

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 ACCC® composite-core bare overhead conductor. This document is intended to provide an overview of the differences in installation techniques between the composite-core ACCC® conductor and conventional steel-core conductor, but is not intended to serve as a more intensive training manual or act as a substitute for required personnel skill sets or industry experience.

2. SCOPE

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

3. TRAINING

3.1. CTC strongly recommends that all line personnel, safety inspectors and construction crew attend a CTC sponsored training seminar prior to or in conjunction with the pre-construction 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, CTC 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 CTC Warrantee Program and could result in line failure. CTC Cable will provide training certificates to all personnel who attend the training session.

4. ASSOCIATED DOCUMENTS

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

5. DEFINITIONS

5.1. ACCC® is defined as Aluminum Conductor Composite Core. Stranded with Aluminum 1350-O annealed Trapezoidal Wire.

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, GAGES, FIXTURES

7.1. All equipment shall be maintained in accordance with applicable safety standards.
7.2. Only sheaves identified herein as correct for each conductor size shall be used.

8. SAFETY REQUIREMENTS

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

8.2. This 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 cable per OSHA Regulation 1910.269 and 1926.950 in the U.S. and similar requirements in other countries; 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 trap wire type conductors.

8.4. CONDUCTOR GROUNDS MUST BE PLACED DIRECTLY ON THE ALUMINUM STRANDS, AS THE COMPOSITE CORE IS ESSENTIALLY NON-CONDUCTIVE.

8.5. We at CTC are always committed to the health and safety of the people who produce and work with our composite core out in the field. Our MSDS makes accurate recommendations on how personnel should protect themselves from the dust that is created by cutting the composite. 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 core when installing the ACCC® conductor to minimize the irritation that could be caused by the dust resulting from cutting or sanding.

8.6. The composite core does not use nanotechnology. The carbon and glass fibers have diameters that range from 7 to 25 microns, and these fibers are imbedded in a thermoset resin. Nanotechnology, such as carbon nanotubes, or nanofillers, that have diameters in the nanometer range, are not used in the composite core. When cutting the composite during installation, the size of the dust particles will be governed by the cutting device used; a hand saw will generate relatively large dust particles compared to the diameters of the fibers that make up the core. Thus, no nano dust is created when cutting or sanding down the core. The dust that is created consists of carbon dust and glass fibers, that only if exposed to over a long period of time and in amounts that are hundreds of times more than the small amount of dust that is created by sanding or cutting can be detrimental, as excessive exposure to any dust is detrimental to an individual's health.

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. All reels will have, 36-inch (915 millimeters) diameter drum (D) or larger with 5.25-inch (134 millimeter) arbor hole for 90-inch (2286 millimeters) reels and 3.25-inch (83 millimeter) arbor holes for 74 inch (1880 millimeters) reels unless otherwise specified.

- 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. Returnable 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 braking 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 ACCC® 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 ACCC® conductor could be damaged if such devices are used.
- 9.6. Lift reel by approaching from the side and placing forks under flanges. The trapezoidal strands of the conductor are annealed, and are subject to damage.
- 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 or storage.
- 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 CORE ISN'T BROKEN

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 cardboard cover 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. Recommended storage temperature
 - 10.4.1.1. Maximum storage temperature +45°C
 - Minimum storage temperature -40°C

11. STRINGING CONDUCTOR

- 11.1. Conductor reels should be loaded into their payout cradles prior to the removal of lagging or protective wrapping. After the removal of the covering, all reels must be examined for nails or other sharp objects that may damage the conductor, 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 the core. 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. Tensioner bull wheels must be 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. 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.
- 11.6. 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.
- 11.7. The conductor must not be pulled across the ground or underlying structure (such as a fence) as that could damage the soft aluminum strands causing electrical discharge or corona when energized.

- 11.8. It is a good practice to retain the reel tags and document the section of line where the specific reels of conductor are used.
- 11.9. 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.
- 11.10. Should the conductor unintentionally come in contact with the ground, any dirt or debris build up should be cleaned off.
- 11.11. Always use Neoprene or Urethane lined dollies, sheaves, rollers, blocks, etc. as listed on Table 1 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 ACCC® conductor.

- 11.12. A “bug and washer” available from CTC shall be placed on the core before placing the conductor in the Kellum grip/pulling sock. Remove approximately 4 inches (102 millimeters) of aluminum from the end of the conductor. Wipe the core with a clean dry cloth and remove the shine from the core using the sanding medium enclosed in the dead end kits. After the “bug and washer” are attached, tape several layers to the strands of the cut ends approximately 3 inches (77 millimeters) to prevent spreading.
- 11.13. If back-to-back Kellums are used, the above procedure shall be utilized for the second Kellum grip.
- 11.14. Ensure that tape is placed on any rough edges on the outside of the Kellum 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 Kellum grip(s) pass through the sheaves.



- 11.15. **Never bend the conductor less than the recommended minimum bend diameter or damage could occur to the core (see Table 1).**

