placed over the ACCR during conductor stranding should be removed upon delivery.

2. Conductor Information

Material Properties

The 3M ACCR is a non-homogeneous conductor consisting of high-temperature aluminum-zirconium strands covering a stranded core of fiber-reinforced composite wires. Both the composite core and the outer aluminum-zirconium (Al-Zr) strands contribute to the overall conductor strength.

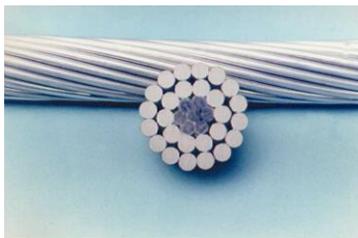
Composite Core

The composite core contains 3M metal matrix composite wires with diameters ranging from 0.074” (1.87 mm) to 0.116” (2.94 mm). The core wires have the strength and stiffness of steel, but with much lower weight and higher conductivity. Each core wire contains many thousand, ultra-high-strength, micrometer-sized fibers. The fibers are continuous, oriented in the direction of the wire, and fully embedded within high-purity aluminum. Visually, the composite wires appear as traditional aluminum wires, but exhibit mechanical and physical properties better than those of aluminum and steel. For example, the composite wire provides nearly 8 times the strength of aluminum and 3 times the stiffness. It weighs less than half of an equivalent segment of steel, with greater conductivity and less than half the thermal expansion of steel, as shown in Table 2.

Outer Strands

The outer strands are composed of a temperature-resistant aluminum-zirconium alloy which permits operation at high temperatures (210°C continuous, 240°C emergency). The Al-Zr alloy is a hard aluminum alloy with properties and hardness similar to those of standard 1350-H19 aluminum but a microstructure designed to maintain strength after operating at high temperatures; that is, it resists annealing. In contrast, 1350-H19 wire rapidly anneals and loses strength with excursions above 120–150°C. The temperature-resistant Al-Zr alloy wire has

equivalent tensile strengths and stress-strain behavior to standard 1350-H19 aluminum wire, as shown in Table 3.



The outer strands maintain strength after operating at high temperatures.

Table 2: Properties of Composite Core

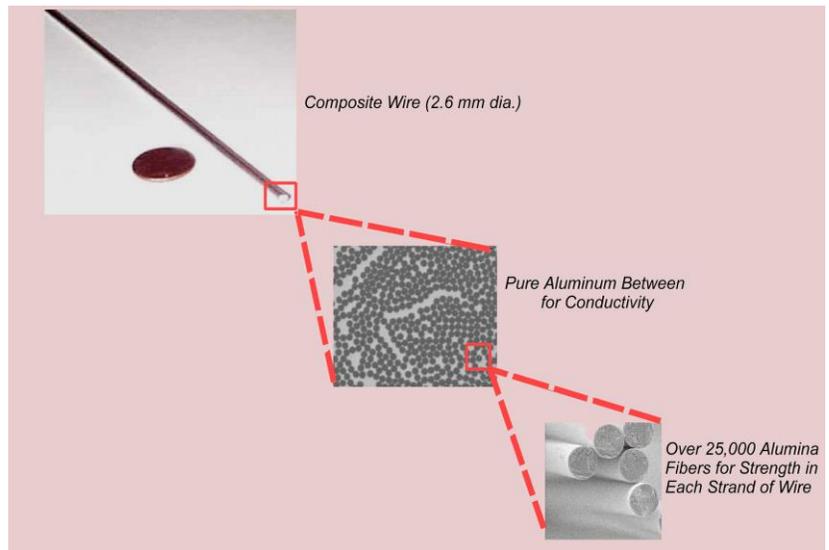
Property	Value
Tensile Strength	200 ksi (1380 MPa)
Density	0.12 lbs/in ³ (3.33 g/cc)
Stiffness	31 Msi (215 GPa)
Conductivity	27% IACS
Thermal Expansion	3.3 x 10 ⁻⁶ / °F (6 x 10 ⁻⁶ / °C)
Fatigue Resistance (Endurance)	> 10 million cycles at 100 ksi (690 MPa)
Emergency Use Temperature	> 570°F (300°C)

Table 3: Properties of Aluminum – Zirconium Wire

Property	Value
Tensile Strength (<0.153” diameter) #	>23.5 ksi (162 MPa)
Tensile Strength (>0.153” diameter) #	>23.0 ksi (159 MPa)
% Tensile Elongation ¹	> 2%
Tensile Strength Retention after 280°C/1hr #	> 90%
Density	0.097 lbs/in ³ (2.7 g/cm ³)
Conductivity / Resistivity at 20°C	>60% IACS <28.73 x 10 ⁻⁹ Ohm.m
Continuous use temperature	210°C
Emergency use temperature	240°C

10 in. (250 mm) gauge length

Source: *Properties of Heat-Resistant Aluminum-Alloy Conductors For Overhead Power-Transmission Lines*, K. Kawakami, M. Okuno, K. Ogawa, M. Miyauchi, and K. Yoshida, Furukawa Rev. (1991), (9), 81-85.



The composite wire provides high strength and conductivity at low weight.

3. Installation Equipment

Drum pullers like the one shown have been used successfully in the stringing procedures of 3M ACCR. In conjunction with a back-tensioning device such as a bullwheel tensioner, this device can be used with any installation of 3M ACCR.

Drum Puller



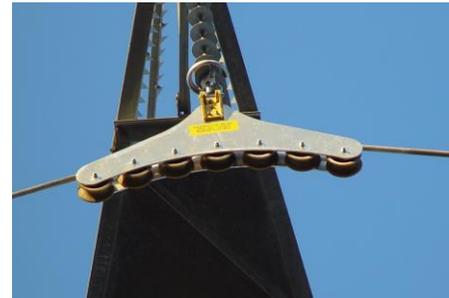
Bullwheel Tensioner

Bull wheel tensioners have been used during the installation of 3M ACCR. It is very important to use a larger sized bull wheel diameter when stringing this type of conductor. **Before installing, consult 3M on the recommended size Bullwheel to use pertaining to the installation needs.** The picture below shows an example of a 54” (1.37m) diameter combination tensioner with a reel stand.

54” Bullwheel Tensioner



Never install 3M ACCR using a ‘V-Groove’ type tensioner. Use of V-Groove type tensioner may damage the inner core wires of the 3M ACCR.



Roller Array Block

Stringing Blocks

A combination of high stringing tension with a small bend radius can damage the inner core wires of the 3M ACCR. Therefore, the need for larger diameter stringing blocks is essential when installing 3M ACCR. **Before installing, consult 3M on the recommended stringing blocks size to use pertaining to the installation need.**



28” (71cm) Stringing Block

Selecting the Proper Stringing Block

The sheaves used at suspension towers should have a minimum diameter of 28” (600 mm). ¹ The groove radius should follow the standard guidelines for ACSR. The break-over angle used with single sheaves should not exceed 24°. ² All stringing block sheaves are required to be urethane lined when used to install ACCR.

Roller array blocks are to be used on the first (tension site break-over tower), last tower (pull site break-over tower) and at towers with running angles greater than 24°. The roller array should be designed to carry less than a 9° angle per roller. A typical roller array block has seven rollers and can handle a 50° break-over angle with 3M ACCR. ³ The roller diameter is 3” at the bottom of the groove with a standard groove diameter following ACSR guidelines.

Roller array blocks have a maximum vertical load rating of 7,500 lbs. (33 KN). If the vertical load exceeds this rating, then a tandem 35” (800 mm) minimum sized block can be used with vertical loads exceeding 7,500 lbs. (33 KN).

DANGER

To reduce the risks associated with hazardous voltage, mechanical impact, and working at heights which, if not avoided, will result in serious injury, death and/or property damage:

- If there is possible conductor core damage due to failure to follow the **⚠ WARNING** safety instructions in this document, personnel shall not climb out on the conductor, use a conductor cart, trolley, spacer cart or any other equipment that relies on the 3M ACCR as a single means of personal fall protection safety until it is determined that the conductor or conductor core is not damaged.
- If there is outside aluminum strand or core damage, personnel shall not climb out on the conductor, use a conductor cart, trolley, spacer cart or any other equipment that relies on the 3M ACCR as a single means of personal fall protection safety until it is determined that the conductor or conductor core is not damaged.

WARNING

To reduce the risks associated with hazardous voltage, mechanical impact, and working at heights which, if not avoided, could result in serious injury, death and/or property damage:

- Do not use damaged roller array sheaves. Always check tool for damage before use, including the inner surfaces. Sheaves must roll smoothly without impediment.
- Do not change or repair the tool itself. Repair must be performed by the manufacturer only.
- For a specific project, the maximum allowed tension for the ACCR cable guided by the roller array sheave shall not exceed the maximum allowed break over angle specified by 3M.
- Always check the safety mechanism on the roller array block for damage and correct closing after putting the cable through it. Always check whether the safety bolt is secured by the safety ring.

¹ for conductors with a rated breaking strength greater than 46,000 lbs. (204 KN) a minimum of a 35” diameter (800 mm) block must be used.

² 20° maximum angle for 3M ACCR Hawk, Lark, Stilt or Dove. **Before installing, consult 3M if your 3M ACCR size is unknown.**

³ **Before installing, consult 3M if the total break-over angle exceeds 50°.**

Hold-Down (Let-Up) Blocks

Hold-down blocks can be used on the 3M ACCR during a let-up procedure after a splice is installed at a snub (splice) area set up. Hold-down blocks have two sheaves mounted in a frame that can be connected to a hold-down line. The hold-down line is connected to the shackle at the bottom of the frame. A second line called a “trip-rope” is then used to remove the block off the line. Tension is first relieved on the hold-down line, then the trip rope is pulled. This dumps the block and lets it hang from a loop of the trip rope. The block is then lowered to the ground without interruption of the pulling operation or the requirement of a climb. The minimum size sheaves on the hold-down block are to be 14” (355 mm) each when being used on any size 3M ACCR conductor hold-down or let-up procedure.



14” Hold-Down Block in use



14” Hold-Down Block

⚠ DANGER

To reduce the risks associated with hazardous voltage, mechanical impact, and working at heights which, if not avoided, will result in serious injury, death and/or property damage:

- If there is possible conductor core damage due to failure to follow the **⚠ WARNING** safety instructions in this document, personnel shall not climb out on the conductor, use a conductor cart, trolley, spacer cart or any other equipment that relies on the 3M ACCR as a single means of personal fall protection safety until it is determined that the conductor or conductor core is not damaged.
- If there is outside aluminum strand or core damage, personnel shall not climb out on the conductor, use a conductor cart, trolley, spacer cart or any other equipment that relies on the 3M ACCR as a single means of personal fall protection safety until it is determined that the conductor or conductor core is not damaged.

⚠ WARNING

To reduce the risks associated with hazardous voltage, mechanical impact, and working at heights which, if not avoided, could result in serious injury, death and/or property damage:

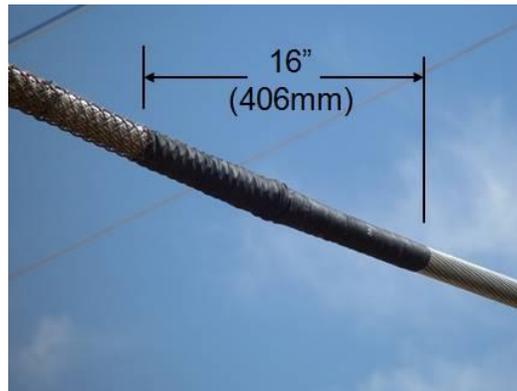
- Ensure that the minimum size sheaves on the hold-down block are 14” (355 mm) each when being used on any size 3M ACCR conductor hold-down or let-up procedure.

Sock Splices

A sock splice, also known as a basket grip, wire mesh or Kellum grip can be used to string 3M ACCR conductor. It is required that a swivel connection be utilized with the sock splice to reduce any twisting of the conductor during the tension stringing operation. The conductor should not be used that is under the sock splice and should be cut out. No bands should be used on the end to hold the sock splice. Pulling socks splices through stringing blocks with bands can cause damage to the composite core wires. Friction tape (3M™ Temflex™ Cotton Friction Tape 1755, typical) is to be applied over the end of the sock splice and the conductor 16" (406mm).



Sock Splices with Swivel



Friction Tape Applied to Sock Splice

DANGER

To reduce the risks associated with hazardous voltage, mechanical impact, and working at heights which, if not avoided, will result in serious injury, death and/or property damage:

- If there is possible conductor core damage due to failure to follow the **⚠ WARNING** safety instructions in this document, personnel shall not climb out on the conductor, use a conductor cart, trolley, spacer cart or any other equipment that relies on the 3M ACCR as a single means of personal fall protection safety until it is determined that the conductor or conductor core is not damaged.
- If there is outside aluminum strand or core damage, personnel shall not climb out on the conductor, use a conductor cart, trolley, spacer cart or any other equipment that relies on the 3M ACCR as a single means of personal fall protection safety until it is determined that the conductor or conductor core is not damaged.

