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I. Introduction

The purpose of the ACCC® Conductor Installation Guidelines is to provide experienced personnel with guidelines, recommendations, and requirements necessary to successfully install the bare overhead composite-core ACCC Conductor and Accessories. This document is an overview and guideline covering what to do but not necessarily how to do it. It 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.

Safety practices applicable to other conductors are identical for ACCC Conductor installations.

ACCC Conductor is installed using industry standard installation equipment, methods, and standards such as IEEE-524, National Grid Linesmen's Manual M1 (UK), and others. Many regulatory and utility standards exist world-wide, and applicable standards must be observed.

These standards apply equally to ACCC Conductor with a very few but very important exceptions. These guidelines cover those exceptions.

II. Scope

These guidelines are for use where conductors are suspended below insulator strings at tangent structures, typical for transmission level voltages. For lower voltage applications, where conductors are mounted above or alongside insulators, see companion ACCC® Conductor Installation Guidelines for Distribution Applications, M181005-15. These guidelines apply to all sizes and types of ACCC® Conductors including ACCC® Ultra-Low Sag (ULS), ACCC® AZR™, and ACCC® InfoCore™.

III. Supporting Documentation

- Minimum Sheave and Tensioner Sizes Chart M181005-62 (Appendix A)
- Die Selection Chart M181005-64
- IEEE Std. 524-2016
- ACCC® Conductor Specifications F-750-315
- Tooling and Equipment List M181005-61

IV. Conductor Storage

ACCC Conductor may be stored indefinitely and there are no ambient temperature limits for storage. All-steel reels are recommended for storage greater than one year and required for storage exceeding 6 months if average humidity is greater than 80%. ACCC Conductor should never be submerged or allowed to remain wet during storage.

V. General Conductor Handling Guidelines

Never bend ACCC Conductor further than its minimum sheave working diameter.

To prevent damage, it is CRITICAL that the conductor never experiences sharp bends. The minimum bending diameter for each conductor is found in the Minimum Sheave and Tensioner Sizes Chart.

It is not always obvious that a particular handling practice may apply a bending force over a too-small radius and result in core damage. For instance:

1. Fairlead rollers
2. Undersized sheaves
3. Entry and exit points of grips and hardware
4. Poor brake operation on the payout reel, resulting in bouncing of the conductor on the tensioner fairlead rollers
5. Hoisting a section of conductor or placing a force on the conductor using a hook, chain, rope, or narrow sling
6. Dropping the conductor on, or pulling it over trees, obstacles, structures or edges
7. The conductor itself if looseness on the payout reel results in a cross or a jam

VI. Training

CTC's ACCC® Installation Training course is included for all crews inexperienced with the installation of ACCC Conductor. Linemen, operators, groundmen and supervisors should attend the training which consists of classroom instruction, hands-on deadend and splice assembly instruction (for approved hardware), and then on-the-job training up to a total of 7 days. This training is most effective when presented immediately prior to the start of installation.

VII. Installation Planning

A. ACCC Hardware

Termination hardware (deadends and splices) and all auxiliary hardware which contacts ACCC Conductor must be approved for use by CTC Global. The current list of approved hardware, manufacturers, and part numbers may be found on the CTC Global website: https://www.ctcglobal.com/accc-hardware-suppliers-parts-database/

B. Manual Stringing

Either "slack" (conductor is pulled from stationary reel along the ground) or "layout" (conductor is deposited on the ground from moving reel) methods may be used. Braking of a moving reel to prevent overrun is required. When using manual methods, it is critical to prevent sharp bends in the conductor. It is also important to avoid damage to the surface of the soft aluminum (except ACCC® AZR™ Conductors). Ground rollers or temporary ground cover are recommended.

Hoisting ACCC Conductor from the ground into position must always be done with great care to avoid creating sharp angles in the conductor.

Pulling, laying out, lifting, carrying, or hoisting ACCC Conductor must always prevent sharp angles or over-bending the conductor.

C. Tensioned Stringing

Tensioned stringing, using pulling and tensioner equipment is the preferred method for installation of ACCC Conductor. Most of these guidelines assume that the tensioned stringing method is in use.

