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ACSS : Conductor Installation

WORK INSTRUCTION : AILS/IM/ACSS/01
Issue Date : 30.07.2013, Rev.06, Rev Date : 03.04.2026

1. PURPOSE

1.1. The purpose of this document is to provide experienced transmission engineers, field inspectors, utility personnel and linemen with guidelines, recommendations and requirements necessary to safely install the ACSS bare overhead conductor.
This document is not intended to serve as a more intensive training manual or act as a substitute for proper training, required personnel skill sets or industry experience.

2. SCOPE

2.1. These guidelines apply to equipment and techniques required to install ACSS conductor.

3. TRAINING

3.1. APAR strongly recommends that all line personnel, safety inspectors and construction crew attend a APAR sponsored training seminar prior to or in conjunction with the preconstruction meeting, at a time and place agreed to by all parties. Attendance by all Installation Supervisors is mandatory prior to the start of construction. Should a change in crew occur during the course of construction, APAR should be notified as soon as possible so that additional field training and support can be provided in a timely manner. Improper installation techniques are not covered by the APAR Warrantee Program and could result in line failure.

4. ASSOCIATED DOCUMENTS

4.1. IEEE Standard 524™ Guide to the Installation of Overhead Transmission Line Conductors.

5. DEFINITIONS

5.1. ACSS is defined as Aluminum Conductor Steel Supported.

6. RESPONSIBILITY

6.1 It is the responsibility of the Installation Contractor and Field Inspectors to ensure a safe installation by following the instructions provided in this guideline, as well as customary safe installation practices.

7. TOOLS, GAUGES, FIXTURES

7.1. All equipment shall be maintained in accordance with applicable safety standards.

8. SAFETY REQUIREMENTS

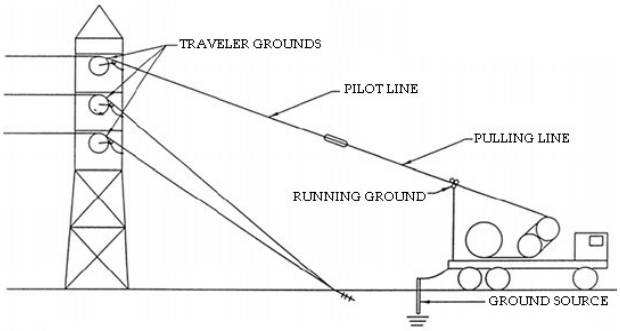
8.1. All safety requirements associated with the operation of approved equipment shall be followed.

8.2. The conductor can be broken or damaged if bent or handled in a careless manner that exceeds this document recommended bend radiuses.

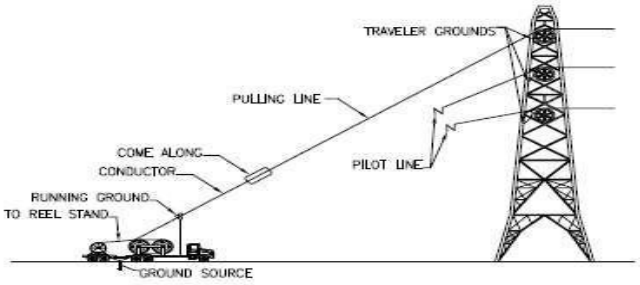
8.3. Electrical grounds shall be placed on all equipment and conductor per OSHA Regulation must include Equi-potential. First and last traveler shall be grounded along with the running ground at the tensioner. The grounds shall be placed approximately 20 feet (6 meters) out from the insulators

during the dead-ending process and likewise the grounds shall be placed 20 feet (6 meters) on each side of the splice during the splicing process. The placement of the grounds at 20 feet (6 meters) helps to eliminate the birdcaging process that could occur in Aluminum wire of conductors.