WARNING

To reduce the risks associated with hazardous voltage, mechanical impact, and working at heights which, if not avoided, could result in serious injury, death and/or property damage:

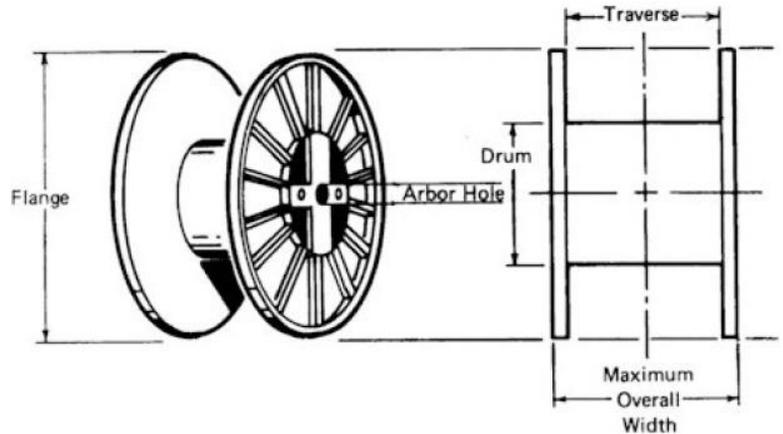
- Do not use bands when pulling sock splices through stringing blocks.

Chain Hoists

Any type of chain hoist may be used to tension or hold the 3M ACCR. To grip the 3M ACCR when using a chain hoist, a special conductor grip must be used. This grip is detailed on page 17.

Reel Stands/NEMA Reels

Standard reel stands may be used to hold the reel of 3M ACCR during the stringing operation. Reel stands combined with bullwheel tensioners are used to ensure proper back tensions on the 3M ACCR during the stringing operation. It is required that a bullwheel tensioner along with a reel stand be utilized to maintain proper stringing tensions. 3M ACCR is delivered primarily on NEMA standard steel returnable reels:



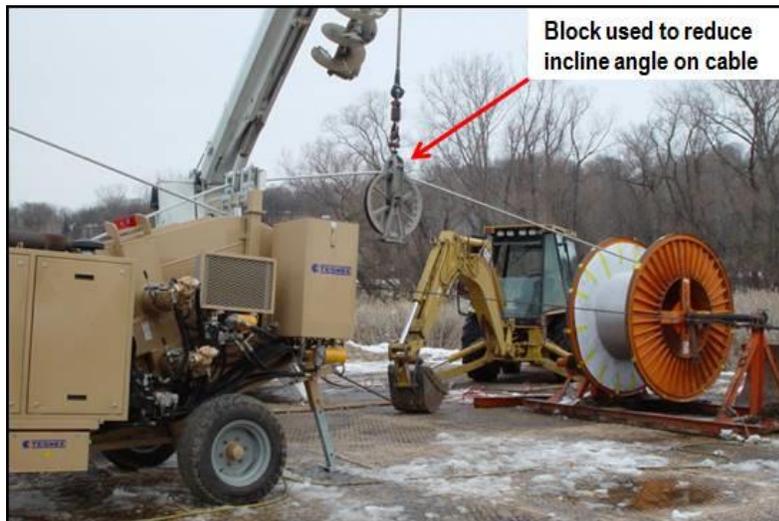
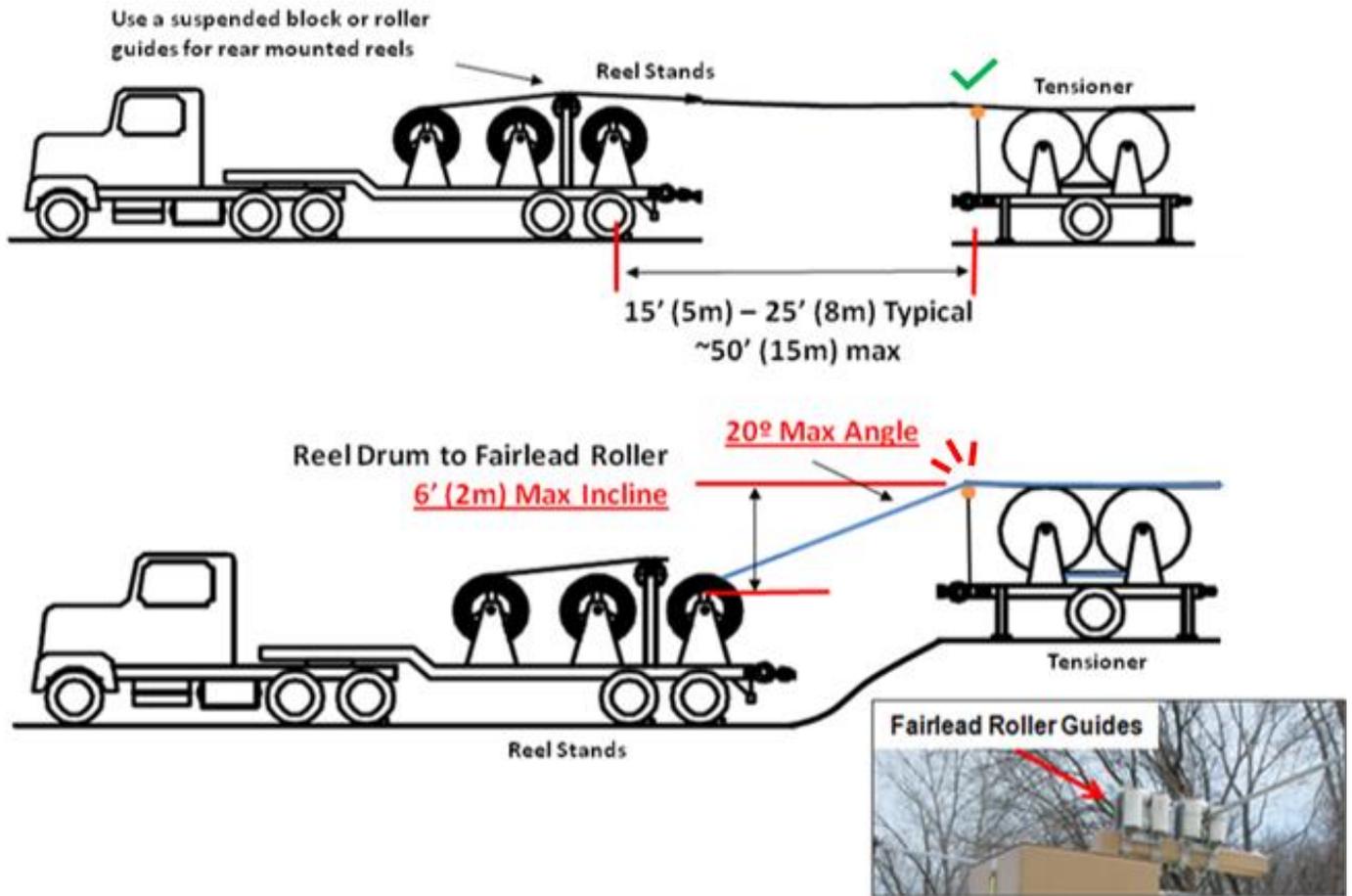
Alum. Assoc. #	Southwire ID (Class)	Flange	Traverse	Arbor Hole (Hub) ID	Empty Reel Weight
RMT 84.36	S-120	84" [213.3cm]	36" [91.4cm]	5.25" [13.3cm]	895 Lbs [406 Kg]
RMT 84.45	S-153	84" [213.3cm]	45" [114.3cm]	5.25" [13.3cm]	930 Lbs [422 Kg]
RMT 90.45	S-187	90" [228.6cm]	45" [114.3cm]	5.25" [13.3cm]	1030 Lbs [467 Kg]
RMT 96.60	S-300	96" [243.8cm]	60" [152.4cm]	5.25" [13.3cm]	1268 Lbs [575 Kg]
	S-422	108" [274.3cm]	74" [187.9cm]	5.25" [13.3cm]	1762 Lbs [799 Kg]

NOTICE

- To avoid potential conductor staining due to water and/or condensation, the plastic wrap that is placed over the ACCR during conductor stranding should be removed upon delivery.

Reel Stand Set-Up with Tensioner

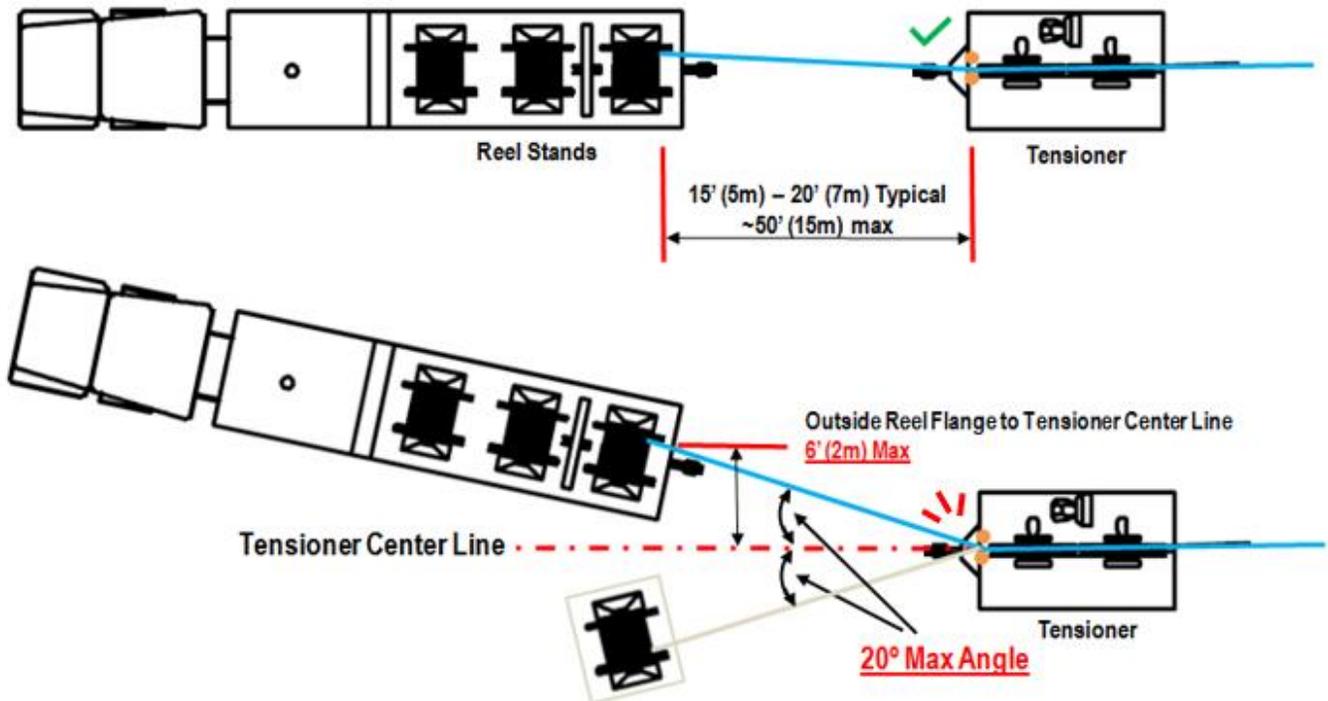
As described in the diagram below, the orientation of the reel stands in relation to the tensioner should be that the 3M ACCR does not exceed a 20° angle over the fairlead roller guides mounted on the tensioner. The set-back distance from the tensioner to the reel stands is typically 15' (5m) – 25' (8m) and should never exceed 50' (15m). Proper tension control on both the tensioner and the reel stand is important as to not cause any sudden jerking or bouncing of the 3M ACCR as it is pulled off the reel.



A 28" (700mm) min stringing block should be used between the reel stand and the tensioner if the incline angle over the fairlead roller is greater than 20°. An example of this procedure is shown in the picture here. The stringing block suspended by a crane reduces the angle over the fairlead roller mounted on the tensioner.

The reel stands should also be orientated so that they are in-line as best as possible with the tensioner centerline. In the case of a bundled conductor pull, the reel stands should be orientated so the off-set

angle through the fairlead roller does not exceed 20°. This is also the case if multiple reel stands are used during single conductor installations in order to change out conductor reels quickly.



⚠ DANGER

To reduce the risks associated with hazardous voltage, mechanical impact, and working at heights which, if not avoided, will result in serious injury, death and/or property damage:

- If there is possible conductor core damage due to failure to follow the **⚠ WARNING** safety instructions in this document, personnel shall not climb out on the conductor, use a conductor cart, trolley, spacer cart or any other equipment that relies on the 3M ACCR as a single means of personal fall protection safety until it is determined that the conductor or conductor core is not damaged.
- If there is outside aluminum strand or core damage, personnel shall not climb out on the conductor, use a conductor cart, trolley, spacer cart or any other equipment that relies on the 3M ACCR as a single means of personal fall protection safety until it is determined that the conductor or conductor core is not damaged.

⚠ WARNING

To reduce the risks associated with hazardous voltage, mechanical impact, and working at heights which, if not avoided, could result in serious injury, death and/or property damage:

- Always use a 28" (700mm) minimum stringing block between the reel stand and the tensioner if the incline angle over the fairlead roller is greater than 20°.

Conductor Grips (Preformed Grips)

Important Note: Chicago grips or pocket-book grips are not to be used in any way to hold, grip or tension 3M ACCR. Tests done with these types of grips has shown that due to the offset gripping action, it induces a sharp bend to the conductor and causes damage to the composite core wires even at low tensions.