Core retainers must always be used for tensioned stringing on the free or leading end of the conductor.

D. Pulling Line (Pulling Conductor)

Hard line or pilot line is always recommended for pulling ACCC Conductor, especially for long pulls, long crossings, mountainous terrain or many line angles. Existing conductor may be used as a pulling bond providing it is in good condition. It is not recommended to pull ACCC Conductor directly using rope.

It is recommended to cut out and replace splices in existing conductor. Splices should be replaced with pulling socks and swivels. If splices are not removed, then pulling speed should be reduced whenever splices pass over sheaves. Splices should not be pulled over sheave angles of 30° or more.

ACCC splices are longer than conventional splices and are never allowed to be pulled over sheaves.

E. Long Pulls

ACCC Conductor reels may be pulled back-to-back for a variety of reasons including to avoid difficult setup areas. A maximum of 20 structures is recommended for long pulls. Contact your Regional Service Manager or fieldservice@ctcglobal.com for specific recommendations for very long pulls exceeding 20 structures.

F. Long Spans, Mountainous Terrain, Elevation Changes

Providing that bending limits and angles are respected, ACCC Conductor may be installed exactly as any other conductor in special applications. Due to its typically higher tension capability, ACCC Conductor may be strung or sagged at higher tensions when needed, up to 35% of rated tensile strength (RTS), assuming structure and equipment capability.

G. Bundled Pulling

It is recommended that all of the sub-conductors for bundled applications using ACCC Conductor be pulled in together using normal bundled pulling equipment, tools, and techniques.

If ACCC bundled sub-conductors are not pulled in together, the alternate sagging procedure must be used (see Section XI.B.2).

VIII. Tools and Equipment

CTC will produce a size-specific Required Tooling and Equipment checklist upon request. Send your request, with the desired ACCC Conductor size, to: Fieldservice@ctcglobal.com

A. Tensioner

Tensioner bull-wheels must be minimum diameter as specified in Minimum Sheave and Tensioner Sizes Chart M181005-62 (Appendix A).

Tilted bull wheel style tensioners are recommended for stringing ACCC Conductor. Offset style bullwheel style tensioners must be threaded left-to-right for right-hand lay conductors and right-to-left for left-hand lay conductors.

Tensioner bull-wheel groove surfaces must be hard enough to avoid torsional friction on the outer layer of strands which can lead to bird-caging on the bull-wheels.

B. Payout Reel Stand Brakes

Hydraulic brakes synchronized with and controlled by the tensioner are strongly preferred for ACCC Conductor installation. Properly maintained and operated disc brakes may be used.

C. Core Retainer (Bug)

ACCC Conductor is constructed with a smooth composite core surrounded by one or more layers of aluminum strands. A special fitting called a core retainer ("Bug") assures that the core and aluminum are kept the same length during tensioned stringing and that the core is accessible for termination at the end of the pull. The Bug is temporary, used only during handling and pulling/stringing and removed after the tension grips are installed.

Bugs are ACCC Conductor specific and supplied by CTC without charge. Bugs may be re-used. Do not reuse a Bug when the nut does not screw into the body easily or if the inside collet or outer collar are worn or damaged.

D. Pulling Socks

Pulling grips (socks) must have reinforcement at the eye end to protect the wires of the sock where they come in contact with the Bug.

E. Tension Grips

When preparing the conductor for termination (deadending) the tension grips (clamps) must temporarily hold the conductor and the ACCC Core.

Parallel-jaw ("Chicago") style grips or "wedge" style clamps are required; no other styles are allowed. Grip (or grip insert) diameters must be sized correctly for the conductor diameter, and the working surfaces free from damage or contamination.

Parallel-jaw type grips must be long jaw, rated for the loads as determined by the conductor size and the project pulling and sagging tensions. Jaw length must be 185mm (7.25 inch) or greater for conductors with 21.8mm (0.858 inch) outside diameter or smaller, and jaw length must be 270mm (10.75 inch) for larger conductors.

F. Sheaves and Blocks

Correct sheaves (pulleys, blocks, travelers) are a crucial element for successful installation of ACCC Conductor.