Table 1 - Sheave Sizes Required

ACCC® Conductor Code Name	ACCC® Conductor Diameter		ACCC® Core Diameter		Minimum Bend Diameter		First and Last Structure Sheave Diameter <u>Minimum Size</u>		Intermediate Structure Sheave Diameter <u>Minimum Size</u>		Sheaves Required for Change in Path Direction (Greater than 20 degrees)***	
	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm
Helsinki	0.616	15.65	0.235	5.97	13	330	20	508	20	508	20	508
Linnet	0.720	18.29	0.235	5.97	13	330	20	508	20	508	20	508
Copenhagen	0.720	18.29	0.235	5.97	13	330	20	508	20	508	20	508
Oriole	0.741	18.82	0.280	7.11	18	457	20	508	20	508	20	508
Reykjavik	0.741	18.82	0.280	7.11	18	457	20	508	20	508	20	508
Glasgow	0.769	19.53	0.305	7.75	21	534	22	560	20	508	22	560
Casablanca	0.807	20.50	0.280	7.11	18	457	20	508	20	508	20	508
Lisbon	0.857	21.78	0.280	7.11	18	457	20	508	20	508	20	508
Hawk	0.858	21.79	0.280	7.11	18	457	20	508	20	508	20	508
Oslo	0.882	22.40	0.345	8.76	27	686	28	710	22	560	28	710
Dove	0.927	23.55	0.305	7.75	21	534	22	560	20	508	22	560
Amsterdam	0.927	23.55	0.305	7.75	21	534	22	560	20	508	22	560
Grosbeak	0.990	25.15	0.320	8.13	23	584	28	710	20	508	28	710
Brussels	0.990	25.14	0.320	8.13	23	584	28	710	20	508	28	710
Stockholm	1.039	26.40	0.345	8.76	27	686	28	710	22	560	28	710
Warsaw	1.091	27.72	0.345	8.76	27	686	28	710	22	560	28	710
Drake	1.108	28.14	0.375	9.53	32	813	35	890	28	710	35	890
Dublin	1.108	28.15	0.375	9.53	32	813	35	890	28	710	35	890
Hamburg	1.127	28.62	0.345	8.76	27	686	28	710	22	560	28	710
Milan	1.146	29.10	0.345	8.76	27	686	28	710	22	560	28	710
Rome	1.177	29.89	0.375	9.53	32	813	35	890	28	710	35	890
Cardinal	1.196	30.38	0.345	8.76	27	686	28	710	22	560	28	710
Vienna	1.198	30.42	0.345	8.76	27	686	28	710	22	560	28	710
Budapest	1.240	31.50	0.375	9.53	32	813	35	890	28	710	35	890
Prague	1.251	31.77	0.345	8.76	27	686	28	710	22	560	28	710
Munich	1.293	32.85	0.375	9.53	32	813	35	890	28	710	35	890
London	1.315	33.40	0.385	9.78	34	864	35	890	28	710	35	890
Bittern	1.345	34.16	0.345	8.76	27	686	28	710	28	710	28	710
Paris	1.345	34.17	0.345	8.76	27	686	28	710	28	710	28	710
Antwerp	1.451	36.85	0.385	9.78	34	864	35	890	28	710	35	890
Lapwing	1.504	38.20	0.385	9.78	34	864	35	890	28	710	35	890
Berlin	1.504	38.20	0.415	10.54	40	1016	42	1067	42	1067	42	1067
Madrid	1.504	38.20	0.385	9.78	34	864	35	890	28	710	35	890
Chukar	1.602	40.69	0.395	10.03	36	915	42	1067	35	890	42	1067
Bluebird	1.762	44.75	0.415	10.54	40	1016	42	1067	42	1067	42	1067

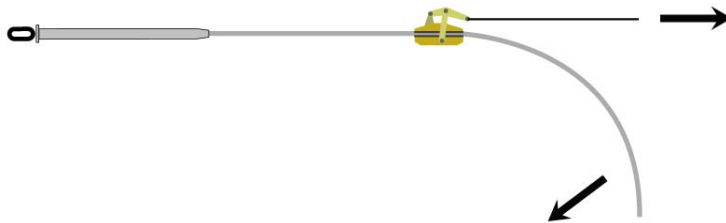
*** For changes in path direction greater than 30°, please consult CTC's engineering department. Multiple sheaves and yoke plates may be required.

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 incorrect conductor grips.



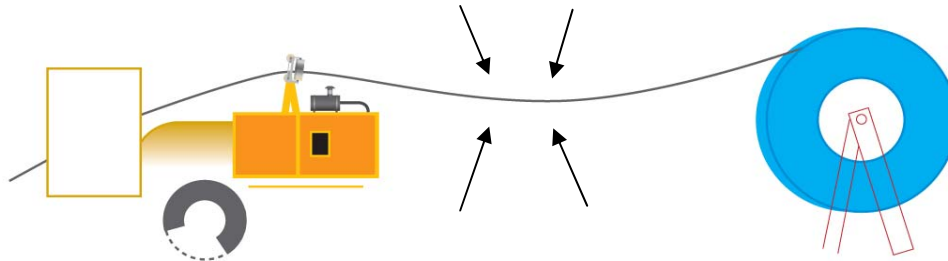
11.16.2. Incorrect conductor suspension after gripping.



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 birdgaging 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 they will be approximately one-half the groove spacing. For ACCC[®] 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.

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 nonspecular 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 ACCC[®] conductor. The conductor doesn't ride in the groove properly and will break the core.



Three to One Ratio Between Tensioner and First Structure

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.**

Note: There may be times when the 3 to 1 height to distance ratio can't be maintained. In this case, CTC 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 ACCC® conductor. Good radio contact must be maintained between the operators and lines people watching the conductor being pulled in.

11.18.1.Only multi-groove tensioners should be used. A minimum of four grooves should be used.



Sample pictures of multi-groove tensioners.

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 Kellum grips, also known as sock splices, basket grips, or wire mesh can be used to pull ACCC® conductor. The Kellum grips should be double banded at the end of the grip. The banding accomplishes two things:

1. The bands force the Kellum 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 Kellum 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 Kellum grip. There may be times when two reels of ACCC® can be successfully installed using two sets of back to back Kellum grips. CTC engineering will assist the installation crew in analyzing how many reels can be connected together for the pull.

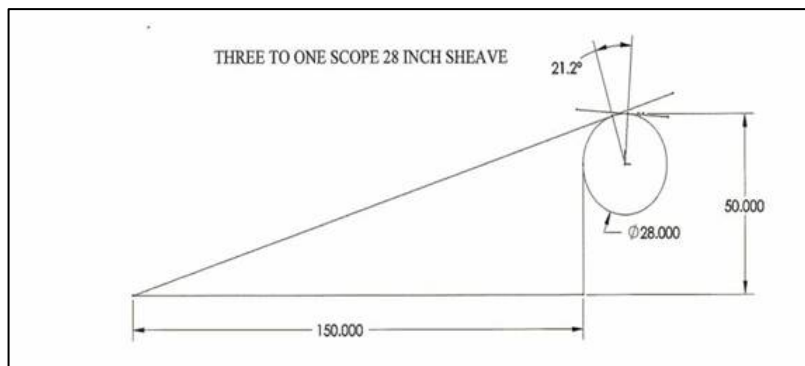
11.19.1. Swivels in good operating condition must be used at all times during pulling operations.