8.4. CONDUCTOR GROUNDS MUST BE PLACED DIRECTLY ON THE ALUMINUM STRANDS



Puller equipped with pulling line connected to pilot line



Tensioner with conductor connected to pulling line and ground
Connection between conductor, tensioner and reel

8.5. We at APAR are always committed to the health and safety of the people who produce and work with our conductor in the field. Our MSDS makes accurate recommendations on how personnel should protect themselves from the dust that is created by cutting conductor. While the amount of dust that is created is very small, appropriate protections such as a dust mask are recommended to filter out dust particles and the use of appropriate skin protection (gloves) should be considered by the people working with the conductor when installing the ACSS conductor to minimize the irritation that could be caused by the dust resulting from cutting or sanding.

9. SHIPPING AND REEL HANDLING REQUIREMENTS

9.1 Aluminum conductors are shipped in sturdy, carefully designed containers or reels that safeguard the conductor from damage in transit, storage, and at the point of installation. The conductor is carefully inspected during all stages of fabrication; packaging is inspected prior to shipment, and only properly packaged material is delivered to the carrier. The reel shall have a spindle hole diameter as per the project specific approved drum drawing.

9.2 Reel Handling. Reels are constructed so that they must be supported either on an axle through the arbor hold or by the reel flange. Metal reels may be supported by a singletree arrangement that clamps to the flange and is lifted from above. When an axle supported from above lifts the reels, a

spreader bar must be employed to prevent damage to the conductor or reel, or both, by inward pressure on the reel flange. Proper equipment must be available to lift the reels.

9.2.1 Reel stands are designed to be used with tensioners to supply the necessary back tension to the conductor. The stand(s) are selected to accommodate the conductor (or ground wire) reel dimensions and weight.

9.2.2 Some reels are not designed to withstand the forces developed by breaking during tension stringing operations. Direct tension stringing from the reel at transmission line stringing tensions should not be attempted. The conductor may be pulled directly from the reel stand when employing slack stringing methods.

9.2.3 If the reel stand is not self-loading, a crane, forklift or other suitable equipment is used to load the reel into the stand.

9.3 Reels should be properly controlled during the loading, unloading and staging processes.

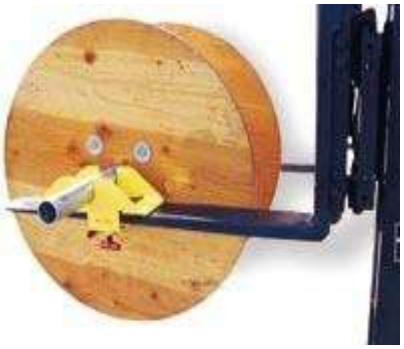
9.4 Cranes or other equipment of adequate capacity should be used to avoid damage and to avoid safety hazards.

9.5 It is important that reels of ACSS conductor are not lifted by placing the forks of the forklift directly under the drum area of the reel which would allow the forks to come in direct contact with the conductor or its wrapping material. Slings, winch lines, nylon straps or other types of lifting devices shall never be placed around the conductor to lift the reel. The conductor could be damaged if such devices are used.

9.6 Lift reel by approaching from the side and placing forks under flanges.

9.7 A spreader bar with slings or chains attached directly to the reel is the preferred method of unloading.

9.8 At no time should the reel be laid on its side either during Unloading, Storage, shifting & stringing at site.



9.9 If the conductor is to be rewound on the existing reel or onto another reel, extreme caution shall be exercised. The conductor must have backpressure applied at all times. Personnel must ensure that the conductor doesn't cross over itself during the rewinding process.

NOTE: PREVENTING CONDUCTOR CROSS-OVER ON THE REELS AND KEEPING BACK PRESSURE WHILE REWINDING HELPS TO ENSURE THAT THE CONDUCTOR REMAIN INTACT.

10 STORAGE

10.1 If the conductor is to be stored for an extended period of time before use, the reel containing the conductor should be kept off of the ground and otherwise protected from possible damage. It is recommended that steel reels be used for storage of backup conductor.