The working diameter (measured at the bottom of the groove) must meet or exceed the minimum diameter (Minimum Sheave and Tensioner Sizes Chart, Appendix A).

Tandem sheaves or 4-roller array blocks are recommended where conductor pulling angles exceed 30°.

Groove surfaces should be free of surface defects which will mark or mar the aluminum surface. Grooves may be nylon or lined with neoprene or urethane.

G. Hoist Hooks, Rigging

ACCC Conductor can be damaged by using a simple hook to handle the conductor.

Hoisting or side forces in a length of conductor must not create a conductor angle greater than 10°, and forces must be spread using wide hooks or nylon slings.

Slings should be spread to provide for wide contact with the conductor.

H. Hand Tools

1. Ratchet Cutter or Cable Cutter

Use for rough cuts only! Never use a ratchet cutter or cable cutter for final cut.

2. Hacksaw

Use a fine tooth (24 TPI or more) blade. In all cases, the final cut of ACCC Core must be made with a fine-tooth hacksaw

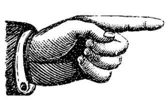
3. Cable Trimmer

Cable trimmers must be kept sharp and in good mechanical condition. Cable trimmers with (correctly selected) cut depth control bushings are preferred. A cable trimmer that cuts too deeply can nick or score the conductor core, which will result in failure.

4. Crescent Wrenches

Two (2) standard adjustable "crescent" wrenches approximately 380mm (15 inches) length will provide sufficient leverage to apply the necessary torque (120 Nm or 89 ft-lb) to threaded tooling and component threaded joints.

5. Presses and Dies



Hydraulic press motor and press head must be of sufficient capacity to completely close the dies.

Use of press dies sized and configured correctly for both the press and the hardware, is critical for successful termination hardware installation. Die Selection Chart M181005-64 is available for guidance, but the manufacturer's hardware drawing die call-out must be followed.

Locally manufactured dies may be used **<u>only</u>** when approved by the hardware manufacturer, and they must conform exactly to the manufacturing drawings. Certified dies from the hardware manufacturer are always strongly recommended.

6. Consumables

- Hacksaw Blades – Fine Tooth (24 TPI)
- Deadend Body and Splice Body Lubricant or Soap
- HT Penetrox™ or Alnox® Electrical Joint Compound or equivalent oxidation inhibitor MUST be high temperature (200° C) oxidation inhibitor. This is normally supplied by the hardware manufacturer.

IX. Equipment Set-Up

A. Tensioner Placement

The tensioner must normally be placed no closer than **three times** the attachment height of the highest conductor to be pulled.

B. Payout Reel Placement

Minimum 10 meters is required between the tensioner and payout reel to avoid loosening of the strands between tensioner and payout reel.

The payout reel must be aligned with the tensioner (or tensioner feed sheave) to avoid scrubbing of the conductor surface against the adjacent wrap of conductor or contact with the reel flange.

C. Tensioner Feed Sheave

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

The purpose of the tensioner feed sheave is to guide the conductor into the tensioner without causing deflection at the fairlead. The feed sheave should be positioned at any distance or position that achieves this purpose.

The tensioner feed sheave must be positioned in the plane of the conductor path and be located far enough from the payout reel that the conductor does not scrub on the sheave flanges at the maximum fleet angles during payout.

D. Sheave Alignment

All sheaves and sheave blocks must be supported and rigged in the plane of the conductor path.

Assure that ACCC Conductor always runs in the center of the sheave groove to avoid twisting, birdcage, and possible conductor damage. This is especially important for sheaves with softer groove linings like neoprene.

X. Stringing / Pulling

A. Load Payout Reel

All normal conductor reel and drum handling safety and procedures apply. Control the free end of the conductor when it is released from its shipping constraint.

> The residual energy of the coiled ACCC Conductor can cause the end to whip as it tends to straighten, which can cause personal injury and can damage the conductor.

B. Install Bug and Pulling Grip (sock)

Install the core retainer (Bug) and pulling grip (sock) on the leading end of the new ACCC Conductor before it is threaded through the tensioner. After the sock is in place, anchor the sock and tape the sock around the anchor and the Bug to assure that the Bug stays in the sock and to protect sheave surfaces. Otherwise, all normal requirements and procedures of working with sock grips apply.