- 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 ACCC® 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.
 - 11.19.12.1. IEEE 524™ recommends that conductors be 'sagged' and 'clipped' in place within 24 – 48 hours of installation.
 - 11.19.12.2. 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 back from the first structure at least at a 3 to 1 ratio. If the structure is 100 feet (31 meters), the reel shall be back a minimum of 300 feet (92 meters) before starting to pull any conductor.



- 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 CTC 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 ACCC® 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. The sharp bend may have inadvertently damaged some of the fibers in the pultruded core material. 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 ACCC® 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 ACCC® 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.
- 12.4. Armor rod
- 12.4.1. Because the aluminum is annealed and therefore softer than the aluminum used in steel-core type conductors, it is critical to use high temperature armor rod. The armor rod used in conjunction with high temperature suspension clamps helps dissipate the heat at the insulator position and protects the annealed conductor strands.
- 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.



Picture of PLP suspension AGS system.

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.

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 annealed aluminum.

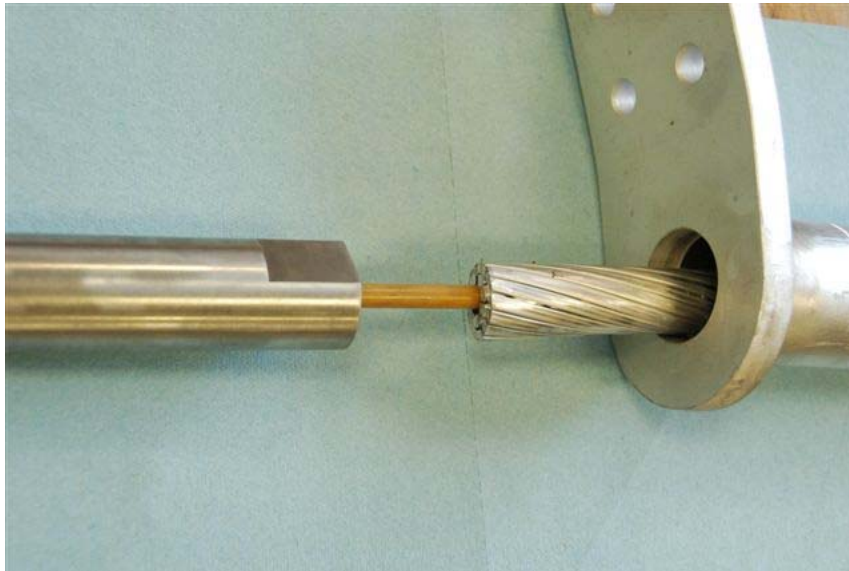
12.9.2. Ground clamps shall be placed on the outside of the grip dead-ending the conductor towards the next structure. This is to prevent any unnecessary birdcaging.

13. DEAD-END INSTALLATION INSTRUCTIONS

- 13.1. The ACCC® dead-end assembly kit includes the following: Threaded internal collet housing, collet assembly, threaded eyebolt or clevis, aluminum filler sleeve, outer aluminum housing compression sleeve, terminal pad, high temperature oxidation inhibitor, and sanding medium.
- 13.2. Remove prescribed amount of aluminum stranding from core. See Table 2 for amount of core to expose. This is best done with a pipe cutter to reduce the possibility of the core being nicked or damaged. **Ensure the core is not damaged when cutting the inner strands. This can be achieved by lightly scoring the strands then bending the inner strands back and forth to remove.**
- 13.3. The exposed end of the core needs to be cut very cleanly. This is best done with a hacksaw.
- 13.4. Wipe the core clean to remove any oils and/or debris. Lightly remove shine from the core with sanding medium provided in the kit.
- 13.5. Clean and remove any dirt or particles from the exposed core with a clean cloth.
- 13.6. Clean inside sleeve of any dirt or oil.
- 13.7. Slide the inner sleeve over the conductor with the tapered end facing the end of the conductor. Slide it down about 3 feet (1.0 meter).
- 13.8. Slide the outer sleeve over the conductor with the pad 2 feet (0.6 meters) from the cut end of the conductor.
- 13.9. Slide the collet housing, wrench flats toward the aluminum strands onto the core, and butt it against the aluminum strands.
- 13.10. Install the collet, narrow end towards the housing, onto the core leaving ¼ inch (6 millimeters) of the core exposed from the wide end of the collet.
- 13.11. Install the eyebolt or clevis and hand tighten before fully tightening with a wrench to 85 ft lbs (115 Newton meters) of torque.
- 13.12. **Thoroughly wire brush the aluminum strands and apply the high temperature oxidation inhibitor along the brushed length of the aluminum strands. Then use wire brush to penetrate the spaces between strands with the high temperature oxidation inhibitor.**
- 13.13. Slide the aluminum outer sleeve towards the eyebolt or clevis.
- 13.14. Liberally apply the high temperature oxidation inhibitor to the outer diameter of the aluminum inner sleeve and slide the inner sleeve into the outer sleeve all the way to the stop point.

NOTE: Inner sleeve will stick out approximately 1 to 1 ½ inches (25.4 to 38.1mm) from nose of outer tube.

- 13.15. Once assembled there will be a space between the collet housing and the aluminum conductor, see picture below and table 2 for reference.