10.2 Identification tags and other markings should be retained on all packages until such time as the conductor is to be used. Identification tags should be protected from weather to retain information.

10.3 The reels are delivered from the factory with a wooden lagging cover or polypropylene sheet covering of thickness 5mm held down with steel bands over the outermost layer of conductor. It is recommended that the cover be left on the reels if they are going to be stored for an extended period of time.

10.4 Please refer APAR's instruction manual for **"Handling, Loading, Unloading and Storage Guide of Conductor Drums"**.

11 STRINGING CONDUCTOR

11.1 Conductor reels should be loaded into their payout cradles prior to the removal of protective covering. After the removal of the covering, all reels must be examined for sharp objects that may damage the conductor (Nails in case of wooden reels), as it is unreeled. Reel trailer mandrels shall match the size of reel or correctly sized collars shall be used to maintain control of the reel. If the mandrels are too small, the conductor has a tendency to bounce and could damage. Additionally, brakes will not work properly if the reel isn't controlled properly.

11.2 In all cases, the reel stand shall be anchored before pulling any conductor.

11.3 A reel brake mechanism must be utilized in a straight line with tensioner at all times to avoid spring action or uncoiling. Adequate back-tension must be applied at all times during the pulling operation to prevent the conductor from unraveling, binding or jumping out of alignment with tensioning or stringing equipment.

11.4 The tensioner bull wheel diameter must be large enough to avoid excessive bending of the conductor. The bottom groove diameters for tensioner bullwheel should be sized in accordance with IEEE Std.
524. APAR recommends a minimum of 40 times the diameter of the conductor being strung measured at the bottom of the grooves of the bull wheel sheaves.

11.5 The following precautions shall be taken while conductor end Preparation before paying out :

a) Ensure proper securing of the conductor end with a hose clamp/Metal band.
b) Use an electric abrasive cutter/ring cutter exclusively for conductor cutting. Before cutting, ensure that the conductor is securely tied and fastened in accordance with the instructions in point a) above.

11.6 Conductor must be continuously inspected as it is fed into the stringing equipment for dirt, bits of foreign material, nicks or abrasions in the conductor.

11.7 Precautions should be taken to keep pulling lines and stringing sheaves free from dirt and foreign debris that would cling to the conductor as it passes through the sheaves.

11.8 The conductor must not be pulled across the ground or underlying structure (such as a fence) as that could damage the aluminum strands causing electrical discharge or corona when energized.

11.9 It is a good practice to retain the reel tags and document the section of line where the specific reels of conductor are used.

11.10 It is recommended that the protective paper wrap that is removed from the reels be placed on the ground to protect the conductor during set up and splicing operations.

11.11 Should the conductor unintentionally come in contact with the ground, any dirt or debris build up should be cleaned off.

11.12 The optimal pulling tension applied to the conductor should ideally be limited to 5%. If higher clearances are necessary, it is permissible to increase the tension, but it should not exceed 10% of the conductor's rated breaking strength, as recommended by IEEE Standard 524. A good guideline is not to exceed 50% of sagging tension.

11.13 Always use Neoprene or Urethane lined dollies, sheaves, rollers, blocks, etc. when stringing conductor.

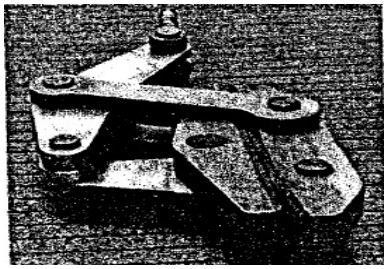
EXCEPTION: Some of the countries overseas use plain metallic sheaves for the stringing process. If metallic, non-lined sheaves are used it is critical that all of the sheaves are examined for abrasiveness, debris or marks on the rollers and removed so that no damage is caused to the conductor.