C. Reeve the Tensioner

To avoid the conductor strands loosening as they pass over the tensioner bull-wheels, it is important to reeve (thread) the tensioner as follows:

- Right hand lay - left to right as facing the first tower
- Left hand lay - right to left as facing the first tower

D. Connect to Pulling Line

> Swivels must be used between <u>every</u> length (hard line, old conductor, and ACCC) when pulling ACCC Conductor.

Swivels should be checked for proper function under tension.

E. Payout Reel – Brake Operation

Payout reel brakes should apply only the minimum tension needed to prevent over-run during a speed change or stop. Excessive brake tension can cause distortion of the reel flanges and lead to permanent reel damage. It can also wedge conductor between underlying wraps, risking conductor damage. Where disc brakes are used for the payout reel it is important that a trained operator controls the brake throughout the duration of the pull. Good payout reel operation will avoid bouncing between the payout reel and tensioner and risk of damage to the conductor at the payout reel or tensioner fairlead.

F. Pulling Tension and Speed

Pulling (stringing) tension should be high enough to clear obstacles (approximately 10% of conductor rated tensile strength) and should never exceed sagging tension. The pulling speed for installing ACCC Conductor should not exceed 5 km/h. Low pulling speeds should also be avoided as they can cause significant insulator swinging.

G. Last Tower

Don’t pull through last sheave unless puller to structure distance ratio is 3:1 or more.

H. Rewinding

ACCC Conductor may be rewound, however, it is important that crossing of the conductor wraps on the reel and excessive looseness is avoided.

I. Weather

No special considerations exist for ACCC Conductor installation with respect to any other conductor installation, due to weather conditions.

J. Birdcage Discussion

Mild loosening and opening of the conductor strands, commonly called “birdcage” is not a failure, is difficult to avoid in some special situations, and can usually be corrected.

Birdcage is caused by a displacement of the aluminum strands which first appears as a loosening of the strands. In most cases, the loosening normally appears not at the source of the displacement, but where the strands are constrained near the source. If the nearest constraint is far enough away (about 10m in the case of ACCC Conductor), the strands have room to distribute the displacement and the loosening is not noticeable.

The first cause of displacement is the result of compression of the conductor, usually the normal compression of installation of a compression sleeve – deadends and splices and compression repair sleeves. These are usually avoided by making successive compressions away from the constraint, known as back-pressing.

A second cause of displacement is the result of normal tension applied with compression grips. As the conductor on the tension side of the grip stretches the conductor, the aluminum on the non-tension side is displaced. Another grip (“short-gripped”), a Bug, or a previously installed deadend or splice can act as the constraint in this case.

A third cause is displacement of the aluminum strands by “unwinding” which can occur if the conductor is not running in the bottom of sheave or tensioner grooves. This happens particularly at line angles when the sheave is not supported in the plane of the conductor path. Unwinding can also occur as a result of failure to use or maintain swivels.

Finally, a fourth cause occurs if there is keystone in any layer of the conductor. This may allow relative movement between the layers, effectively allowing displacement of the top layer. Keystone is normally a defect in the stranding of the conductor.

If loosening occurs, it often takes care of itself when the constraint is removed, allowing the displacement to re-distribute over a longer length of conductor and become unnoticeable.

The re-distribution can be assisted if necessary, by applying pulling force after the constraint has been removed. Tapping the conductor with a rubber hose can supply vibration which facilitates the re-distribution.

Never strike the conductor with wood or a hammer in an effort to address a birdcage condition. Never attempt to realign strands with a screwdriver or other tools.

Extreme birdcage, involving severe plastic deformation of the strands, cannot be corrected and must be replaced.

XI. Sagging

Sagging methods used for ACCC Conductor are identical to methods for any other bare conductor. Any of the four common methods of sagging may be used: 1) line of sight (sagging scope), 2) transit (theodolite), 3) stopwatch, or 4) dynamometer.

A. Sagging Grips

See section VIII.E Tension Grips

B. Pre-tensioning

In special cases, ACCC Conductor may be pre-tensioned. Please contact your conductor supplier or fieldservice@ctcglobal.com.