13.16. Check with the enclosed installation instructions. The sleeves are back pressed once the inner and outer sleeve are in position with the prescribed eyebolt or clevis space exposed, see picture below:



13.17. Start back pressing inside the sleeve markings on the end furthest from the eyebolt or clevis, see picture below. (see Table 3 for compression die size)



13.18. Continue to press the outer sleeve, overlapping the crimps approximately 1/8 to 1/4 each press until you reach the next mark on the sleeve (approximately 8 to 14 presses, depending on the width of the die). The eyebolt or clevis shaft will be exposed. Move the press to inside the mark of the outer tube and press the outer sleeve until the rubber/felt washer is snug against the pad. See picture below.



13.19. It will require 1 to 3 overlapping presses until washer is snug. See picture below.



13.20. Use a file to remove any burrs or flashing that result from the crimping.

Table 2
Length of Exposed Core for Dead Ends and Splices

ACCC® Conductor Code Name	kcmil	mm ²	Dead End or Splice Side A Exposed core length (inch)	Dead End or Splice Side A Exposed core length (mm)	Splice Side B Exposed core length (inch)	Splice Side B Exposed core length (mm)
Helsinki	303	153.7	9.0	230	7.0	180
Linnet	431	218.4	9.0	230	7.0	180
Copenhagen	440	223.0	9.0	230	7.0	180
Oriole	438	221.9	9.0	230	7.0	180
Reykjavik	447	226.3	9.0	230	7.0	180
Glasgow	473	239.8	9.0	230	7.0	180
Casablanca	546	276.8	9.0	230	7.0	180
Hawk	611	309.6	9.0	230	7.0	180
Lisbon	629	318.7	9.0	230	7.0	180
Amsterdam	733	317.4	9.0	230	7.0	180
Dove	713	361.3	9.0	230	7.0	180
Brussels	839	425.3	9.0	230	7.0	180
Grosbeak	816	413.5	9.0	230	7.0	180
Oslo	627	317.7	12.5	315	10.5	267
Stockholm	913	462.7	12.5	315	10.5	267
Warsaw	1016	514.8	12.5	315	10.5	267
Drake	1020	516.8	12.5	315	10.5	267
Dublin	1043	528.5	12.5	315	10.5	267
Hamburg	1092	553.3	12.5	315	10.5	267
Milan	1134	574.6	12.5	315	10.5	267
Rome	1183	599.4	12.5	315	10.5	267
Cardinal	1222	619.2	12.5	315	10.5	267
Vienna	1255	635.9	12.5	315	10.5	267
Budapest	1332	674.9	12.5	315	10.5	267
Prague	1377	697.7	12.5	315	10.5	267
Munich	1461	740.3	12.5	315	10.5	267
London	1512	766.1	12.5	315	10.5	267
Bittern	1572	796.5	12.5	315	10.5	267
Paris	1620	820.9	12.5	315	10.5	267
Antwerp	1879	952.1	12.5	315	10.5	267
Lapwing	1965	995.7	12.5	315	10.5	267
Berlin	2004	1015.4	12.5	315	10.5	267
Madrid	2020	1023.5	12.5	315	10.5	267
Chukar	2242	1136.0	12.5	315	10.5	267
Bluebird	2726	1381.5	12.5	315	10.5	267

Table 3
Compression Dies for Dead End & Splices

ACCC® Conductor Code Name	CTC Dead End Part No.	CTC Splice Part No.	Dia. of Outer Sleeve (inch)	Dia. of Outer Sleeve (mm)	Burndy Die Part No.	Alternate 60 ton Die Part No.
Linnet	5600-1020	5600-2020	1.97	50	L727W	30AH-60
Copenhagen	5600-1022	5600-2022	1.97	50	L727W	30AH-60
Helsinki	5600-1024	5600-2024	1.97	50	L727W	30AH-60
Oslo	5600-1026	5600-2026	2.5	63.5	L735W	40AH-60
Casablanca	5600-1028	5600-2028	1.97	50	L727W	30AH-60
Hawk	5600-1030	5600-2030	1.97	50	L727W	30AH-60
Lisbon	5600-1032	5600-2032	1.97	50	L727W	30AH-60
Oriole	5600-1034	5600-2034	1.97	50	L727W	30AH-60
Reykjavik	5600-1036	5600-2036	1.97	50	L727W	30AH-60
Dove	5600-1040	5600-2040	1.97	50	L727W	30AH-60
Amsterdam	5600-1042	5600-2042	1.97	50	L727W	30AH-60
Glasgow	5600-1044	5600-2044	1.97	50	L727W	30AH-60
Grosbeak	5600-1050	5600-2050	1.97	50	L727W	30AH-60
Brussels	5600-1052	5600-2052	2.5	63.5	L735W	40AH-60
Stockholm	5600-1054	5600-2054	2.5	63.5	L735W	40AH-60
Warsaw	5600-1056	5600-2056	2.5	63.5	L735W	40AH-60
Hamburg	5600-1058	5600-2058	2.5	63.5	L735W	40AH-60
Drake	5600-1060	5600-2060	2.5	63.5	L735W	40AH-60
Dublin	5600-1062	5600-2062	2.5	63.5	L735W	40AH-60
Milan	5600-1064	5600-2064	2.5	63.5	L735W	40AH-60
Rome	5600-1066	5600-2066	2.5	63.5	L735W	40AH-60
Cardinal	5600-1070	5600-2070	2.5	63.5	L735W	40AH-60
Vienna	5600-1072	5600-2072	2.5	63.5	L735W	40AH-60
Budapest	5600-1074	5600-2074	2.5	63.5	L735W	40AH-60
Prague	5600-1076	5600-2076	2.5	63.5	L735W	40AH-60
Munich	5600-1078	5600-2078	2.5	63.5	L735W	40AH-60
London	5600-1079	5600-2079	2.5	63.5	L735W	40AH-60
Bittern	5600-1080	5600-2080	2.5	63.5	L735W	40AH-60
Paris	5600-1082	5600-2082	2.5	63.5	L735W	40AH-60
Antwerp	5600-1088	5600-2088	TBD	TBD	TBD	TBD
Lapwing	5600-1090	5600-2090	TBD	TBD	TBD	TBD
Madrid	5600-1092	5600-2092	TBD	TBD	TBD	TBD
Berlin	5600-1094	5600-2094	TBD	TBD	TBD	TBD
Chukar	5600-1100	5600-2100	TBD	TBD	TBD	TBD
Bluebird	5600-1110	5600-2110	TBD	TBD	TBD	TBD