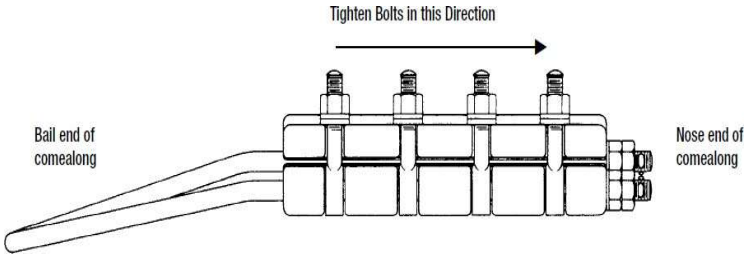
11.14 Grips must be rated for conductor strength. Ensure that tape is placed on any rough edges on the outside of the grip near the pulling eye(s) and swivel to help the grips and swivel pass smoothly through the blocks (sheaves). The tape also helps protect the lining on the blocks as the grip pass through the sheaves.

11.15. Never bend the conductor less than the recommended minimum bend diameter of conductor. We at APAR recommend the minimum bend diameter of ACSS conductor as 25 times the diameter of conductor.

11.16 Damage to the conductor can occur if it is over bent. Below are possible ways the conductor can be over bent.

11.16.1 Use of correct conductor grips.

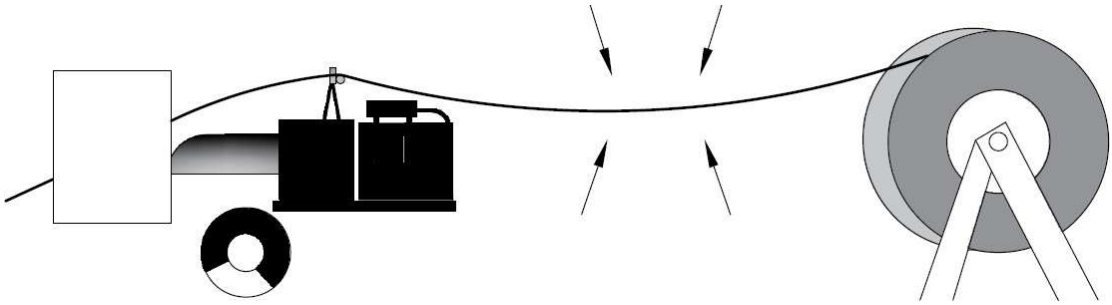




11.16.2 Incorrect conductor suspension after gripping.

11.16.3 Incorrect positioning of the brake tensioner.

11.16.4 Allowing the conductor to "bounce" up and down from the payout reel.

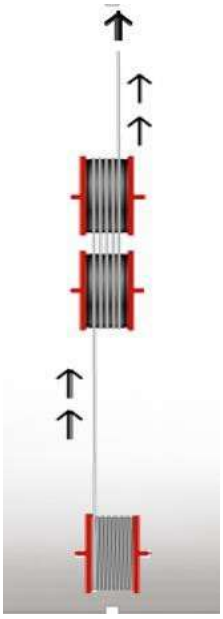


11.17. Tensioners

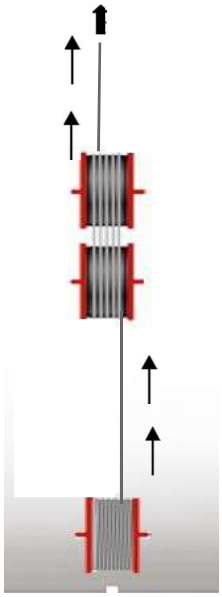
11.17.1 Semicircular grooves with depths in the order of 0.5 or more times the conductor diameter have been found to be satisfactory. Anything smaller than the 0.5 times the conductor diameter may result in the conductor strands loosening and or birdcaging on the bullwheel. Close attention should be paid to the stringing tension as this will help mitigate the loosening of the strands.

11.17.2 The number of grooves in the bullwheel shall be sufficient to prevent the outer layer of wires of multilayer conductors from slipping over underlying layers.