C. Termination, Deadend Assembly

Deadend (and splice) assembly and pressing instructions are always included and provided by ACCC Hardware manufacturing partners and ACCC® Installation Training.

The most common installation errors with ACCC Conductor are due to excessive bending loads at the tension grips or clamps during tension transfer or termination procedures. See section XIII.2.

The only unique element of ACCC® AZR Conductor installation, compared to other ACCC Conductors, is the installation of an extra sleeve during deadend assembly. Sleeves and instructions are included with deadend (and splice) hardware. A special tool is required to install the sleeve. These tools are ACCC Core specific and supplied by CTC without charge. The tools are re-useable.

D. Sagging Procedures

Tension grips should be placed a minimum of 4 meters (13 ft.) from the end of the insulator to provide working room to install the deadend hardware and avoid birdcage.

Install a split rubber hose over the conductor to protect the aluminum from the rigging. Use small ropes to fasten the free end of the conductor to the rigging.

The fully annealed aluminum used for ACCC Conductors (except ACCC® AZR™ Conductor) requires small but important modifications to sagging procedures. The annealed aluminum elongates under tension load (creeps) much more quickly than aluminum alloys found in conventional conductors. To allow for this higher creep rate, one of the two following sagging procedures must be followed:

1. Preferred Sagging Procedure

Step 1 Connect the soft side dead-end and apply at least 90% of initial sag chart tension, but DO NOT EXCEED initial sag chart tension.

Step 2 Allow the conductor to remain at this tension for at least 10 hours or overnight. If sagging must be completed the same day, then subtract 5° C (9° F) from the conductor temperature in the sagging chart.

Step 3 After 10 hours or after the temperature adjustment has been made, apply sag chart initial tension and install the hard side dead-end.

For bundled applications, sub-conductors must follow these steps within 15 minutes of one-another OR use the following Alternate Sagging Procedure.

2. Alternate Sagging Procedure

This optional, alternate procedure may be used for bundled applications when sub-conductors have not been pulled simultaneously or brought up to the target sag within 15 minutes of each other.

Step 1 Assemble and connect the soft-side dead-ends and apply AT LEAST 90% of initial sag chart tension to all sub-conductors, but DO NOT EXCEED initial sag chart tension.

Step 2 After the last conductor of the bundle has been pulled into position, allow ALL the sub-conductors in the bundle to remain at this 90% tension for AT LEAST 72 hours after initial sag chart tension has been applied to the LAST sub-conductor pulled. (See section XII.B for extended time in sheaves.)

Step 3 After a minimum of 72 hours re-apply sag chart initial tension, mark and install the hard side dead-ends.

Step 4 Make final adjustments to match sag of all sub-conductors using turnbuckles or sagging links.

XII. Auxiliary Hardware, Clipping, Spacers

A. Auxiliary Hardware

All fittings and auxiliary hardware in contact with ACCC Conductor while in service must be rated for ACCC temperatures and approved by CTC Global for use with ACCC. The current list of approved hardware, manufacturers, and part numbers may be found on the CTC Global website: https://www.ctcglobal.com/accc-hardware-suppliers-parts-database/

B. Clipping

IEEE 524 recommends the total time that conductors are allowed to remain in the stringing blocks, from installation until clipping, should not be more than 72 hours. If high winds are experienced while the conductor is in blocks or the 72 hour time limit is exceeded, the conductor should be inspected (especially where the conductor makes contact with the stringing blocks) for damage to determine if any of the strand wires were flattened or broken from winds buffeting the conductor while sitting in the blocks. There is also the potential that conductors sitting in the blocks under tension and without dampeners may be subjected to Aeolian vibration damage.

Conductor hose or tie-downs can help prevent conductor damage from wind.

C. Spacers

Small sag differences between sub-conductors in bundled applications can be visible and detract from the appearance of a good installation. Keep weight loads on sub-conductors even during the installation of spacers and follow spacer installation instructions exactly.