⚠ DANGER

To reduce the risks associated with hazardous voltage, mechanical impact, and working at heights which, if not avoided, will result in serious injury, death and/or property damage:

- If there is possible conductor core damage due to failure to follow the **⚠ WARNING** safety instructions in this document, personnel shall not climb out on the conductor, use a conductor cart, trolley, spacer cart or any other equipment that relies on the 3M ACCR as a single means of personal fall protection safety until it is determined that the conductor or conductor core is not damaged.
- If there is outside aluminum strand or core damage, personnel shall not climb out on the conductor, use a conductor cart, trolley, spacer cart or any other equipment that relies on the 3M ACCR as a single means of personal fall protection safety until it is determined that the conductor or conductor core is not damaged.

⚠ WARNING

To reduce the risks associated with hazardous voltage, mechanical impact, and working at heights which, if not avoided, could result in serious injury, death and/or property damage:

- Chicago grips or pocket-book grips are NOT to be used in any way to hold, grip or tension 3M ACCR conductors. Tests done with these types of grips have shown that the offset gripping action induces a sharp bend to the conductor and causes damage to the composite core wires, even at low tensions.

A Tensioning Grip (TG-Grip) or a THERMOLIGN™ dead end assembly are the only 3M approved conductor grips (Preformed Grips) to be used on the 3M ACCR.

TG-Grip Usage: TG-Grips can be applied no more than 3 times on a single conductor for the tensioning or final sagging of the conductor. The reapplication is acceptable for the purpose of re-positioning the TG-Grip for adjusting the sag on that single conductor only. TG-Grips are not to be re-used after 3 applications or the final use on that single conductor. The TG-Grip has a rated holding strength of 40% of the conductor rated breaking strength (RBS).

The rods of the TG-Grip must be fully snapped down before any tension is applied to the grip. The TG-Grip can be removed by use of a Nylon removal tool supplied by PLP or 3M.



Tensioning Grip (TG-Grip)

The use of a thimble clevis with the TG-Grip is always required. The thimble clevis can be no more than 20 times or for one installation project.



Thimble Clevis installed on TG-Grip

THERMOLIGN™ Dead End Assembly Usage: THERMOLIGN™ Dead Ends may be used only once as a conductor grip (sagging), is removed and then reapplied only once more for permanent installation, for a total of two applications. **DO NOT** re-use after initial, permanent installation is completed. THERMOLIGN™ Dead Ends are typically used on high-type, high-strength rated 3M ACCR. Contact 3M with your 3M ACCR cable size to determine the preformed conductor grip style that is to be used for your application. The THERMOLIGN™ Dead End has a rated holding strength of 95% of the conductor rated breaking strength (RBS).



THERMOLIGN™ Dead End

Both types of these preformed grips have been used successfully to grip the 3M ACCR during the sagging procedures before the permanent dead end is installed. TG-Grips and THERMOLIGN™ dead end assemblies must be used any time the 3M ACCR needs to be gripped or caught-off.

TG-Grips or THERMOLIGN™ dead end assemblies (Preformed Grips): Do not place side loading angles on the Preformed Grip assemblies when gripping the 3M ACCR. Side loading angles can cause conductor damage or Preformed Grip failure (commonly known as “peel-out”). When gripping the 3M ACCR with a Preformed Grip, use a 6:1 ratio for rigging length as per the diagram

below. Be sure to keep the rigging in-line with the conductor and do not place side loading angle on the Preformed Grip. The maximum side loading angle placed on the Preformed Grip is 10°.

⚠ DANGER

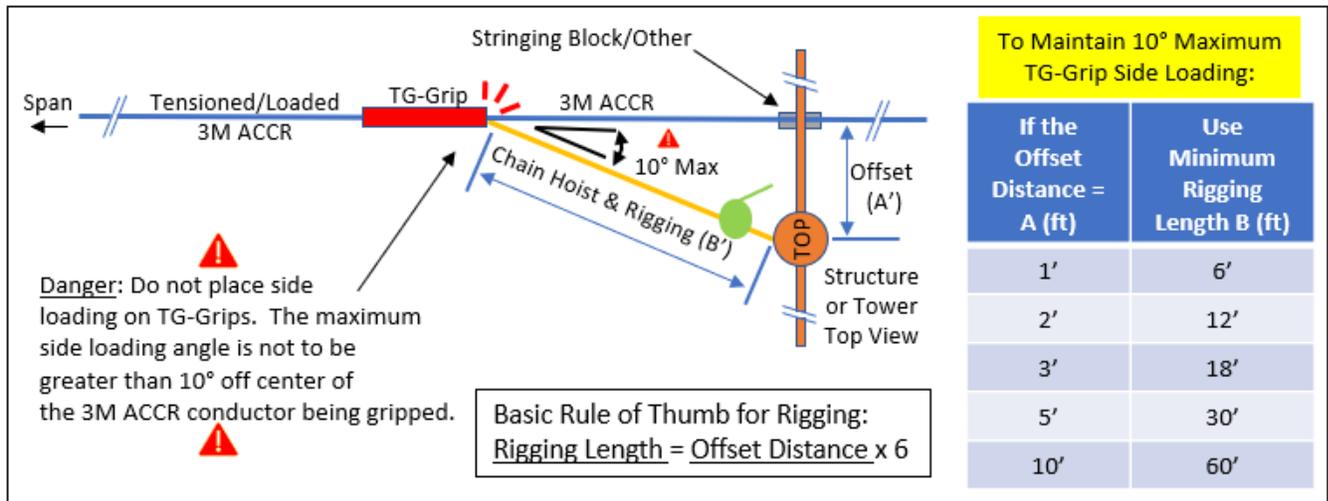
To reduce the risks associated with hazardous voltage, mechanical impact, and working at heights which, if not avoided, will result in serious injury, death and/or property damage:

- If there is possible conductor core damage due to failure to follow the **⚠ WARNING** safety instructions in this document, personnel shall not climb out on the conductor, use a conductor cart, trolley, spacer cart or any other equipment that relies on the 3M ACCR as a single means of personal fall protection safety until it is determined that the conductor or conductor core is not damaged.
- If there is outside aluminum strand or core damage, personnel shall not climb out on the conductor, use a conductor cart, trolley, spacer cart or any other equipment that relies on the 3M ACCR as a single means of personal fall protection safety until it is determined that the conductor or conductor core is not damaged.

⚠ WARNING

To reduce the risks associated with hazardous voltage, mechanical impact, and working at heights which, if not avoided, could result in serious injury, death and/or property damage:

- Do not place large side angle loading on the Preformed Grip assembly when gripping the 3M ACCR. Large side loading angles placed on the Preformed Grip can cause conductor core damage to the 3M ACCR or Preformed Grip failure (commonly known as “peel-out”). The maximum side loading on a Preformed Grip assembly shall not be greater than 10° from the center line of the 3M ACCR conductor that is being gripped.



Handling Jumper Tails: Do not allow jumper tails of the 3M ACCR to become unsecured and cause the tail to fall and swing into the Preformed Grip. Be sure to tie and secure the tail to the rigging.

⚠ DANGER

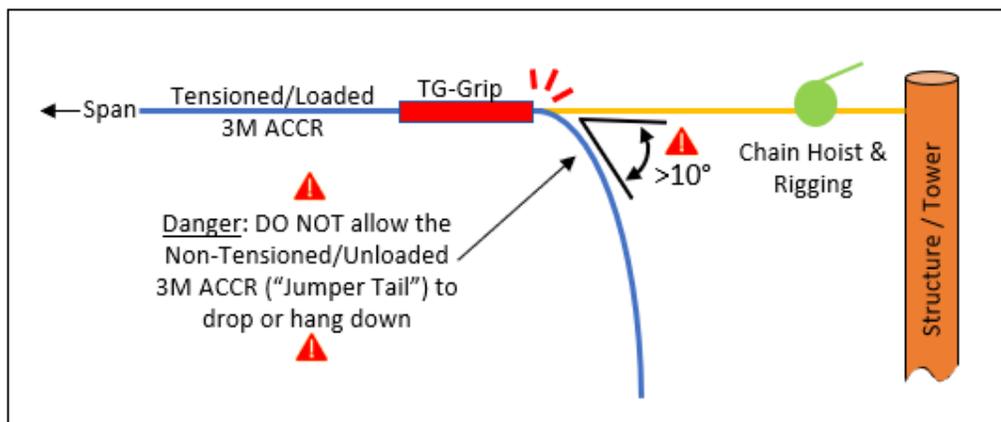
To reduce the risks associated with hazardous voltage, mechanical impact, and working at heights which, if not avoided, will result in serious injury, death and/or property damage:

- If there is possible conductor core damage due to failure to follow the **⚠ WARNING** safety instructions in this document, personnel shall not climb out on the conductor, use a conductor cart, trolley, spacer cart or any other equipment that relies on the 3M ACCR as a single means of personal fall protection safety until it is determined that the conductor or conductor core is not damaged.
- If there is outside aluminum strand or core damage, personnel shall not climb out on the conductor, use a conductor cart, trolley, spacer cart or any other equipment that relies on the 3M ACCR as a single means of personal fall protection safety until it is determined that the conductor or conductor core is not damaged.

⚠ WARNING

To reduce the risks associated with hazardous voltage, mechanical impact, and working at heights which, if not avoided, could result in serious injury, death and/or property damage:

- After a Preformed Grip is placed on the 3M ACCR, do not allow the unloaded section, or jumper tail, for example, of the 3M ACCR to become unsecured resulting in this section of conductor falling and/or swinging towards the Preformed Grip. This can cause conductor core damage to the 3M ACCR.



Cable Cutters

Any type of cable cutter that is meant to cut ACSR or AAAC may be used to cut the 3M ACCR. Tape the outer conductor strands down before cutting the cable to prevent the aluminum strands from un-stranding or “bird caging.”

Conductor Grounding Clamps

Grounding clamps that are typically used on other conductors are compatible with use on the 3M ACCR. Grounding clamps should be sized appropriately to fit the size conductor being installed. This picture shows a typical grounding clamp used on a 795 Kcmil 3M ACCR.



Conductor Grounding Clamp

Running Grounds

The use of running grounds or traveling grounds can be used when installing 3M ACCR. The proper sized running ground should be used when installing the 3M ACCR. The picture below shows a running ground that was used during a 3M ACCR installation.



Running Ground

4. Installation Procedures and Hardware

Tension Stringing

The required stringing procedure used to install 3M ACCR is the tension stringing method. This method involves pulling or stringing the 3M ACCR under tension and not allowing the conductor to drag on the ground.

The “slack” stringing procedure involves that the conductor would be pulled out on the ground by means of a pulling truck or placed out on the ground by dispensing the cable from a moving vehicle holding the reel stand. This method is not recommended by 3M as it may cause unknown damage to the 3M ACCR.

It is required that the contractor or utility installing the 3M ACCR chooses the correct equipment to maintain appropriate back tension and pulling tension when installing the 3M ACCR. 3M ACCR shall not be allowed to drag onto the ground, trees, buildings, guard structures, etc. during the stringing procedure. On the other hand, elevated back tensions combined with small bend radiuses such as small diameter stringing blocks can cause damage to the inner composite core wires. **Before installing, consult 3M on the recommendations of stringing blocks pertaining to the installation needs.** Tensioning equipment shall be located at 3X the height of the break-over block on the first tower with minimum running angle as well. Every attempt should be made to obtain this set-up distance to reduce the pulling angle over the break-over point.

Experience has shown that pulling speed is an important factor in achieving a smooth stringing operation. 3M ACCR should be pulled within speeds of 3-5 mph (5-8 km/h). This speed usually

provides a smooth passage of connecting hardware over the stringing blocks, whereas slower speeds may cause significant swinging of the stringing blocks and insulator hardware assemblies. Higher pulling speeds create a potential hazard of damage in case of an equipment malfunction.

 DANGER
<p>To reduce the risks associated with hazardous voltage, mechanical impact, and working at heights which, if not avoided, will result in serious injury, death and/or property damage:</p> <ul style="list-style-type: none"> • If there is possible conductor core damage due to failure to follow the ⚠ WARNING safety instructions in this document, personnel shall not climb out on the conductor, use a conductor cart, trolley, spacer cart or any other equipment that relies on the 3M ACCR as a single means of personal fall protection safety until it is determined that the conductor or conductor core is not damaged. • If there is outside aluminum strand or c  damage, personnel shall not climb out on the conductor, use a conductor cart, trolley, spacer cart or any other equipment that relies on the 3M ACCR as a single means of personal fall protection safety until it is determined that the conductor or conductor core is not damaged.
WARNING
<p>To reduce the risks associated with hazardous voltage, mechanical impact, and working at heights which, if not avoided, could result in serious injury, death and/or property damage:</p> <ul style="list-style-type: none"> • Do not use the 'slack stringing' method for installation as it may cause unknown damage to the 3M ACCR. • Avoid elevated back tensions combined with small bend radiuses, such as small diameter stringing blocks, as this may cause damage to the inner composite core wires.

Sagging Procedures

Methods of sagging that have been used on the 3M ACCR include line-of-sight measurements and rope or wave reflection sagging. Sagging procedures of 3M ACCR are very similar to that of any other conductor. Whether or not a compression type or THERMOLIGN™ dead end is to be used on the conductor, the preformed conductor grip must be placed on the conductor at least 15' to 20' (5m to 6m) from the connection point to the insulator string. After the final sag tension is set, the dead ends can be installed onto the 3M ACCR. With the initial placement of the preformed grip at 15' to 20' (5m to 6m), this should allow enough slack in the conductor to maneuver it and apply the dead-end assembly. This will be detailed in the next few sections.