11.17.3 Tandem bullwheels should be so aligned that the will be approximately one-half the groove spacing. For ACSS conductors, which have a right-hand direction of lay for the outer wires, bullwheels should be arranged so that when facing in the direction of pull, the conductor will enter the bullwheel on the left and pull off from the right side. This arrangement is necessary to avoid any tendency to loosen the outer layer of strands as the conductor passes over the bullwheels. Static wire, guy wire, and messengers generally will be left hand lay and therefore should enter on the right and pull off from the left.

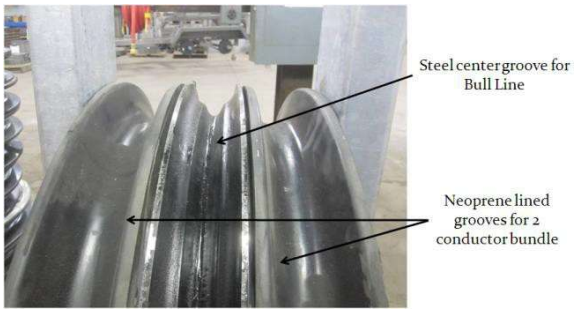


Left to Right
(Right - hand lay wire)



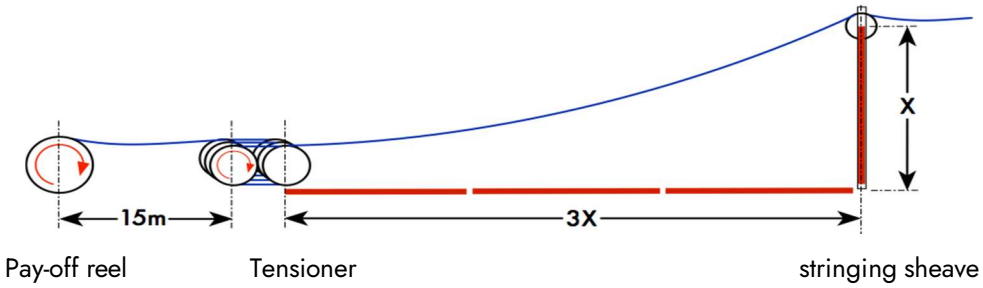
Right to Left
(Left - hand lay wire)

11.17.4 The material and finish of the grooves must be such as not to mar the surface of the conductor. Elastomer lined grooves are recommended for all conductors, but are particularly important for non-specular conductors. When a semi conducting elastomer is used for lining the grooves, it should not be relied upon for grounding.



11.17.5 V-groove type bullwheels shall not be used for ACSS conductor. The conductor doesn't ride in the groove properly and will break.

11.17.6 It is critical that a minimum of 3 to 1 ratio be used between the tensioner and the traveler on the first structure and between the puller and traveler on the last structure during the stringing pull in order to avoid bending the conductor at severe angles. The tensioner must be right hand lay, meaning the conductor coming off of the wire reel goes into the left side of the tensioner, and the conductor going to the first structure will be coming out of the right side of the tensioner. Stringing equipment and sheave wheels must be in good alignment at all times.



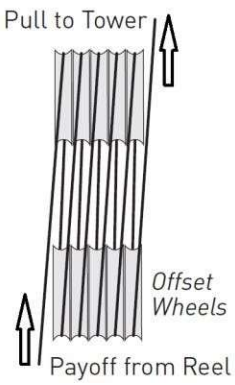
Stringing Setup Equipment Alignment

A sheave (meeting the minimum working diameter requirements) is required between the pay-off reel and the tensioner. Position the sheave to guide the conductor into the centre of the tensioner fairlead.