D. Spacer Carts

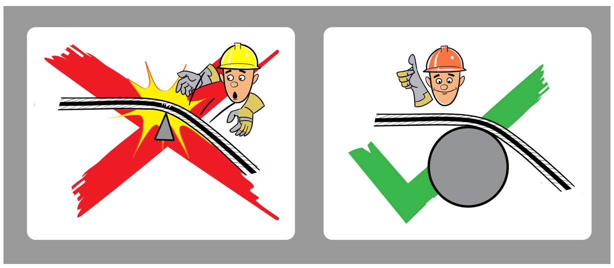
Devices supporting personnel (spacer carts or buggies, baker boards, ladders, or working platforms) must <u>never</u> create a conductor angle greater than 8° (6° for ULS) where the device touches the ACCC Conductor.

XIII. Do's and Don'ts

These are not the only don'ts. All of the don'ts that apply to installing any bare overhead conductor also apply! These five don'ts are specific to ACCC Conductor:

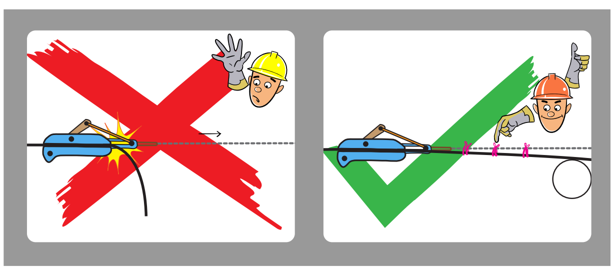
1. **DON'T OVER-BEND!**

   Don't allow the conductor to contact surfaces that present sharp angles or small diameters.

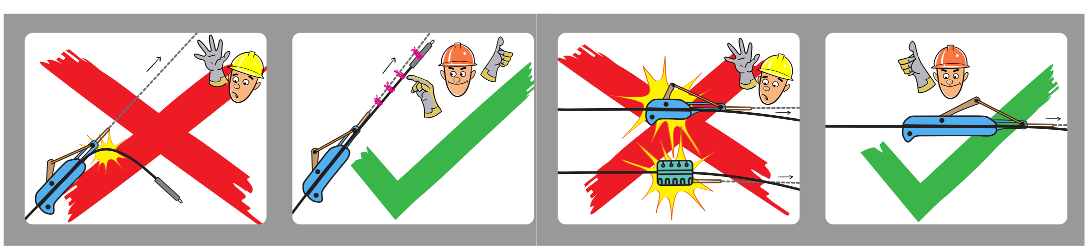


2. **Tension Grip DON'Ts:**

   Don't allow the conductor tail or the deadend to fall or droop unsupported while handling the conductor. If the tail is not controlled, it will damage the core at the back of the grip.

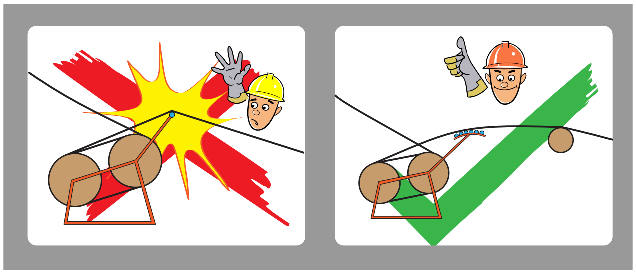


Don't allow the conductor tail or the deadend to fall or droop unsupported while handling the conductor. If the tail is not controlled, it will damage the core at the back of the grip. Don't use pocketbook grips or short-jaw parallel jaw grips.



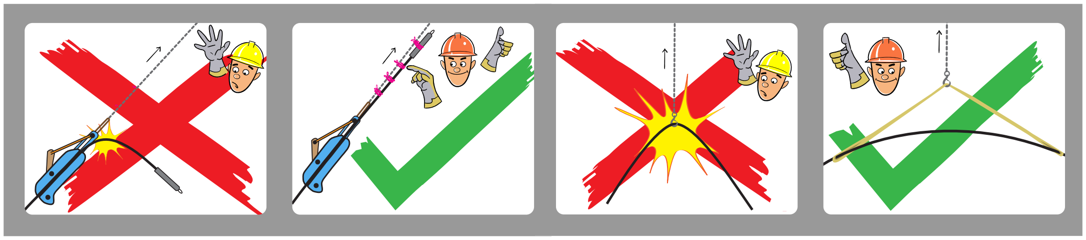
3. **Fairlead DON'T:**

   Don’t let ACCC Conductor run hard against any roller of the fairlead. Always use a tensioner feed sheave (meeting minimum sheave diameter requirements) between the payout reel and tensioner to guide the conductor into the middle of the tensioner fairlead opening.