The time limit allowed from when the 3M ACCR is pulled or strung into position and hanging in stringing blocks to when the cable is tensioned to the specified sag is 72 hours.

Dead ending Procedures

Compression Dead Ends

Compression type dead ends manufactured by AFL have been successfully utilized in the installation of 3M ACCR. These compression dead ends are specifically designed by AFL to grip not only the outside aluminum strands but also to grip the core wires separately of the 3M ACCR. Therefore, the installation steps of the dead end consist of a two-step compression procedure.

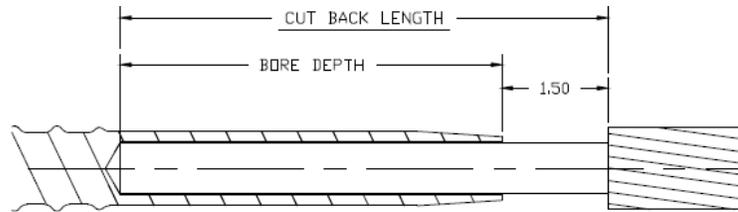


AFL Brand Compression Dead End

After the final sag tension of the conductor is established, a measurement is made to determine where the dead ends will be connected to the insulator string. The Preformed Grip is to be placed on the 3M ACCR at a minimum distance of 8' (3m) from where the end of the dead-end body will be compressed on to the 3M ACCR. This will reduce strand-loosening during compression of the dead-end body. The cable is then cut at this point. The first step to install the AFL dead end is to slide, or “park” the large outer aluminum body of the dead end over the conductor making sure that the jumper pad on the body is facing the end of the cable that was just cut. Park the large aluminum body on the conductor about 3' (1m) down from the end of the cable.

By using a cable strand-trimming device, also known as a cable circumciser, the outer layers of aluminum are removed. It is very important to not nick the composite wires while trimming the aluminum layers. Specific 3M ACCR sized trimmer dies may be purchased through 3M. Prior to

cutting back the aluminum strands, the depth of the bore must be determined in the steel forging. Insert a clean object or length of core until it bottoms out in the forging. Measure the bore depth and add 1.50" (40mm). This will be the length to cut back the aluminum strands:

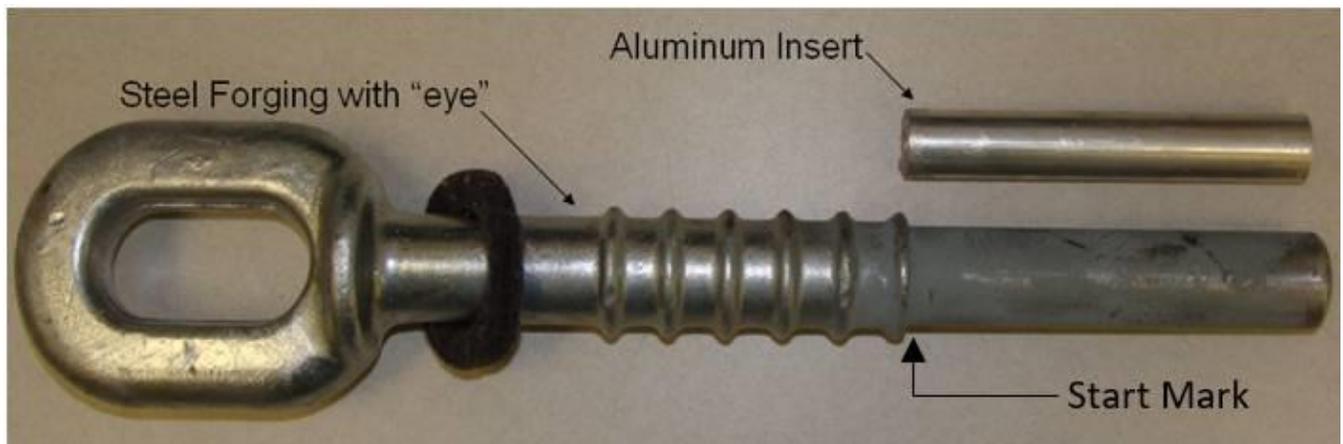


Aluminum tape is wrapped over the composite wires on the 3M ACCR. Normally this tape is not removed from the core wires when pressing a dead-end forging except for a few 3M ACCR sized conductors. This is explained in more detail on the requirement to remove the core tape on page 25 (slotted inserts).



Trimming the Aluminum layers

Located inside of the end fitting (steel forging) is an aluminum tube insert. The main purpose of this aluminum insert is to obtain a strong bond between the 3M ACCR core wires and the steel sleeve that is connected to the "eye" of the forging. This "eye" is then connected to the insulator string on the dead-end tower or at a substation connection. Please note the compression "start mark" on the steel forging.





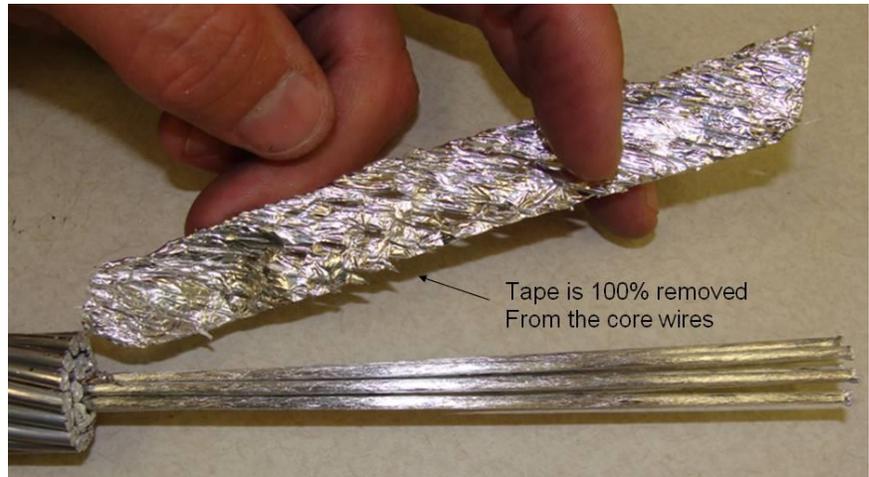
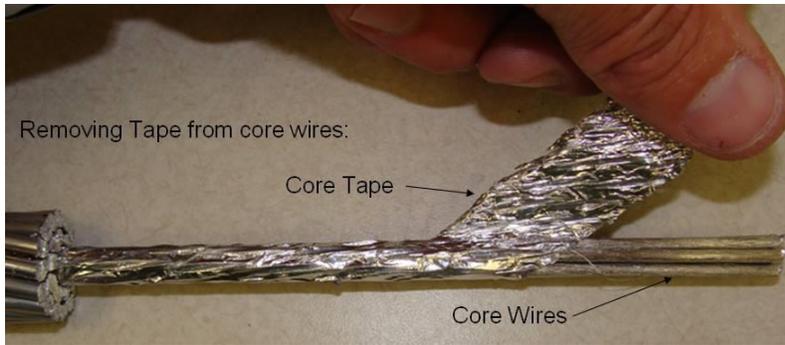
Details on Slotted Aluminum Inserts

On some 3M ACCR sizes, the aluminum insert for the AFL dead end will have slots or grooves manufactured into it. This allows for greater gripping force on some core sizes used for a given 3M ACCR size. As mentioned in the beginning of this section there is an aluminum tape wrapped over the core wires. Normally this tape is left on the core wires and the core is inserted into the aluminum sleeve/steel forging and then compressed. **However: If an aluminum sleeve is found to have any number of slots or grooves cut into the length of the sleeve, then ALL (100%) of the tape must be removed from the length of the core that would be inserted into this sleeve. If the aluminum insert is found to have no slots or grooves, then the tape is NOT to be removed from the core wires.**



← Non-slotted Aluminum Insert
(Leave all tape on core wires)

← Slotted Aluminum Insert
(Remove 100% of the core wire tape)



Next, the steel forging with the aluminum insert installed in it is placed over the core wires until the core wires bottom out. Make sure that the aluminum insert is pushed into the steel forging and that it is flush with the end of the steel bore.

Details on Compression Dies for the 3M ACCR

There are two sized dies used to compress the AFL dead end: One die for the steel forging and another die for the larger outer aluminum body of the dead end. All dies used to install compression hardware on the 3M ACCR must be stamped with an “-ACCR” suffix after the die part number as in this example:



All qualified “-ACCR” stamped dies may be purchased through 3M. Any dies not stamped may be sent to 3M to be measured, qualified and then stamped with the “-ACCR” suffix. Please contact 3M for more information on where to ship your dies to be qualified for usage when installing compression hardware on the 3M ACCR.

Install the correct steel compression die used for the steel forging into the 100-ton (90.8 metric tons) press head. While holding the core wires tight inside the steel forging, make the first compression on the steel forging at the “start mark”. Make sure that the two die halves come together, and the pump pressure reaches 10,000 PSI for each compression bite. Continue to press the entire length of the steel forging to the end, overlapping each die bite by 0.5” (10mm). Lubrication of the steel forging is not recommended.

Compressing the Steel Forging



After the steel forging is compressed, care should be taken to secure the forging assembly to the rigging to not allow the conductor to be dropped. This can cause stress on the 3M ACCR core wires.

⚠ DANGER

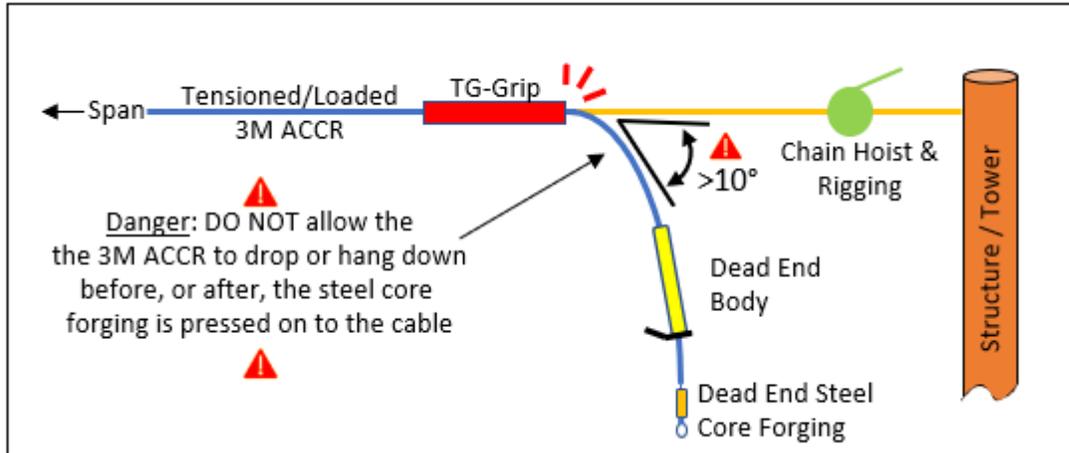
To reduce the risks associated with hazardous voltage, mechanical impact, and working at heights which, if not avoided, will result in serious injury, death and/or property damage:

- If there is possible conductor core damage due to failure to follow the **⚠ WARNING** safety instructions in this document, personnel shall not climb out on the conductor, use a conductor cart, trolley, spacer cart or any other equipment that relies on the 3M ACCR as a single means of personal fall protection safety until it is determined that the conductor or conductor core is not damaged.
- If there is outside aluminum strand or core damage, personnel shall not climb out on the conductor, use a conductor cart, trolley, spacer cart or any other equipment that relies on the 3M ACCR as a single means of personal fall protection safety until it is determined that the conductor or conductor core is not damaged.

⚠ WARNING

To reduce the risks associated with hazardous voltage, mechanical impact, and working at heights which, if not avoided, could result in serious injury, death and/or property damage:

- After a steel forging of the compression dead end is installed onto the 3M ACCR, do not allow the forging to become unsecured resulting in this section of conductor falling and/or swinging towards the Preformed Grip. This can cause conductor core damage to the 3M ACCR.



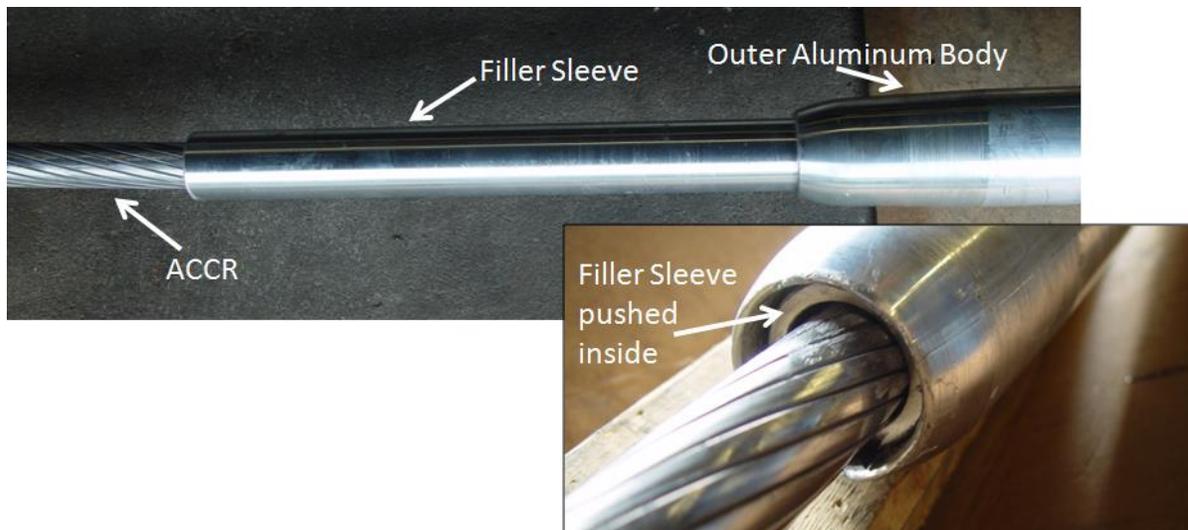
It is mandatory that the cable is brushed with a wire brush to remove oxides from the cable surface. To do this, apply a bead of HiTemp® AFL Filler Compound (AFCHT™) on to the conductor surface over which the large aluminum body will be pressed. Vigorously brush the compound into the conductor aluminum strands with a wire brush covering the entire area of the cable.