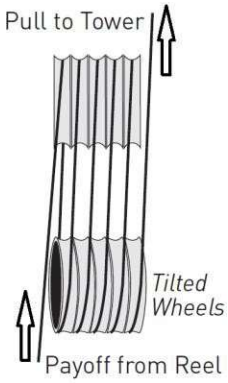
Note: There may be times when the 3 to 1 height to distance ratio can't be maintained. In this case, APAR engineering personnel may be able to provide an alternative-stringing plan using larger blocks or double blocks. It may be possible to rotate the tensioner and puller so that the conductor can be stopped at the dead end without causing any damage to the conductor. Severe angles have the tendency to flatten the conductor, which ultimately causes severe birdcaging during dead end, or splice installation.

11.18 Brakes on the reel trailer need to be used diligently in order to avoid any unnecessary "slack" occurring between the payout reel and the tensioner. This slack can cause the conductor to jump out of the tensioner sheave and become damaged or broken. The reel brake operator, tensioner operator and puller operator must be experienced with the equipment being used to pull in ACSS conductor. Good radio contact must be maintained between the operators and lines people watching the conductor being pulled in.

11.18.1 Dual drum multi-groove bullwheel tensioners are recommended to be used. A minimum of four grooves should be used. The bull wheel drums may be offset or tilted so that the offset will be approximately one-half the groove spacing.



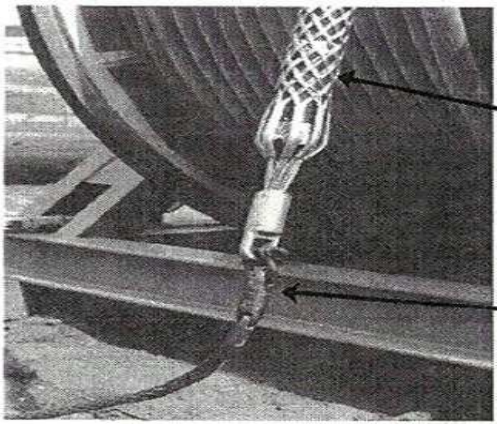
Offset Bullwheel Tensioner



Tilted Bullwheel Tensioner

11.18.2 When pulling in conductor it is important to maintain enough tension in order to avoid excessive bending around travelers.

11.19 Standard Kellem grips, also known as sock splices, basket grips, or wire mesh can be used to pull ACSS conductor. The Kellem grips should be double banded at the end of the grip. The banding accomplishes two things:
1. The bands force the Kellem grip to apply pressure on the strands allowing for a tighter grip on the core during the pulling process.



2. When using back to back Kellem grips, the grip closest to the pulling rope or old conductor could possibly catch the block; thus, releasing the conductor if the two bands were not on the end of the Kellem grip. There may be times when two reels of ACSS can be successfully installed using two sets of back to back Kellem grips. APAR engineering will assist the installation crew in analyzing how many reels can be connected together for the pull.

11.19.1. Swivels in good operating condition must be used at all times during pulling operations.

11.19.2 Klein "Chicago" grips or an approved equal grip may be used to grip the conductor when tensioning the conductor.

11.19.3 The grips must be properly sized to match the conductor diameter in order to minimize strand distortion and maximize gripping power.

11.19.4 The jaw length for these grips must be the long body type with smooth finish.

11.19.5 Do not use grips designed to fit a large number of conductor sizes, or with the short length jaws.

11.19.6 Consult with the grip manufacturer for the correct sizing and the recommended installation procedure.

11.19.7 All of the conductor grips must be clean, properly sized, and load tested prior to use to ensure that they will exceed the intended maximum installation tension(s).

11.19.8 It may be necessary to use tandem grips for certain high-tension applications.

11.19.9. Consult with the equipment supplier to ensure the attachment device is suitable for the ACSS Conductor and for the intended load rating.

11.19.10 Tandem grips do not provide double the gripping power.

11.19.11 Consult with the equipment manufacturer as to the rating system they apply for tandem grips.

11.19.12 Stringing tension/sagging time.

1. IEEE 524™ recommends that conductors be 'sagged' and 'clipped' in place within 24 - 48 hours of installation.
2. IEEE 524™ recommends that the maximum time for conductors sitting in the rollers (from initial installation until clipping) should never be more than 72 hours.