Note: Installation Tooling 60 Ton Hydraulic Press (Not included)

Table 4
Compression Dies for Terminal Pads (Non-Cast & Cast)

ACCC® Conductor Code Name	Terminal Pad Non Cast (Rated for 20% RTS)					Terminal Pad Cast (Rated for 5% RTS)				
	CTC Part No.	Dia. of Terminal Pad (inch) (mm)		Burndy Die Part No.	Alternate 60 ton Die Part No.	CTC Part No.	Dia. of Terminal Pad (inch) (mm)		Burndy Die Part No.	Alternate 60 ton Die Part No.
Linnét	-	-	-	-	-	600-153-1	1.19	30.2	L717W	76AH-60
Copenhagen	600-253-1	1.80	45.7	L725W	27AH-60	600-153-1	1.19	30.2	L717W	76AH-60
Helsinki	600-253-2	1.80	45.7	L725W	27AH-60	-	-	-	-	-
Oslo	600-253-4	1.80	45.7	L725W	27AH-60	-	-	-	-	-
Casablanca	600-253-1	1.80	45.7	L725W	27AH-60	-	-	-	-	-
Hawk	-	-	-	-	-	600-153-3	1.41	35.8	L720W	24AH-60
Lisbon	600-253-4	1.80	45.7	L725W	27AH-60	600-153-3	1.41	35.8	L720W	24AH-60
Oriole	-	-	-	-	-	600-153-1	1.41	35.8	L720W	24AH-60
Reykjavik	600-253-1	1.80	45.7	L725W	27AH-60	600-153-1	1.41	35.8	L720W	24AH-60
Dove	-	-	-	-	-	600-153-5	1.50	38.1	L722W	24AH-60
Amsterdam	600-253-4	1.80	45.7	L725W	27AH-60	600-153-5	1.50	38.1	L722W	24AH-60
Glasgow	600-253-1	1.80	45.7	L725W	27AH-60	-	-	-	-	-
Grosbeak	-	-	-	-	-	600-153-7	1.61	40.9	L724W	27AH-60
Brussels	600-253-3	1.80	45.7	L725W	27AH-60	600-153-7	1.61	40.9	L724W	27AH-60
Stockholm	600-253-5	1.80	45.7	L725W	27AH-60	-	-	-	-	-
Warsaw	600-253-5	1.80	45.7	L725W	27AH-60	-	-	-	-	-
Hamburg	600-253-6	1.97	50.0	L727W	30AH-60	-	-	-	-	-
Drake	600-253-5	1.80	45.7	L725W	27AH-60	-	-	-	-	-
Dublin	600-253-5	1.80	45.7	L725W	27AH-60	-	-	-	-	-
Milan	600-253-6	1.97	50.0	L727W	30AH-60	-	-	-	-	-
Rome	600-253-6	1.97	50.0	L727W	30AH-60	-	-	-	-	-
Cardinal	600-253-7	1.97	50.0	L727W	30AH-60	-	-	-	-	-
Vienna	600-253-7	1.97	50.0	L727W	30AH-60	-	-	-	-	-
Budapest	600-253-7	1.97	50.0	L727W	30AH-60	-	-	-	-	-
Prague	600-253-7	1.97	50.0	L727W	30AH-60	-	-	-	-	-
Munich	600-253-9	1.97	50.0	L727W	30AH-60	-	-	-	-	-
London	600-253-11	2.25	57.2	L728W	-	-	-	-	-	-
Bittern	600-253-11	2.25	57.2	L728W	-	-	-	-	-	-
Paris	600-253-11	2.25	57.2	L728W	-	-	-	-	-	-
Antwerp	600-353-1	TBD	TBD	TBD	TBD	-	-	-	-	-
Lapwing	600-353-1	TBD	TBD	TBD	TBD	-	-	-	-	-
Madrid	600-353-1	TBD	TBD	TBD	TBD	-	-	-	-	-
Berlin	600-353-1	TBD	TBD	TBD	TBD	-	-	-	-	-
Chukar	600-353-3	TBD	TBD	TBD	TBD	-	-	-	-	-
Bluebird	600-353-5	TBD	TBD	TBD	TBD	-	-	-	-	-

Note: Installation Tooling 60 Ton Hydraulic Press (Not included)

14. SPLICE INSTALLATION INSTRUCTIONS

- 14.1. The ACCC® splice assembly kit includes the following: Two threaded internal collet housings, two collets, splice coupling, collet retainer, two aluminum inner sleeves, outer aluminum sleeve, high temperature oxidation inhibitor and sanding medium.
- 14.2. With the tapered end of the inner sleeves facing the end of the conductor, slide the inner sleeves down the conductor about 3.5 feet (1 meter). See Figure 1