The outer sleeve is then slid over the compressed steel forging and filled with the proper amount of HiTemp® AFL Filler Compound (AFCHT™). The grease port is then plugged with the provided plug or “pill”.

Larger Outer Aluminum Sleeve:



On some 3M ACCR sizes, the dead-end assembly also contains an aluminum filler sleeve that must be fitted inside of the larger outer aluminum body. This filler sleeve must be pushed into the outer aluminum body, so it is recessed inside of it.



Solid Lubricant - Soap

3M approved bar soap is required as a solid lubricant on the outer aluminum sleeve on the areas that will be pressed. Do not use lubricants other than 3M approved bar soap. 3M approved bar soaps contain SODIUM TALLOWATE.

Applying solid lubricant (bar soap):



Change the dies used to press the steel forging in the 100-ton press head to the dies used to press the large outer aluminum sleeve. Making sure that the large outer sleeve is held tight against the felt washer installed on the steel forging, press the large outer aluminum sleeve with the 100-ton (90.8 metric tons) press. There are 2 areas to be pressed on the dead-end body. These areas are stamped with “**Start**” and “**Press to End**” knurl markings on the aluminum body. The area over the compressed section of the steel forging is not compressed. This area is stamped “**Do Not Press**”.

Make sure that the two die halves come together for each compression bite and the pump pressure reaches 10,000 PSI. Continue to press the 2 areas of the aluminum body overlapping each die bite by 0.5” (10mm).

IMPORTANT:

Under no circumstances can the tension on the conductor be “let off” and tension placed through the 3M ACCR to the dead end prior to completely compressing the entire dead-end body.

Pressing the outer aluminum sleeve:



After the entire dead-end body is completely pressed on to the 3M ACCR, take care to secure the dead-end assembly to the rigging and do not allow the dead end to be dropped.

 DANGER

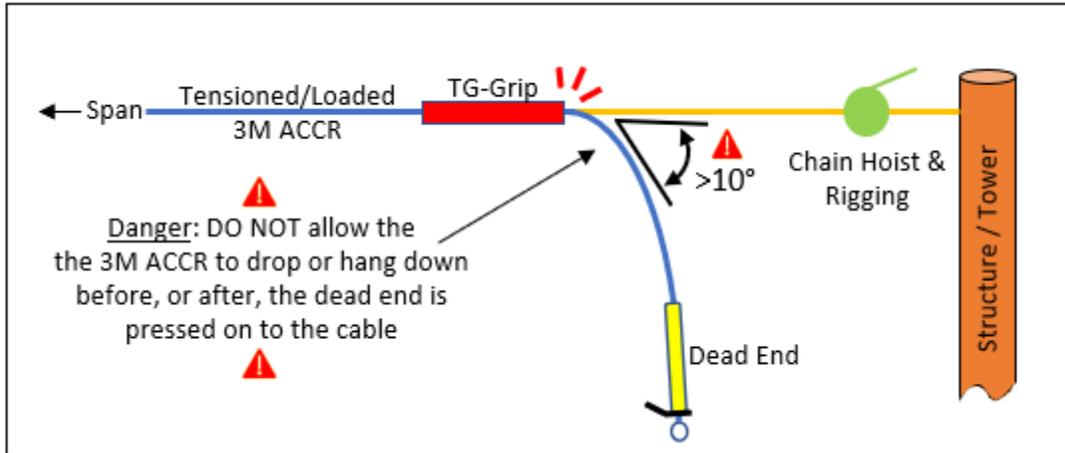
To reduce the risks associated with hazardous voltage, mechanical impact, and working at heights which, if not avoided, will result in serious injury, death and/or property damage:

- If there is possible conductor core damage due to failure to follow the **⚠ WARNING** safety instructions in this document, personnel shall not climb out on the conductor, use a conductor cart, trolley, spacer cart or any other equipment that relies on the 3M ACCR as a single means of personal fall protection safety until it is determined that the conductor or conductor core is not damaged.
- If there is outside aluminum strand or core damage, personnel shall not climb out on the conductor, use a conductor cart, trolley, spacer cart or any other equipment that relies on the 3M ACCR as a single means of personal fall protection safety until it is determined that the conductor or conductor core is not damaged.

 WARNING

To reduce the risks associated with hazardous voltage, mechanical impact, and working at heights which, if not avoided, could result in serious injury, death and/or property damage:

- After a compression dead end assembly is installed onto the 3M ACCR, do not allow the assembly to become unsecured resulting in this section of conductor falling and/or swinging towards the Preformed Grip. This can cause conductor core damage to the 3M ACCR.



The compression dead end can now be connected to the insulator string and appropriate jumper connectors can then be installed. Brushing of the terminal pads of the dead end and jumper terminal with a wire brush is required. The use of AFL's Alnox® Electrical Joint Compound (EJC) or any other EJC approved by 3M for this application is required between the terminal pad and the dead-end pad for a good electrical connection.

THERMOLIGN™ Dead End

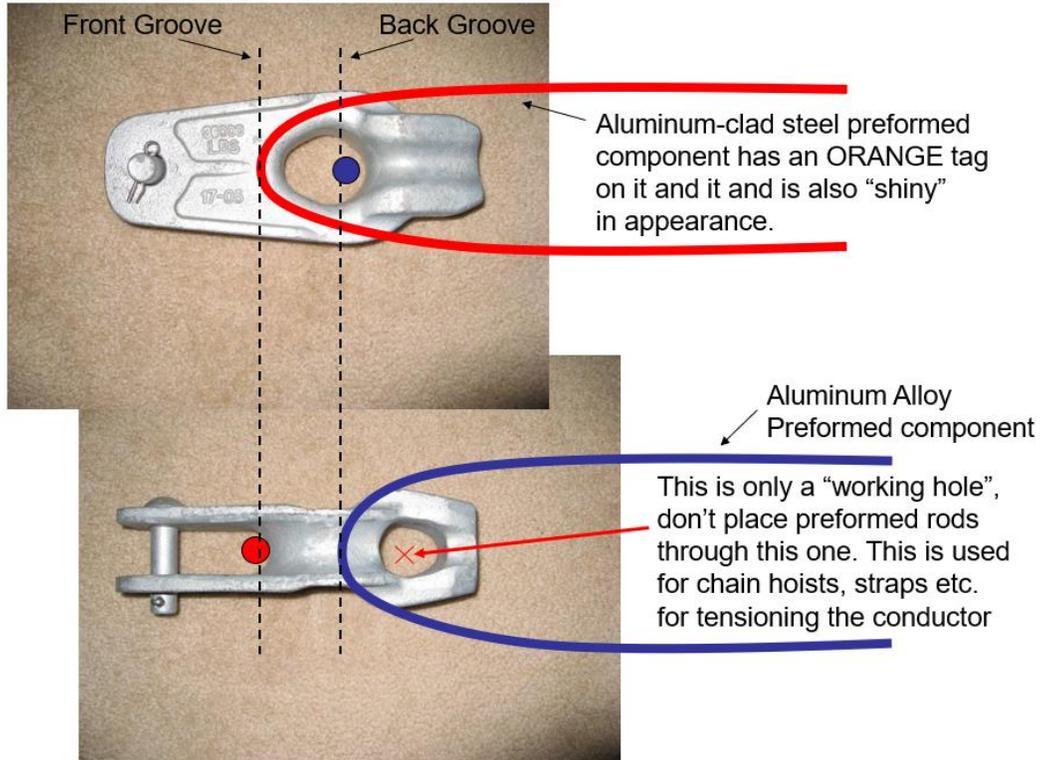
THERMOLIGN™ dead ends produced by Preformed Line Products have been used successfully in the installation of 3M ACCR. The dead end designed for the 3M ACCR is a two-layer construction consisting of a reinforcement rod layer and two preformed dead-end layers, which are used as the connection point to the insulator string.



After the final sag tension of the conductor is established, a measurement is made on the conductor to determine where the dead-end assembly will connect to the insulator string. There are two layers that make up the construction of the preformed dead-end assembly. Each layer has match markings on them. These match markings will determine where the first layer of reinforcement rods will be placed onto the

conductor. After the rods are installed onto the conductor, the preformed wire dead-end layers are placed over the rods matching up the markings over each other.

There are two separate types of preformed wire dead end components: **Aluminum-Clad Steel** and **Aluminum-Alloy**. A thimble clevis is used to attach the preformed wire dead end components to the insulator string. The location of each type of dead-end component into the thimble clevis is described below.



⚠ DANGER

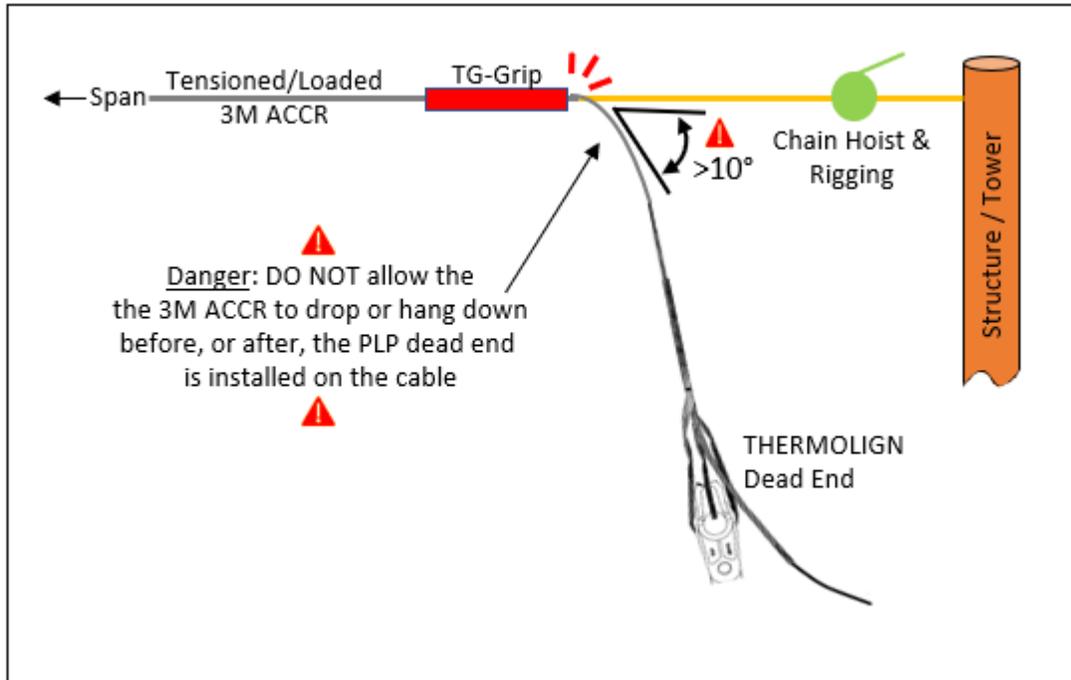
To reduce the risks associated with hazardous voltage, mechanical impact, and working at heights which, if not avoided, will result in serious injury, death and/or property damage:

- If there is possible conductor core damage due to failure to follow the **⚠ WARNING** safety instructions in this document, personnel shall not climb out on the conductor, use a conductor cart, trolley, spacer cart or any other equipment that relies on the 3M ACCR as a single means of personal fall protection safety until it is determined that the conductor or conductor core is not damaged.
- If there is outside aluminum strand or core damage, personnel shall not climb out on the conductor, use a conductor cart, trolley, spacer cart or any other equipment that relies on the 3M ACCR as a single means of personal fall protection safety until it is determined that the conductor or conductor core is not damaged.

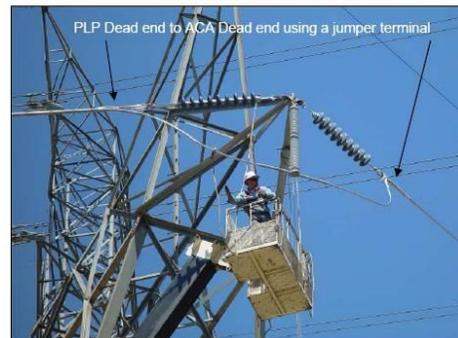
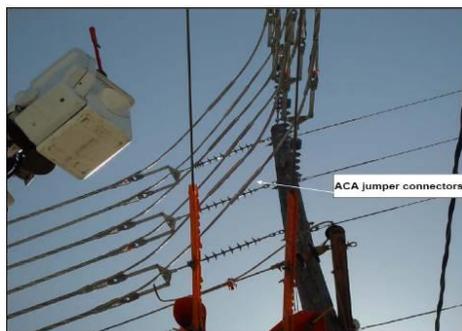
⚠ WARNING

To reduce the risks associated with hazardous voltage, mechanical impact, and working at heights which, if not avoided, could result in serious injury, death and/or property damage:

- After a THERMOLIGN dead end assembly is installed onto the 3M ACCR, do not allow the assembly to become unsecured resulting in this section of conductor falling and/or swinging towards the Preformed Grip. This can cause conductor core damage to the 3M ACCR.