12 STRINGING PRECAUTIONS

12.1 Conductor reel placement

12.1.1 The conductor reel shall be positioned at a distance from the first structure equal to at least three times the structure height. For example, if the structure height is 100 feet (31 meters), the reel must be placed no less than 300 feet (92 meters) away before initiating conductor pulling.

12.1.2 If the 3 to 1 ratio cannot be achieved use a double or oversized block on the first structure from the tensioner. Please consult APAR engineering for input.

12.1.3 Prior to dead ending, it is critical that the grip/hoist and any grounds be placed as far out on the line as possible, preferably 10 feet (3 meters) or more.

12.1.4 If at any time during the installation process the ACSS conductor is bent at a sharp angle, and if this portion of the conductor is going to be put up under tension or non-tension, this section of conductor must be cut out and a full splice installed. Sharp angles can be avoided by proper sheave placement and attention to back tension and reel payout.

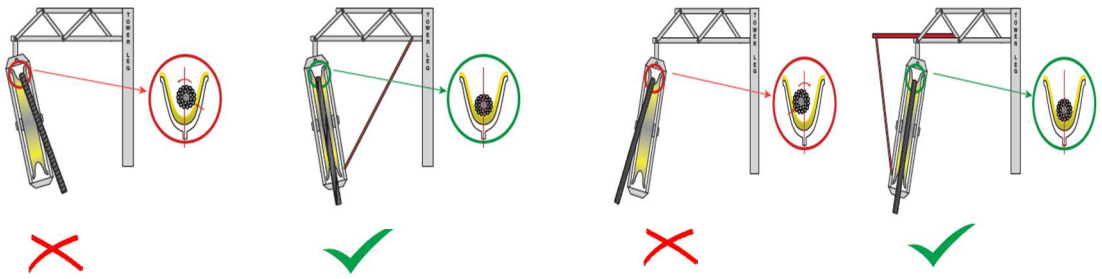
12.2 **Uplift or down pull on the conductor**

12.2.1 Where there is a severe uplift or down pull on the ACSS conductor at any structure or tower, it is critical to use double blocks, preferably 28 inches (712 millimeters) or larger for each block. This is measured to the inside of the sheave wheel and not the overall size of the block.

12.3. Angles larger than 30 degrees

12.3.1 At no time may the ACSS conductor be pulled or sagged to an angle greater than 30 degrees. If the angle is greater than 30 degrees, double or oversized blocks must be used to reduce the angle below 30 degrees. If the angle is too great for the double or oversized blocks to reduce the angle below 30 degrees, then the conductor shall be dead-ended at that structure.

12.3.2 When the conductor is pulled at an angle, the line tension causes it to move away from the center of the sheave and ride along the sides, inducing torsional rotation (clockwise or counterclockwise depending on the direction of displacement).
To prevent this, the sheave shall be properly supported and aligned to ensure the conductor remains centered in the groove. In case of tandem sheaves, all units shall be securely fastened together and supported in the same manner as a single sheave arrangement.



Supporting of Stringing Sheaves at Angles

Photo of Tandem as alternate solution

NOTE: *To prevent conductor rotation during payout or sheave passage, consider using an Anti-Rotational Device (ARD). The ARD employs weighted attachments to keep it vertical, halting cable rotation, facilitating easy travel of conductors over pulling blocks with the collapsible attachments.*