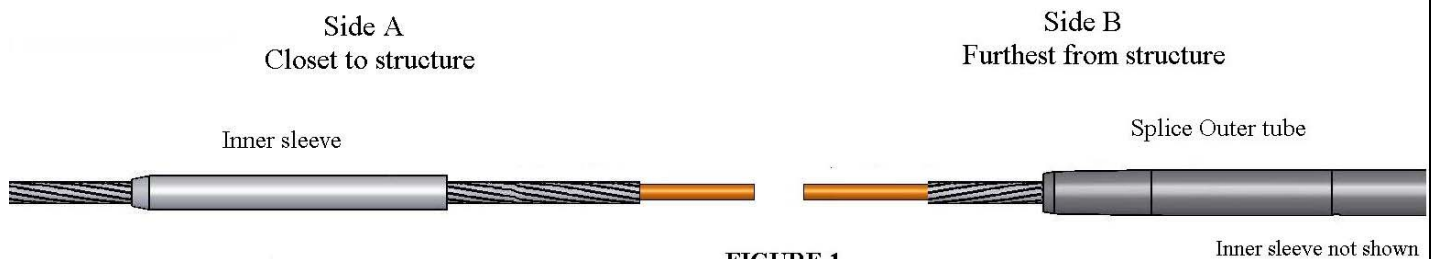


FIGURE 1

- 14.3. Slide the outer sleeve over the side furthest from the structure (Side B) with the end of the tube about 2 feet (0.6 meters) from the cut end of the conductor. See Figure 1
- 14.4. Tape the aluminum strands according to the set distance for the conductor end. See Table 2.
- 14.5. Expose the solid core by cutting aluminum strands at the mark one layer at a time.
- 14.6. **CAUTION:** Do not cut or nick the core. Ensure that the core end is uncrushed; if necessary square off with a hacksaw. Failure to follow these instructions could result in a poor connection
- 14.7. Wipe outer surface of the core clean and free from oil. Then rub the core lightly with 220 mesh sanding paper until it becomes white and re-wipe the core with a clean cloth.
- 14.8. Slide the collet housing with the wrench flats toward the aluminum strands onto the core and butt it against the aluminum strands. See Figure 2

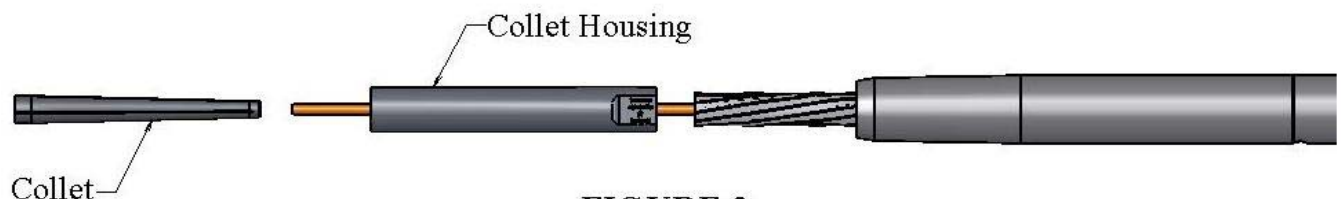


FIGURE 2

- 14.9. Install the collet with the narrow end towards the housing onto the core, leaving ¼ inch (6 millimeters) of the core exposed from the wide end of the collet. Repeat for the opposite side. See Figure 3.

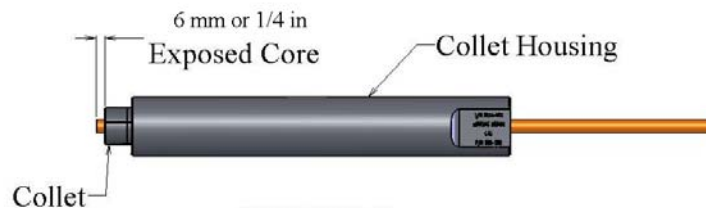


FIGURE 3

- 14.10. Install the coupling on side A (closest to the structure) and the collet retainer on the opposite side B (furthest from structure) and tighten by hand; complete the tightening with wrenches to 85 ft lbs of torque (115 Nm).

- 14.11. Ensure that approximately 3 inch (76 millimeters) is exposed on side A and approximately 1 inch (26 millimeters) is exposed on side B measuring from the conductor to the nose of collet.

- 14.12. Bring the two sides together and hand tighten. Complete tightening with the wrenches to 85 ft lbs of torque (115 Nm). See Figure 4

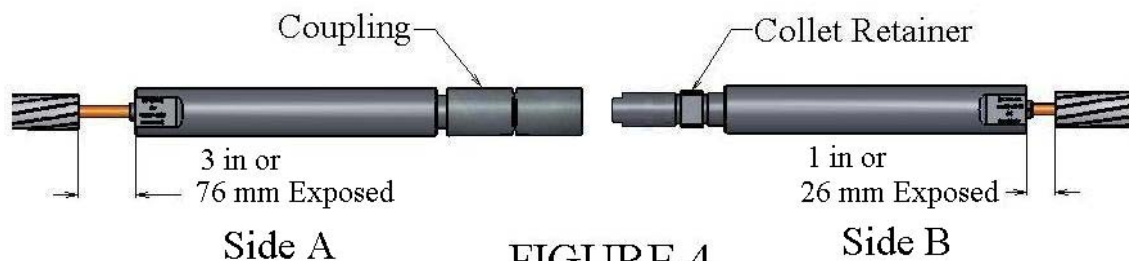


FIGURE 4

- 14.13. Mark the conductor, on side A, 17 inches (432 mm) from the end of the aluminum strands using a felt tip marker. This mark will be the location of the inner sleeve nose end. (See Figure 5).



FIGURE 5

- 14.14. **Thoroughly wire brush the aluminum strands and apply the high temperature oxidation inhibitor along the brushed length of the aluminum strands. Then use wire brush to penetrate the spaces between strands with the high temperature oxidation inhibitor.**
- 14.15. Slide the outer sleeve over the coupling assembly.
- 14.16. Side A – Apply oxidation inhibitor to the outer diameter of the inner sleeve, slide the inner sleeve, nose end, into the outer sleeve up to the 17 inch (432 mm) marked spot on the conductor. Make sure the outer tube bump is up against the inner sleeve. Move outer sleeve as necessary.
- 14.17. Once the outer sleeve is in place, crimp/compress the outer sleeve beginning from side A, starting crimp point, in an inwards direction using the correct die size and overlapping the crimps approximately ¼ in (6.0 mm) to the end of the crimp zone on side A. (See fig. 6)
- 14.18. Crimp the center of the outer tube to the coupling assembly with one crimp. (See fig. 6.)
- 14.19. Side B – Apply oxidation inhibitor to the outer diameter of the inner sleeve; slide the inner sleeve into the outer sleeve. Make sure the outer tube bump is up against the inner sleeve. (See fig. 6)
- 14.20. Crimp side B beginning from inside mark (compressing outwards) up until the ending crimp point. Ensure that the inner sleeve is up against the bump of the outer tube before making the first crimp. Overlap crimps approximately ¼ in (6.0 mm) to the end marks of the crimp zone. (See figure 6.)