The chain hoist can now be removed along with the preformed conductor grip. These assemblies allow the conductor to pass through the dead end and create a “tail”. This tail of the conductor will not be under any tension, can be cut to any length and used as a connector or jumper to the existing line. The pictures below show multiple ways to connect the jumper tail.



Full Tension Splices

Compression Splices

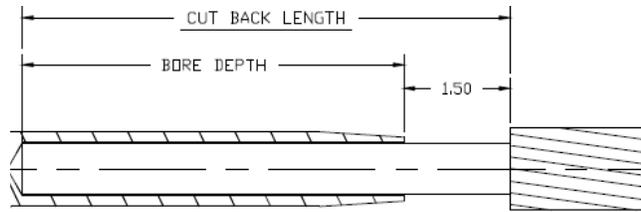
Compression type conductor splices manufactured by AFL have been successfully utilized in the installation of 3M ACCR. These compression splices are specifically designed by AFL to grip not only the outside aluminum strands but also to grip the core wires separately of the 3M ACCR. Therefore, like the compression type dead end assembly, the installation steps of the full tension splice consist of a two-step compression procedure.

Full Tension Compression Splice



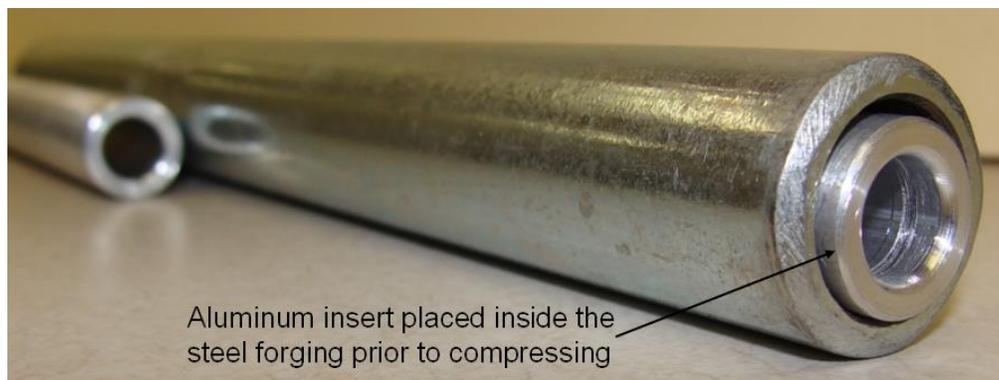
3M recommends that the minimum distance from a final installed splice location to a dead end or suspension tower should be 50' (15m). The two ends of the conductor that are going to be spliced are brought together and held using a chain hoist and two approved conductor grips. (See section 3 on information regarding the proper selection and use of conductor grips). Preformed conductor grips must be spaced out so that the installation of the splice does not interfere with the conductor grips themselves. This distance should be approximately 16' (5m) between the thimbles of the conductor grips, or each grip located a minimum of 8' (3m) from each end of the splice body. Placing the grips at this minimum distance from the splice will reduce strand loosening that may occur when compressing the splice body.

The first step to install the splice is to slide the large outer aluminum body of the splice over one end of conductor and “park” it about 3' (1m) away from the end of the cut cable. The next step consists of trimming back the top aluminum layers of the two conductor ends to be spliced. This procedure involves the use of a cable-trimming device. Care must be taken to not nick the composite wires when trimming the aluminum layers off the conductor. Prior to cutting back the aluminum strands, the depth of the bore must be determined in the steel forging. Insert a clean object or length of core until it bottoms out in the forging. Measure the bore depth and add 1.50” (40mm). This will be the length to cut back the aluminum strands.



Aluminum tape is wrapped over the composite core wires on the 3M ACCR. Normally this tape is not removed from the core wires when pressing a splice forging except for a few 3M ACCR sized conductors. The requirement to remove core tape is explained in more detail in the paragraphs below under Slotted Aluminum Inserts.

Located inside each end of the steel forging for the splice is an aluminum tube insert. The main purpose of this aluminum insert is to obtain a strong bond between the 3M ACCR core wires and the steel sleeve.



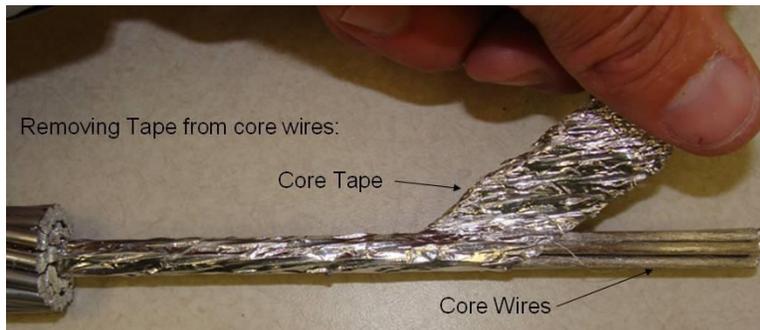
Details on Slotted Aluminum Inserts

On some 3M ACCR sizes, the aluminum insert for the AFL splices will have slots or grooves manufactured into it. This allows for greater gripping force on some core sizes used for a given 3M ACCR size. As mentioned in the beginning of this section, there is an aluminum tape wrapped over the core wires. Normally this tape is left on the core wires and the core is inserted into the aluminum sleeve/steel forging and then compressed. **However: If an aluminum sleeve is found to have any number of slots or grooves cut into the length of the sleeve, then ALL (100%) of the tape must be removed from the length of the core that would be inserted into this sleeve. If the aluminum insert is found to have no slots or grooves, then the tape is NOT to be removed from the core wires.**



← Non-slotted Aluminum Insert
(Leave all tape on core wires)

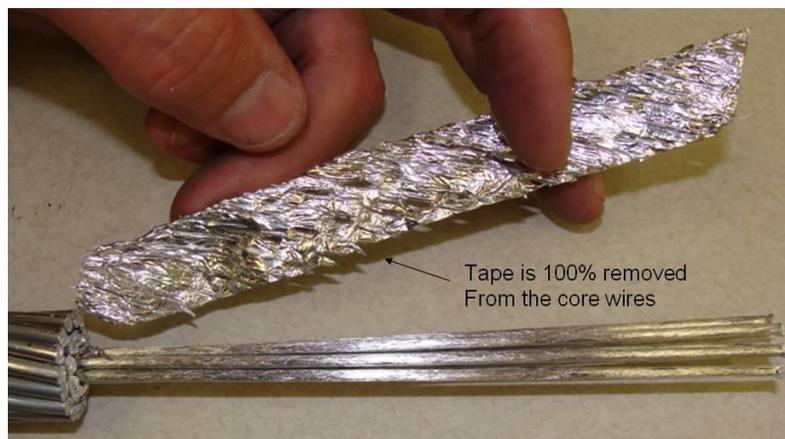
← Slotted Aluminum Insert
(Remove 100% of the core wire tape)



Removing Tape from core wires:

Core Tape

Core Wires



Tape is 100% removed
From the core wires

After the aluminum strands have been removed, the two exposed composite wire cores can be spliced together. The steel forging with the aluminum insert installed in it is placed over the core wires until the core wires bottom out. Make sure that the aluminum inserts are pushed into the steel forging on both sides and that they are flush with the ends of the steel bore.

Details on Compression Dies for the 3M ACCR

There are two sized dies used to compress the AFL dead end: One die for the steel forging and another die for the larger outer aluminum body of the dead end. All dies used to install compression hardware on the 3M ACCR must be stamped with an “-ACCR” suffix after the die part number as in this example:



All qualified “-ACCR” stamped dies may be purchased through 3M. Any dies not stamped may be sent to 3M to be measured, qualified and then stamped with the “-ACCR” suffix. Please contact 3M for more information on where to ship your dies to be qualified for usage when installing compression hardware on the 3M ACCR.

Install the correct steel compression die used for the steel forging into the 100-ton (90.8 metric tons) press head. While holding the core wires tight inside the steel forging, make the first compression on the steel forging at the very center of the steel forging. Make sure that the two die halves come together, and the pump pressure reaches 10,000 PSI for each compression bite.



Continue to press the entire length of the steel forging from the first compression bite at the center towards each end of the steel forging, overlapping each die bite by 0.5” (10mm). Lubrication of the steel forging is not recommended.

Pressing the steel forging of the AFL splice:



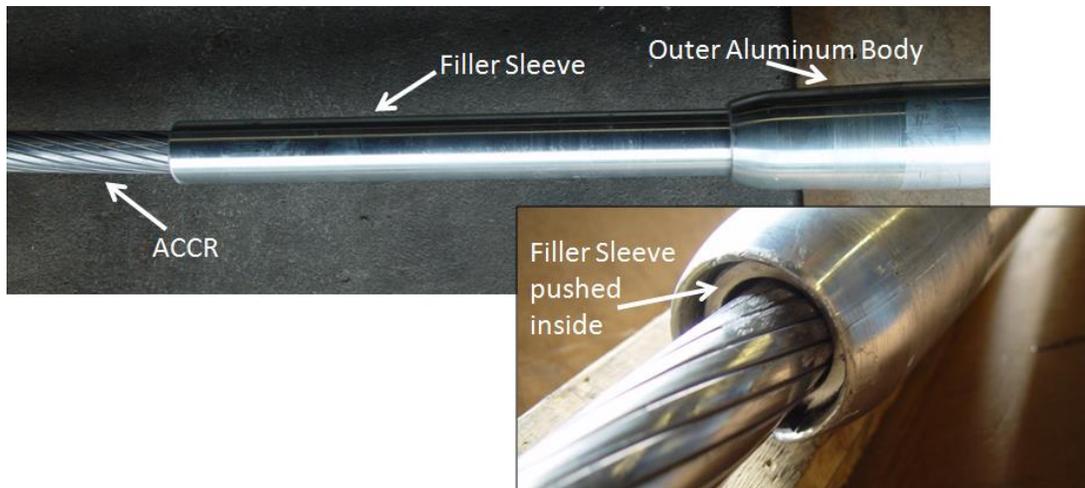
Secure the forging assembly to the rigging to not allow the conductor to be dropped. This can put stress on the 3M ACCR core wires.

It is mandatory that the cable is brushed with a wire brush to remove oxides from the cable surface. To do this, apply a bead of HiTemp® AFL Filler Compound (AFCHT™) on to the conductor surface on each side of the steel forging that the large aluminum body will be pressed over. Vigorously brush the compound into the conductor aluminum strands with a wire brush covering the entire area of the cable. The outer sleeve is then slid over the compressed steel forging and filled with the proper amount of HiTemp® AFL Filler Compound (AFCHT™). The grease port is then plugged with the provided plug or “pill”.

3M approved bar soap is required as a solid lubricant on the outer aluminum sleeve on the areas that will be pressed. Do not use any lubricant other than the approved bar soap. Refer to page 29 for info on 3M approved bar soap.

Change the dies used to press the steel forging in the 100-ton press head to the dies used to press the large outer aluminum sleeve. Slide the large outer aluminum body over the compressed forging making sure it is centered over the steel forging.

On some 3M ACCR sizes, the splice assembly also contains an aluminum filler sleeve that must be fitted inside of the larger outer aluminum body. This filler sleeve must be pushed into the outer aluminum body, so it is recessed inside of it.



Press the large outer aluminum sleeve with the 100-ton (90.8 metric tons) press.

There are 2 areas to be pressed on the outer body of the splice. These areas are stamped with “**Start**” and “**Press to End**” knurl markings on the aluminum body. The area over the compressed section of the steel forging is not compressed. This area is stamped “**Do Not Press**”. Make sure that the two die halves come together for each compression bite and the pump pressure reaches 10,000 PSI. Continue to press the 2 areas of the aluminum body overlapping each die bite by 0.5” (10mm).

IMPORTANT:

Under no circumstances can the tension on the conductor be “let off” and tension placed through the 3M ACCR to the splice prior to completely compressing the entire splice body.

Pressing the outer aluminum sleeve of the AFL Splice:



THERMOLIGN™ Full Tension Splice

Preformed type full tension splices produced by Preformed Line Products have been used successfully in the installation of 3M ACCR. The splice designed for the 3M ACCR is a two-layer construction consisting of a reinforcement inner rod layer and an outer rod layer.

PLP THERMOLIGN Full Tension Splice:



It is mandatory that the cable is brushed with a wire brush to remove oxides from the cable surface. AFL's Alnox® Electrical Joint Compound (EJC) is to be placed on the conductor in the areas where the splice rods are to be installed over. The two ends of the conductor that are going to be spliced are brought together and held using a chain hoist and two approved conductor grips. (See section 3 for information regarding the proper selection and use of conductor grips). Conductor grips must be spaced out so that the installation of the splice does not interfere with the conductor grips themselves. This distance should be approximately 20' (7m) between the thimble end of the conductor grips. 3M recommends that the minimum distance from a splice location to a dead end or suspension tower should be 50' (15M).

The first layer of rods is applied to the conductor making sure that the center markings on the rods are at the splice point of the two conductor ends. After the first layer of rods is applied the second layer can now be installed over the first. There are also center marks on the second layer of rods that match up with markings on the first layer. The installation of the preformed full tension splice is then complete.