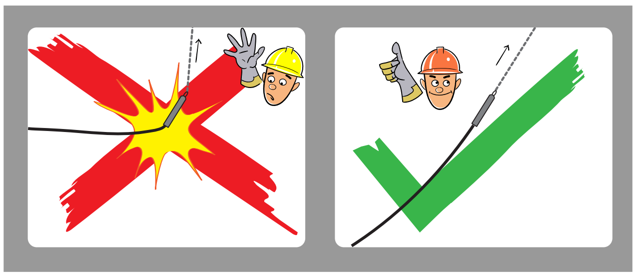
4. **Handling DON'T:**

   Don’t hoist or handle the conductor in any manner which causes a sharp bend in the conductor.



5. **Termination DON’T:**

   Don’t allow a sharp bend where the conductor exits the termination hardware. Hoisting conductor or deadend without paying attention to this area can damage the core at that point.



Appendix A – Minimum Bending Diameters

CTC GLOBAL

Minimum ACCC® Installation Working Diameters

M181005-62-A

ACCC® Conductors

ACCC® Core Diameter		International	ASTM	Minimum Sheave Working Diameter		Minimum Tensioner Bull Wheel Diameter	
millimeters	inches	Name	Name	millimeters	reference inches	millimeters	reference inches
5.97	0.235	Skadar Rijeka Silvassa, AZR Silvassa Helsinki Copenhagen Rovinj, AZR Rovinj Gdansk	Linnet Oceanside	511	20.1	1000	39.4
7.11	0.280	Zadar, AZR Zadar Reykjavik Casablanca Lisbon	Oriole Laredo Hawk	610	24	1200	48
7.75	0.305	Jaipur Glasgow Amsterdam Cordoba	Waco Dove	650	25.6		
8.13	0.320	Brussels	Grosbeak	710	28		
8.76	0.345	Oslo Stockholm Warsaw, AZR Warsaw Hamburg Milan Vienna Prague Paris	Irving Lubbock Galveston Plano Corpus Christi Cardinal El Paso Bittern	800	31.5		
9.53	0.375	Leipzig Calgary, AZR Calgary Dublin Kolkata Rome Budapest Mumbai Munich Dhaka	Amarillo Drake Arlington Fort Worth Beaumont			1500	60
9.78	0.385	London Antwerp Madrid	San Antonio Dallas Lapwing				
10.03	0.395		Chukar	1000	39		
10.54	0.415	Monte Carlo 25 mm Warwick Toronto, AZR Toronto Mahakam Bordeaux Berlin Athens	Curlew Houston Falcon Bluebird				

ACCC® ULS Conductors

ACCC® Core Diameter		International	ASTM	Minimum Sheave Working Diameter		Minimum Tensioner Bull Wheel Diameter	
millimeters	inches	Name	Name	millimeters	reference inches	millimeters	inches
8.76	0.345	ULS Oslo ULS Warsaw ULS Stockholm ULS Hamburg ULS Milan ULS Prague ULS Warsaw ULS Vienna ULS Paris	ULS Irving ULS Lubbock ULS Galveston ULS Plano ULS Corpus Christi ULS El Paso ULS Bittern ULS Cardinal	1020	40	1500	59
9.53	0.375	ULS Leipzig ULS Calgary, AZR ULS Calgary ULS Kolkata ULS Dublin ULS Rome ULS Budapest ULS Mumbai ULS Munich ULS Dhaka	ULS Drake ULS Arlington ULS Fort Worth ULS Amarillo ULS Beaumont	1200	48	1600	63
9.78	0.385	ULS London ULS Antwerp ULS Madrid	ULS Dallas ULS San Antonio ULS Lapwing				
10.03	0.395		ULS Chukar ULS Chukar II			1800	70.9
10.54	0.415	ULS Algiers ULS Mahakam ULS Monte Carlo ULS Ganga ULS Warwick ULS 25mm ULS Bordeaux ULS Toronto, AZR ULS Toronto ULS Berlin ULS Athens	ULS Curlew ULS Houston ULS Falcon ULS Bluebird	4-roller Pivoting Array Blocks Tesmec, Zeck, or equivalent			