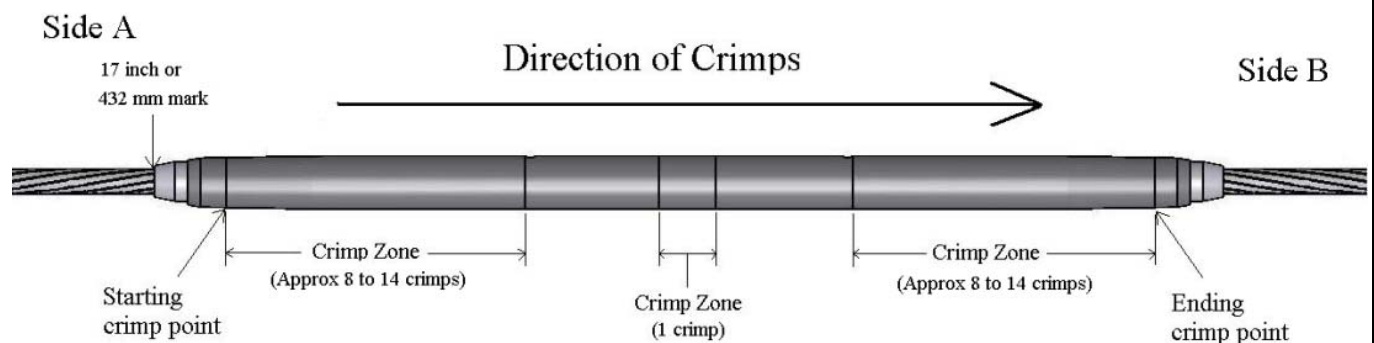


FIGURE 6

15. TERMINAL PAD INSTALLATION INSTRUCTIONS

- 15.1. To reduce the potential of birdcaging in the aluminum strands between the two bolted terminal pad fitting ends, both ends of the terminal pad connector are “back pressed”. Terminal pad connections are designed only for non-tension applications and must never be put under a mechanical tension load.
- 15.2. The ends of the ACCC[®] conductor are cut flush with the core left in place.
- 15.3. Thoroughly wire brush the top layer of aluminum strands. Apply a coating of the high temperature oxide inhibitor. Brush the inhibitor to allow it to penetrate the spaces between the strands.
- 15.4. For the first end of the terminal pad, slide the conductor into the barrel of the terminal pad.
- 15.5. Crimp using a 60-ton press with the prescribed die size (see table 2). The crimps need to overlap in the area marked on the aluminum terminal pad.
- 15.6. For the second end of the terminal pad, slide the conductor into the barrel of the terminal pad, and using a marker pen, mark the conductor where it sticks out of the fitting. Pull the conductor back 1 inch (25.4 millimeters). Crimp using the “back pressing” technique with a 60-ton press with the prescribed die size (see table 2). The crimp needs to overlap in the area marked on the aluminum terminal pad. The crimps start at the conductor end and go towards the four-bolt pad. This technique is known as “back-pressing”.
- 15.7. When the fitting is pressed backwards, a situation can develop where too much of the high temperature oxide inhibitor inside the fitting can hydraulically force open the end plate end of the terminal pad. To prevent this from happening there is a predrilled hole at the bottom of the compression tube. This is to allow excess inhibitor to bleed out. After the terminal pad is pressed on, fill the hole using the special aluminum plug that comes with the terminal pad (or use a small piece of the aluminum strand from the conductor). Then push the plug or strand into the drilled hole hammering flat.
- 15.8. Use a file to remove any burr or flashing that result from crimping.

Connector Notes:

Compression fittings are used for dead-ends and splices. (See ACCC[®] conductor Dead end and Splice Installation Instructions.) Because the aluminum strands are annealed TW, installation of compression dead-ends or splices may cause conductor distortion and minor birdcaging. These can often be repaired satisfactorily by reshaping with a small wooden block or a piece of rubber hose. Installation techniques can also be modified to minimize the potential for birdcaging to form. It is suggested that the location of any grips (20' hoists) and/or grounding clamps be safely attached as far downstream from the end of the dead-end as possible in order to allow for maximum travel of the extruded trapezoidal aluminum strands. **FAILURE TO FOLLOW THESE INSTRUCTIONS COULD RESULT IN A POOR CONNECTION.**

16. ANCILLARY HARDWARE

- 16.1. For assistance with appropriate ancillary hardware selection, such as dampers, suspension clamps, and armor-rod, please contact CTC's engineering department or your preferred hardware supplier.
- 16.2. Because the ACCC[®] conductor is made with annealed 1350-O aluminum, armor rod is required for all applications except where the suspension manufacturer has equipment that can be installed without armor rod such as the CGS suspension system maybe used under the correct set of circumstances. If ACCC[®] is being used for high temperature applications, it is mandatory that high temperature fittings be used. The AGS system that is pictured can reduce the temperature at the insulator by 125° C. The armor rod is an integral part of the heat reduction hardware.



17. CONDUCTOR SAGGING

- 17.1. ACCC[®] conductor is "sagged" the same as conventional ACSR (Aluminum Conductor Steel Reinforced).
- 17.2. Standard sight, return wave, transit and dynamometer methods are applicable for installing ACCC[®] conductor.

18. 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 of CTC Brand ACCC® cable and accessories. ACCC® conductor requires some specific shipping, handling, storage and installation procedures. Unlike traditional ACSR cables that have a steel core, ACCC® conductor consists of a composite core strength member surrounded by one or more layers of conductor. Due to the structure of the ACCC® conductor, the ACCC® conductor cannot be handled in accordance with some of the techniques used to install other overhead transmission line conductors. These guidelines are meant to provide procedures that will help provide a high quality, trouble-free installation so that the ACCC® 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.