Conductor Jumpers / Electrical Connectors

Compression

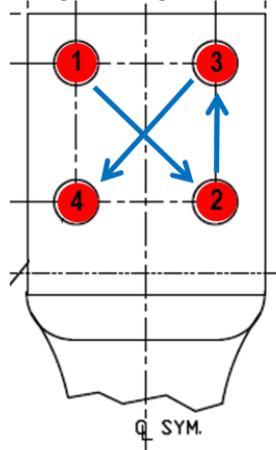
Compression type jumper connectors and jumper terminals have been utilized in the installation of 3M ACCR. These types of compression terminals, made by AFL, can be compressed directly over the outside layer of the 3M ACCR. Since these types of terminals are generally used on the conductor where there are no tensions involved, there is no need to trim back the outside layers of the conductor and compress a second steel sleeve onto the composite wires. An example of a compression type terminal connector is shown below. It is mandatory that the cable is brushed with a wire brush to remove oxides from the cable surface. To do this, apply a bead of HiTemp® AFL Filler Compound (AFCHT™) on to the conductor surface that the aluminum body of the terminal will be pressed over. Vigorously brush the compound into the conductor aluminum strands with a wire brush covering the entire area of the cable.

3M approved bar soap is required as a solid lubricant on the outer aluminum sleeve on the areas that will be pressed. Do not use any lubricant other than the approved bar soap. Refer to page 29 for info on 3M approved bar soap. Be sure to use the proper sized 3M ACCR qualified die to compress the fitting.

Brushing of the terminal pads of the dead end and jumper terminal with a wire brush is required. The use of AFL's Alnox® Electrical Joint Compound (EJC) or any other EJC approved by 3M for this application is required between the terminal pad and the dead-end pad for a good electrical connection.

AFL Jumper Terminal Connectors:

Recommended Bolt Tightening Order



Recommended Bolt Torque

Bolt Diameter	Torque
Inch	lbft (N.m)
7/16	20 (27)
1/2	25 (34)
5/8	40 (54)
3/4	60 (81)

Parallel Groove Clamp (PG-Clamp)

Parallel Groove Clamps, or PG-clamps, have been utilized in the installation of 3M ACCR. These types of connectors, made by AFL, can be installed directly over the outside layer of the 3M ACCR. An example of a PG-Clamp is shown below. It is mandatory that the cable is brushed with a wire brush to remove oxides from the cable surface. To do this, apply a bead of AFL's Alnox® Electrical Joint Compound (EJC) on to the conductor surface where the PG-Clamp will be attached. Vigorously brush the compound into the conductor aluminum strands with a wire brush covering the entire area of the cable. The voltage limit of the PG-Clamp is 230Kv.

Parallel Groove Clamp (PG-Clamp):



Recommended Bolt Torque

Bolt Diameter	Torque
Inch	lbft (N.m)
7/16	20 (27)
1/2	25 (34)
5/8	40 (54)
3/4	60 (81)

Installing a PG-Clamp on 3M ACCR:



T-Tap Connectors

Compression and bolted type T-Tap connectors have been utilized in the installation of 3M ACCR. These types of connectors, made by AFL, can be installed directly over the outside layer of the 3M ACCR.



Bolted T-Tap Connector

Bolt Diameter	Torque
Inch	lbft (N.m)
7/16	20 (27)
1/2	25 (34)
5/8	40 (54)
3/4	60 (81)

Recommended Bolt Torque

Bolted T-Taps from AFL must be the type approved for use on 3M ACCR conductors. It is mandatory that the cable is brushed with a wire brush to remove oxides from the cable surface. To do this for a bolted type T-tap connector, apply a bead of AFL's Alnox® Electrical Joint Compound (EJC) on to the conductor surface. Vigorously brush the compound into the conductor aluminum strands with a wire brush covering the entire area of the cable. The voltage limit of the bolted T-Tap is 230Kv and is only allowed on 3M ACCR 954-T13 and smaller sizes.

Compression T-Taps from AFL must be the type approved for use on 3M ACCR. Be sure to use the proper sized 3M ACCR qualified die to compress the T-Tap. It is mandatory that the cable is brushed with a wire brush to remove oxides from the cable surface. To do this for a compression type T-tap connector, apply a bead of HiTemp® AFL Filler Compound (AFCHT™) on to the conductor surface and vigorously brush the compound into the conductor. Compression T-Taps can be used for EHV applications.

3M approved bar soap is required as a solid lubricant on the outer aluminum sleeve on the areas that will be pressed. Do not use any lubricant other than the approved bar soap. Refer to page 29 for information on 3M approved bar soap. Compression T-Taps are allowed for usage on all 3M ACCR sizes.

Brushing of the terminal pad of the T-Tap connectors with a wire brush is required. The use of AFL's Alnox® Electrical Joint Compound (EJC) is required between the T-Tap terminal pad and the accessory connecting to it for a good electrical connection.

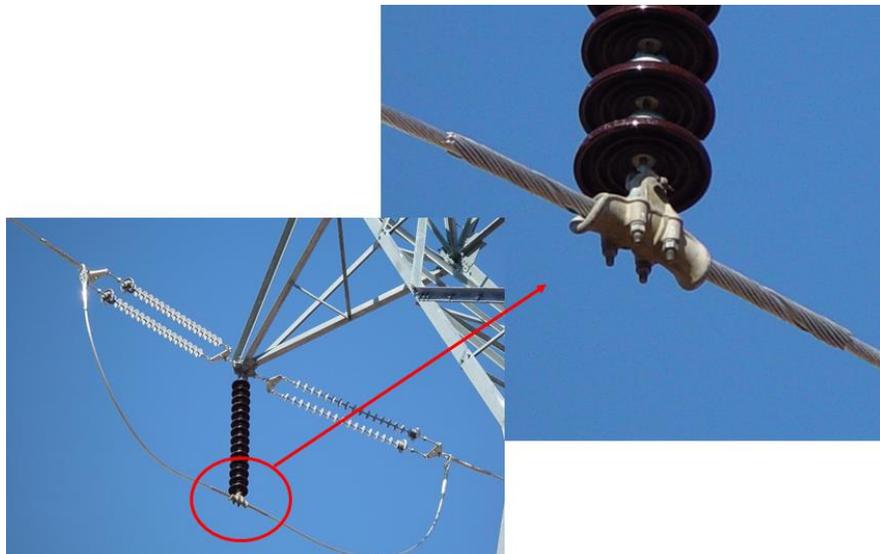
Compression T-Tap



Jumper Support Insulator

When there is a need to use a jumper support insulator, the installation of Line Guard is required to support the 3M ACCR. Line Guard manufactured by Preformed Line Products must be used in the installation of 3M ACCR where it is needed to connect to a jumper support insulator. The Line Guard is installed over the 3M ACCR and then the connector or “shoe” is installed over the Line Guard.

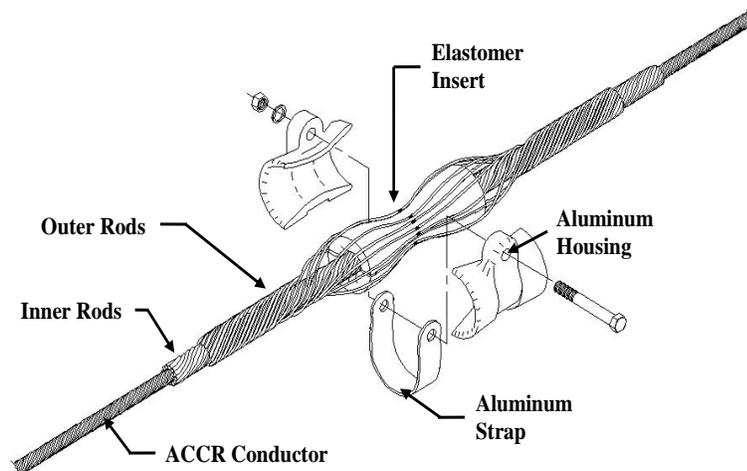
The shoe is then connected to the insulator string. The Line Guard gives the 3M ACCR more rigidity and dissipates and high temperatures away from the insulator string. It is important to note that the shoe size will have to be increased to go over the outside dimensions of the Line Guard plus the 3M ACCR. Please note that 3M does not provide the support shoe.



Clipping-in Procedures / Suspension Assemblies

Preformed Line Products - Thermolign™

Preformed Thermolign suspension assemblies are the required choice for use on the 3M ACCR. This suspension assembly, manufactured by Preformed Line Products, is a 2-layer helical-rod construction consisting of a reinforcement inner rod layer, a neoprene elastomer inserts, and a second outer layer of rods installed over the neoprene insert. For line angles 25° or more, a double suspension is required and may require special instructions and procedures for installation. **Before installing, consult 3M on the required suspension assembly pertaining to the installation needs.**



Helical-Rod Suspension Assembly from PLP.

The clipping portion of the conductor stringing operations involves the work following the sagging and dead ending of the conductors. The first step of installing the suspension assemblies is to mark the conductor's center point referenced to the final connection to the insulator string. This is done while the conductor is still in the stringing block.

The next step is to install the first layer of the inner reinforcement rods to the conductor. It is required that the first layer of rods be installed on the conductor while the conductor is still in the stringing block. The first layer of rods is installed this way because in the next step of removing the block, the conductor must be held up in place using a conductor hook or picking strap along with a chain hoist. By having the reinforcement rods in place before the conductor hook or picking strap is used, this gives the conductor more rigidity. The conductor hook or picking strap can cause damage to the inner composite wires of the 3M ACCR if this first layer of rods is not installed before the conductor is removed from the stringing block. There are center marks on each of the inner rods that must be lined up with the center mark on the conductor.

⚠ DANGER

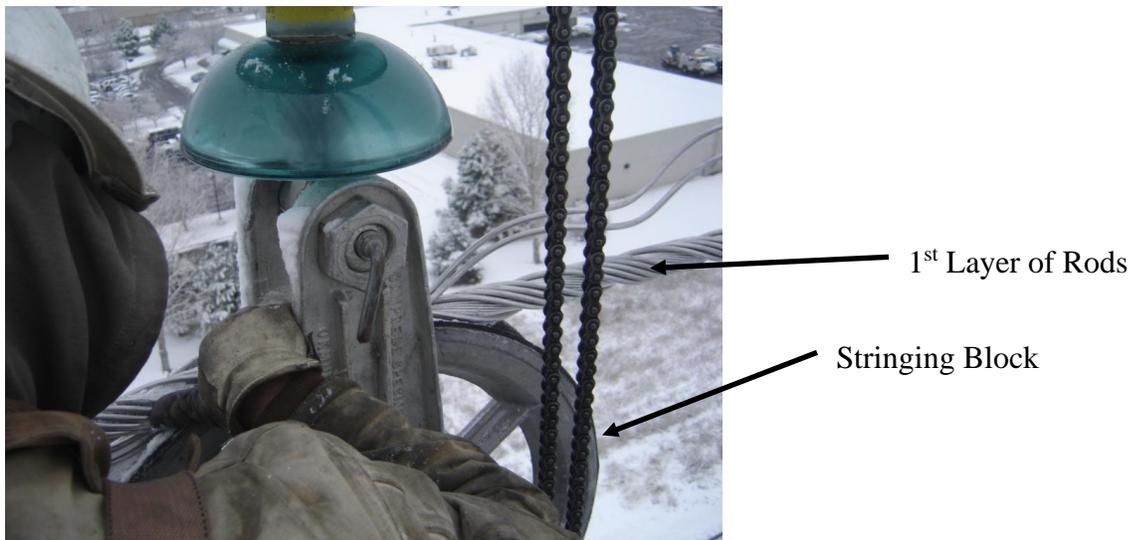
To reduce the risks associated with hazardous voltage, mechanical impact, and working at heights which, if not avoided, will result in serious injury, death and/or property damage:

- If there is possible conductor core damage due to failure to follow the **⚠ WARNING** safety instructions in this document, personnel shall not climb out on the conductor, use a conductor cart, trolley, spacer cart or any other equipment that relies on the 3M ACCR as a single means of personal fall protection safety until it is determined that the conductor or conductor core is not damaged.
- If there is outside aluminum strand or core damage, personnel shall not climb out on the conductor, use a conductor cart, trolley, spacer cart or any other equipment that relies on the 3M ACCR as a single means of personal fall protection safety until it is determined that the conductor or conductor core is not damaged.

⚠ WARNING

To reduce the risks associated with hazardous voltage, mechanical impact, and working at heights which, if not avoided, could result in serious injury, death and/or property damage:

- It is required that the inner reinforcement rod layer of the THERMOLIGN suspension assembly is to be installed over the 3M ACCR prior to picking (lifting) the 3M ACCR out of the stringing block to complete the suspension installation. The picking strap or conductor hook must be installed over this reinforcement rod layer. Conductor core damage to the 3M ACCR can be caused if the picking (lifting) strap or conductor hook is placed directly on the 3M ACCR without the reinforcement rod layer.



Inner rods installed through stringing block

After the first layer of rods is installed onto the conductor, the conductor can now be removed from the stringing block with the use of a picking strap along with a chain hoist. The picking strap must be positioned on the conductor giving clearance to install the neoprene insert and be able to install the outer rods over the insert. Please note that the picking strap must be rated high enough in strength to lift the conductor safely out of the stringing block.