Notes:

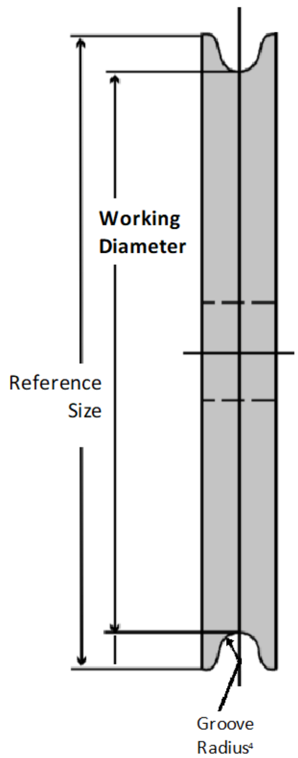
1) Diameters above are WORKING diameters, measured at bottom of groove, see page 2

Appendix A – Minimum Bending Diameters (continued)

CTC GLOBAL

Minimum ACCC® Installation Working Diameters

M181005-62-A



NOTES

1) Minimum Working Diameter is REQUIRED for first and last structure, and structures where stringing path is other than structure to structure (ex: where a splice is made on the ground and then let up).

2) Minimum Working Diameter is RECOMMENDED for tangent structures. Smaller tangent sheave sizes may be considered where conductor stringing angles are less than 10° and tension is less than 20% of conductor rated tensile strength (RTS).

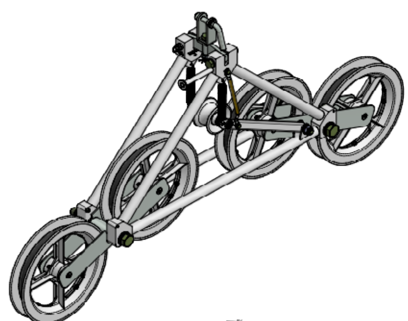
3) Tandem Minimum Working Diameter blocks are RECOMMENDED for conductor stringing angles of 30° or more.

4) ULS Conductors: Minimum Working Diameter is REQUIRED for all structures.

5) Groove Radius is REQUIRED minimum 0.55 times conductor diameter.

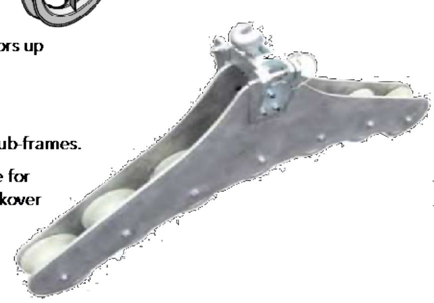
6) Smooth groove surface condition is REQUIRED. Neoprene, nylon, or urethane groove linings are RECOMMENDED.

7) All Sheave Blocks are REQUIRED to be rigged and pivot in the plane of the conductor path.



MULTIPLE ROLLER ARRAYS

1) 4-roller Arrays are ALLOWED substitute for Minimum Working Diameter for ACCC® Conductors:
   a) 52° conductor angle and up to 15% RTS
   b) 36° conductor angle and up to 20% RTS
   c) 32° conductor angle and up to 25% RTS
2) 4-roller Arrays are ALLOWED for ACCC® ULS conductors up
   a) 32° conductor angle and up to 15% RTS
   b) 28° conductor angle and up to 20% RTS
   c) 25° conductor angle and up to 25% RTS
3) 4-roller arrays are REQUIRED with pivoting 2-roller sub-frames.
4) Fixed Multiple Roller Arrays are ALLOWED substitute for Miniminum Working Diameter, up to maximum breakover (total) angle specified by manufacturer.
5) All roller Arrays are REQUIRED to be rigged and pivot in the plane of the conductor path.
6) All roller Arrays are REQUIRED to be rated for loads.



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