12.4. Armor rod

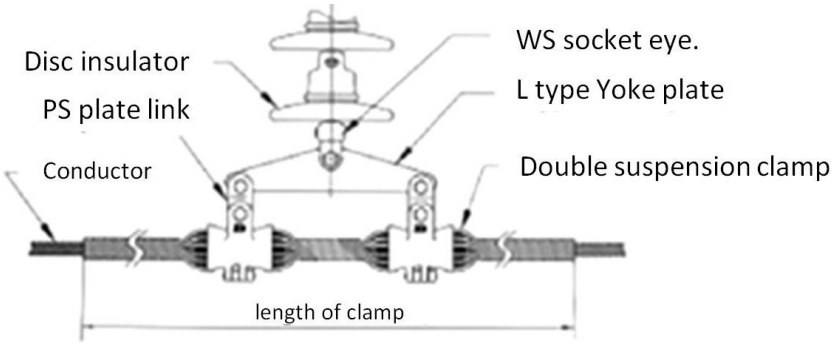
12.4.1 Many dampers utilize armor rods to provide added protection for ACSS. ACSS is suitable for bundling applications. When using dampers, cushioning inserts or line guards are recommended to protect ACSS conductor.

12.5. High temperature hardware

12.5.1. Hardware such as suspension clamps and dampers shall be designed for high temperature applications.

12.6. Double suspension clamps

12.6.1 When double blocks are required for angles less than 30 degrees and or for severe uplift or down pull, double suspension clamps shall be used in conjunction with a yoke plate or other method.



heliformed suspension clamp double clamp

12.7. Conductor grips

12.7.1. Conductor grips shall be Klein "Chicago" type grips. The grips shall be designed for the exact size of conductor installed.

Klein "Chicago" type grips

12.8. **Hoists**

12.8.1 Hoists used for dead-ending or lifting - The hoist shall be large enough to safely handle the conductor being installed.

12.9. **Safety grounds**

12.9.1 Grounds shall be sized to interrupt fault current that could be seen on the installed conductor. It is preferred that the inside of the ground clamp be smooth to ensure it does not damage the aluminum.

12.9.2 Ground clamps shall be placed on the outside of the grip dead-ending the conductor towards the next structure. This is to prevent any unnecessary bird caging.

13 DEAD-END AND SPLICE INSTALLATION:

APAR does not recommend, nor take responsibility, for the use of any conductor hardware. All dead-ends and splices must first be approved by the hardware manufacturer for use with ACSS conductor.

The compression hardware for ACSS is similar to the type used for ACSR. However, the ACSS hardware must be able to handle the higher current densities present in ACSS. ACSS hardware has more aluminium and has been tempered to handle the high operating temperatures.

All compression hardware for ACSS must be two-piece. Two-piece compression hardware has a steel sleeve or eye for the steel core and an aluminum sleeve for the conductor.

Bolted dead-ends, strain clamps, and automatic splices are not recommended.

Check with your hardware manufacturer for a recommendation on the use of these types of hardware on ACSS conductor.

Because of the high operating temperature of ACSS, corrosion inhibitors should be specified as suitable for high temperature use.

14 CONDUCTOR SAGGING

14.1 ACSS conductor is "sagged" the same as conventional ACSR (Aluminum Conductor Steel Reinforced).

14.2 Standard sight, return wave, transit and dynamometer methods are applicable for installing ACSS conductor.

15 LEGAL NOTICES

PLEASE READ THESE LEGAL NOTICES CAREFULLY.

Disclaimer: This guide provides suggestions for methods, equipment and tools that have been found practical based on field-testing. These guidelines are meant to provide procedures that will help provide a high quality, trouble-free installation so that the ACSS conductor once installed, will perform its intended function.
Failure to follow these guidelines may cause a hazardous condition or result in premature line failure.
The information contained herein or related hereto is intended for evaluation by technically skilled persons, with any use thereof to be at their independent discretion and risk. Such information is believed to be reliable, but the accuracy or completeness thereof is not guaranteed. The user assumes all risks and liability whatsoever in connection with such use.

This document is provided for guidance purposes only and shall not be considered a legally binding document.

WARNING: A potential for electrical shock exists when using cables energized with electrical power. Use appropriate safety procedures.

*** END ***