Picking Strap with chain hoist

Stringing block is removed

The neoprene insert is now placed over the inner rods lining up the center of the insert with the center marks on the inner rods. The two halves of the neoprene insert may be temporarily taped together to hold it on to the conductor before the outer rods are installed over it.

The outer layer or rods are now installed over the neoprene insert. These rods also have center marks on them that must match up with the center of the neoprene insert. The provided aluminum housing with the aluminum strap is then placed over the outer rods of the assembly. The suspension assembly is brought up to the insulator string and attached to it using the hardware provided with the aluminum housing.

The chain hoist and picking strap are then removed. The strap is pulled out of the open slots in the outer rods created when they were installed.



Open slots in outer rods

Second layer of rods on suspension

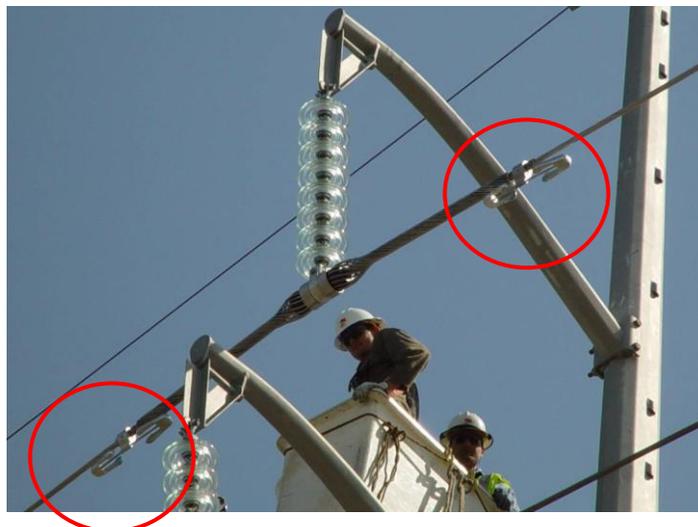
Completed PLP Suspension assembly:



Vibration Dampers

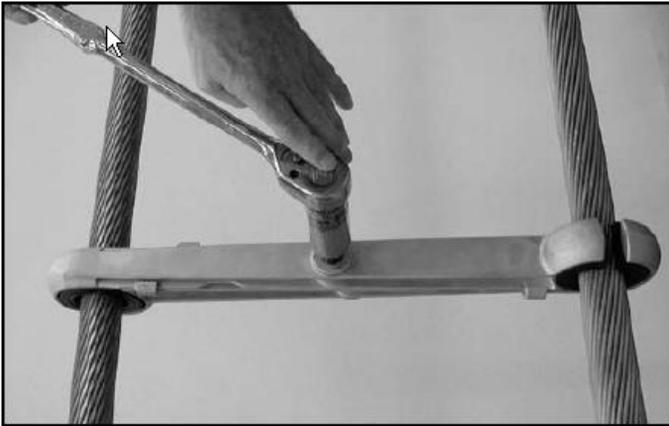
Vibration dampers manufactured by PLP have been successfully used in the installations of 3M ACCR. PLP vibration dampers have a breakaway torque bolt that helps ensure the proper torque setting when installed on the conductor. Vortex damper analysis reports for PLP dampers are utilized for each 3M ACCR project to determine damper type, quantity and placement information on the conductor. Due to the high operating temperature of the 3M ACCR, the PLP dampers must be installed over protector rods, the rods of the PLP THERMOLIGN suspension assembly or rods of the PLP THERMOLIGN dead end assembly.

NOTE: Dampers must be installed on the 3M ACCR within 72 hours *after* the conductor is tensioned to the specified sag and the dead ends are installed.



Spacers/Spacer-Dampers

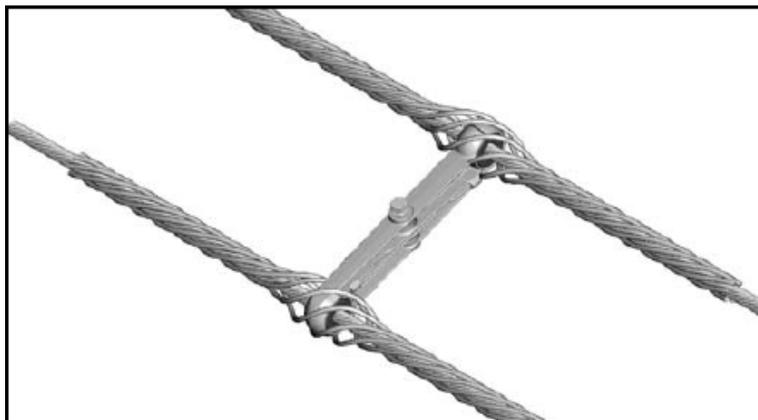
PLP THERMOLIGN spacers are qualified for use on 3M ACCR for bundled installations. The two spacer halves are connected at the proper location of the bundle conductor for each span. The two halves are connected using a single break-away bolt to ensure that the two halves are connected and tightened to the correct torque. The final step of the spacer installation involves applying a single layer of protector rods over the conductor and centered over each side of the connection points of the spacer on the conductor. The figures below show the details of the installation steps to complete the assembly. Tri-Bundle spacer/dampers are also available from PLP for use on 3M ACCR installations.



**Connecting the spacer halves
Using the break-away bolt**



Protector rods applied over the spacer connection point



Completed PLP spacer assembly

5. Maintenance of 3M ACCR

Recommendation for Usage of Repair Rods and Full-Tension Splices

Damage of conductor strands can reduce the strength and electrical conductivity. Restoration of these properties may be achieved using various repair options as presented below. These are recommendations provided by the accessory suppliers. Note: Specific strand counts in this table are provided with reference to a 300-T16 “Ostrich” 3M ACCR with a 26/7 construction:

Supplier	Repair Product	Max. % of Damaged Aluminum Strands	Example: Max Number of Damaged Aluminum Strands for 300-T16 “Ostrich” 26/7 3M ACCR	Max. Number of Damaged Core Strands
PLP	Line guard	11%	3	0
PLP	Repair Rods	22%	5	0
PLP	Full-Tension 3M ACCR Splice	>22%	26	1 or More
AFL	Compression Repair Sleeve for 3M ACCR	33%	8	0
AFL	Compression Full-Tension 3M ACCR Joint	>33%	26	1 or More

PLP – Preformed Line Products – www.preformed.com

AFL – AFL Conductor Accessories (formerly Alcoa) – www.aflglobal.com

Please note that only 3M approved accessories may be used with the 3M ACCR. All other maintenance procedures having to do with the 3M ACCR should follow the requirements in this booklet for safe handling of and installation of any accessories. **If questions arise, consult 3M before proceeding with the installation.**

 DANGER

To reduce the risks associated with hazardous voltage, mechanical impact, and working at heights which, if not avoided, will result in serious injury, death and/or property damage:

- If there is outside aluminum strand or core damage, personnel shall not climb out on the conductor, use a conductor cart, trolley, spacer cart or any other equipment that relies on the 3M ACCR as a single means of personal fall protection safety until it is determined that the conductor or conductor core is not damaged.
- If there is outside aluminum strand or core damage, personnel shall not climb out on the conductor, use a conductor cart, trolley, spacer cart or any other equipment that relies on the 3M ACCR as a single means of personal fall protection safety until it is determined that the conductor or conductor core is not damaged.

 WARNING

To reduce the risks associated with hazardous voltage, mechanical impact, and working at heights which, if not avoided, could result in serious injury, death and/or property damage:

- Damaged 3M ACCR must be repaired according to the guidelines set out in this document.

Hot Line / Hot Stick Work

Case studies have shown while the 3M ACCR is running in a high load condition, the actual surface temperature of the 3M ACCR is only a few degrees above ambient temperature. This actual increase in surface temperature is affected by conditions including actual ambient temperature, wind speed, size of the conductor, line loading, etc. Therefore, the working temperature of the conductor should be well under the heat rating of hot sticks. It is 3M's recommendation, however, to verify the surface of the 3M ACCR under load prior to hot stick work with a noncontact (IR) thermometer and comparing this temperature to the manufacture's recommended temperature limit on the hot stick to be used.

General 3M ACCR Maintenance Information

It is important and required that the only accessories to be installed on 3M ACCR must be qualified for usage by AFL, PLP or 3M. In no case shall another type of accessory used for ACSR, ACSS or other conductor type be used on 3M ACCR. It is 3M's recommendation that all spare accessories used on the 3M ACCR be kept in a separate location and well labeled as to not be confused or mixed in with non-3M ACCR accessories. A typical list of spare or maintenance type accessories should include:

AFL:

Full Tension Compression Splices

Full Tension Compression Dead Ends

Compression Terminals

HiTemp® AFL Filler Compound (AFCHT™)

AFL's Alnox® Electrical Joint Compound (EJC)

Correct Sized Compression Dies (both steel and aluminum sizes) for Compression Hardware

3M Approved Bar Soap for a Solid Lubricant

PLP:

TG Grips to be used as 3M ACCR Grips
Thimble Clevis for TG-Grips
Armor (Repair) Rod
Full Tension Preformed Splice if Applicable
Full Tension Preformed Dead End if Applicable
THERMOLIGN Suspension (or Trunion type) Assemblies

Installation Tools and Equipment:

Bullwheel Tensioner (Diameter size approved by 3M)
Sherman and Reilly Roller Arrays
28” (71cm) Minimum diameter stringing blocks for suspension towers
100 Ton Press (90.8 metric tons) and a 10,000 psi (70,000 kPa (700 bar)) hydraulic pump system
Picking strap (load approved) for installation of suspensions
Steel Wire Conductor Brush
Heavy Duty Friction Tape for Sock Splices

6. 3M On-site Support

The 3M installation representatives may provide on-site installation training for the 3M ACCR and associated accessories prior to installation. 3M representatives do NOT participate in the actual installation of 3M ACCR. The typical duration for training and associated technical support is 2-5 days.

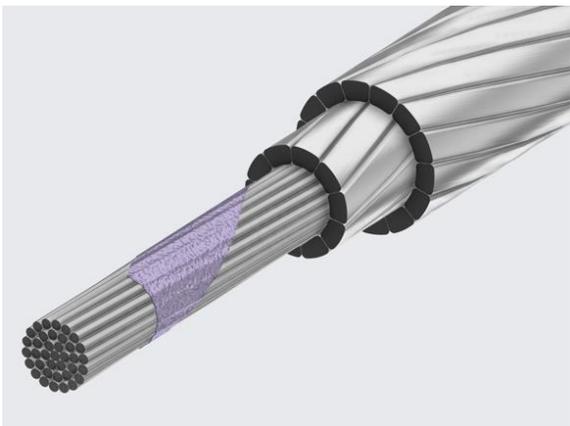
The utility and/or installation contractor are responsible for the entirety of the installation project. This includes, among other things, the following:

- 1) Supervising the installation and the crews.
- 2) Procuring, maintaining and operating equipment including bullwheel, puller, hoist, reel stand, bucket truck, sock splices, swivels, etc.
- 3) Following all applicable safety procedures.
- 4) Obtaining applicable or required permitting, outage, notifications to any regulatory agencies, any required insurance needs, etc.
- 5) Procuring all the installation equipment necessary that is not included in the bill of materials provided by 3M.
- 6) Establishing pulling sites to follow 3M recommendation on maximum angles and tension.
- 7) Stringing the conductor and installing all the accessories according to installation instructions.
- 8) Providing the appropriate sag table.
- 9) Measuring sag.
- 10) On site inspection and final inspection.

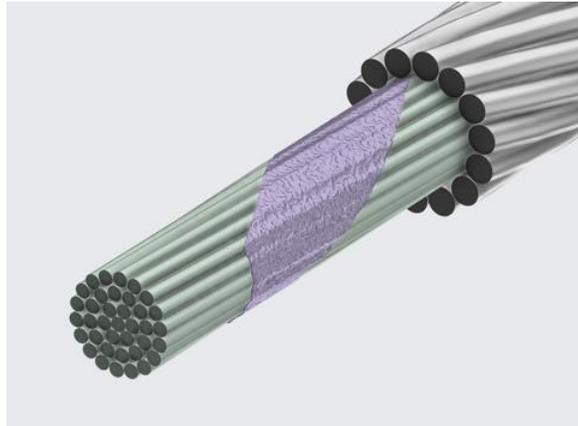
7. High-Type 37-Strand Core Conductors & Long Span/River Crossing Applications

This Installation Guidelines and Maintenance document does NOT apply to 3M ACCR conductors that are constructed with a 37-strand core configuration. 3M ACCR conductors that are constructed with a 37-strand core configuration are considered high type conductors and require special stringing procedures and specialized equipment to successfully install them. High-type conductors are typically used for long span or river crossing applications. 3M ACCR conductor sizes that fall under this category include but are not limited to the following: **558-T73, 558-T73-L1, 668-T61, 1033TW-T28, 1085-T37, 1230TW-T24.**

Examples of 3M ACCR 37-strand core configurations:



1230TW-T24



558-T73-L1

If questions arise concerning the size, type and application of the 3M ACCR that is intended to be installed, consult 3M before proceeding with the installation.

For detailed information on the proper installation guidelines for high-type 3M ACCR conductors, please refer to 3M's instructional document entitled, *3M™ Aluminum Conductor Composite Reinforced (3M ACCR) Long Spans Using High-Type Cable Constructions Installation Guidelines and Maintenance.*

8. Disclaimer and Limitation of Liability

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