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

COMPOSITE TECHNOLOGY CORPORATION SHALL NOT BE LIABLE TO THE USER OR ANY OTHER PERSON UNDER ANY LEGAL THEORY, INCLUDING BUT NOT LIMITED TO NEGLIGENCE OR STRICT LIABILITY, FOR ANY INJURY OR FOR ANY DIRECT, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES SUSTAINED OR INCURRED BY REASON OF THE USE OF ANY OF COMPOSITE TECHNOLOGY CORPORATION'S PRODUCTS.

Trademarks and Copyrights

©2008 by Composite Technology Corporation. All rights reserved. CTC and ACCC® are trademarks of Composite Technology Corporation. Any use of Composite Technology Corporation's copyrights or trademarks require written approval from Composite Technology Corporation. Such permission may be obtained from Composite Technology Corporation's headquarters in Irvine, California.

Additional Information

Composite Technology Corporation reserves the right to make changes in specifications or other information contained in this document without prior notice. Composite Technology Corporation is not responsible for typographical errors contained herein.

REVISION HISTORY

REV.	SECTION	SUB-SEC.	PARA.	CHANGE REQUEST #	DATE	AUTHORIZED BY
H	13.0			Updated Dead End installation instructions.	5/27/08	J Tate
I	11.0	11.14		Updated photo with new "bug".	8/20/08	D Pilling
	15.0	15.5		Removed "The direction of the crimping must always start at the four-bolt connector end of the fitting and crimp out towards the exposed conductor."		
		15.6		Changed "Crimp using a 60-ton press with the prescribed die size (see table 2)" to "Crimp using the "back pressing" technique with a 60-ton press with the prescribed die size (see table 2)".		
		15.7		Changed "To prevent this from happening drill a 9/32" (7mm) hole at the bottom of the compression tube" to "To prevent this from happening there is a predrilled hole at the bottom of the compression tube".		
J	8.0	8.4		Added section 8.4	3/16/09	D Pilling
		8.5		Added section 8.5		
	13.0	13.14		Removed "Wire brush and apply oxidation inhibitor to sleeve."		
		13.16		Removed "Prepare core in accordance to table 2."		
		13.17		Added "(see Table 3 or Table 4 for compression die size)"		
		13.18		Changed "Continue overlap pressing inside the next mark on the sleeve (roughly 10 to 14 presses) at that point less eyebolt shaft will be exposed, move the press to inside the marks near the eyebolt, see picture below" to "Continue to press the outer sleeve, overlapping the crimps approximately 1/8 to 1/4 each press until you reach the next mark on the sleeve (approximately 8 to 14 presses). The eyebolt or clevis shaft will be exposed. Move the press to inside the mark of the outer tube and press the outer		

				sleeve until the rubber/felt washer is snug against the pad. See picture below".		
		13.19		Changed from "Make 2 to 3 overlap presses or until eyebolt washer is snug, see picture below" to "It will require 1 to 3 overlapping presses until washer is snug. See picture below".		
		Table 2		Updated table to included new conductor sizes.		
		Table 3		Separated Table 2 into three tables.		
	14.0			Updated whole section.		
K	Title			Updated logo.	12/4/09	J Tate
				Changed ACCC to ACCC™ throughout document.		
	11.0	Table 1		Updated table to included conductor sizes in one table.		
	13.0	Table 3		Combined Table 3 & 4 into Table 3.		
L	3.0	3.1		Changed "linemen" to line personnel". Removed the word "premature" in second to last sentence.	3/4/10	J Tate D Ayres D Pilling
	8.0	8.2		Added section 8.2 and renumbered to 8.6.		
	10.0	10.1		Added "It is recommended that steel reels be used for storage of backup conductor.		
	11.0	11.1		Added "...or correctly sized collars shall be used to maintain control of the reel.		
		11.12		Added "...several layers to..."		
		11.14		Changed picture of bug to new style of bug being used.		
		11.15		Added "...or damage could occur to the core." Removed "During handling and installation, the radius of curvature for any bend made in the conductor must never be less than listed in Table 1.		
		Table 1		Removed Bern. Added Oriole. Changed Falcon to Berlin. Updated table sheave diameters to a minimum of 20" or 508 mm.		
		11.16		Added section 11.16 to 11.16.4. Renumbered subsequent sections.		
		11.17		Renumbered from 11.16 to 11.17.		
			11.17.1	Added "Anything smaller than the 0.5 times the conductor....		

		11.17.5	Changed picture.		
	11.18	11.18.1	Added "...A minimum of four grooves should be used." & pictures.		
		11.17.2	Removed section.		
	11.19		Added picture & updated formatting for section 11.19		
		11.19.2	Changed "Pocketbook" to "Klein", removed and/or Klein, added "or an approved equal grip".		
	12.0		Changed formatting numbers.		
		12.1.3	Changed from "...preferably 20 feet (6 meters) or more to prevent birdcaging" to "preferably 10 feet (3 meters) or more.		
		12.6.1	Changed picture and added picture title.		
		12.7.1	Removed "or" and "Pocketbook grips designed for the size of the conductor may also be used."		
		12.7.2	Removed section.		
		12.8.1	Changed "conductor" to "hoist",		
		12.9.1	Added "It is preferred that the inside of the ground clamp be smooth to ensure it does not damage the annealed aluminum."		
	13.0	13.14	Added "NOTE: Inner sleeve will stick out approximately 1 to 1 ½ inches (25.4 to 38.1mm) from nose of outer tube."		
		13.20 Table 2	Updated Table 2. Removed Bern, added Oriole, renamed Falcon to Berlin & updated kcmil and mm².		
		Table 3	Replaced table.		
		Table 4	Added table for Compression Dies for Terminal Pads (Non-Cast & Cast).		
	16.0	16.2	Changed "suggested" with "required". Added "...maybe used under the correct set of circumstances."		