



# 3M

**477-kcmil, 3M Brand Composite Conductor  
Repair Sleeve Evaluation  
Mechanical Holding Strength**

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# **477 kcmil, 3M Brand Composite Conductor Repair Sleeve Evaluation Mechanical Holding Strength**

## **Summary:**

Alcoa Conductor Accessories one-piece compression repair sleeves were fitted to 477-kcmil 3M Brand Composite Conductor and then pulled to failure in a tension test. The joints held > 95% of the conductor RBS (Rated breaking Strength), which satisfies the test requirement set forth in ANSI C119.4 (1998) – section 4.4.3 for full tension connectors.

## **Samples;**

477-kcmil 3M Composite Conductor was cut to lengths of 10ft (3.05m), and fitted with Alcoa Conductor Accessories Repair Sleeve C9121-A. The two free ends were fitted with resin terminations.

## **Equipment Used:**

Alcoa Conductor Accessories all-aluminum one-piece 6063 sleeves, and an Alcoa Conductor Accessories 100 ton hydraulic press, with an 10030AH die. Tension tests were performed at the Xcel Energy test laboratories in Minneapolis, MN, using a horizontal tensile machine with a Sheffer Hydraulic ram. The load cell was a BLH Type T2P1 load cell with a maximum capacity of 50,000 lbs. The digital readout was a Daytronics Model 3270P, accurate to 10 Lbs.

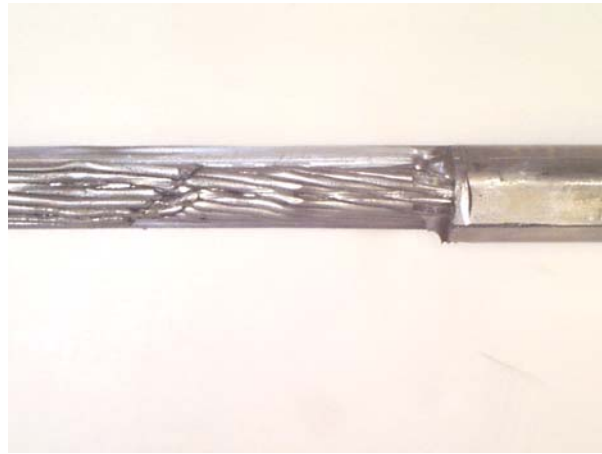
## **Conductor Specification:**

See Appendix A .

## **Procedure:**

Samples of 477-kcmil 3M Composite Conductor each 10ft (3.05m) were cut from a spool supply. Before compression splicing, one third of the aluminum strands (9 wires) were cut at the center of the conductor (center of repair sleeve). Compression splicing was conducted using the above press and die. After splicing, resin terminations were applied at the conductor ends. Samples were preloaded to 25% RBS and left under load for 10 minutes and then reloaded at a rate of 5000 Lbs/minute to failure. The load was displayed on a counter and recorded manually along with notes of acoustic cracking noise or other observations. After testing, the failure location was recorded, and aluminum strands were removed and the sleeves machined open to determine the failure location and any details of failure. The test requirement set by ANSI C119.4 (1998) – section 4.4.3 for full tension connectors, is that the connector should hold at least 95% of the conductor's rated breaking strength.

## Test Results:



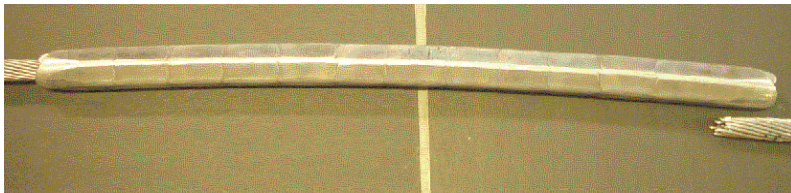
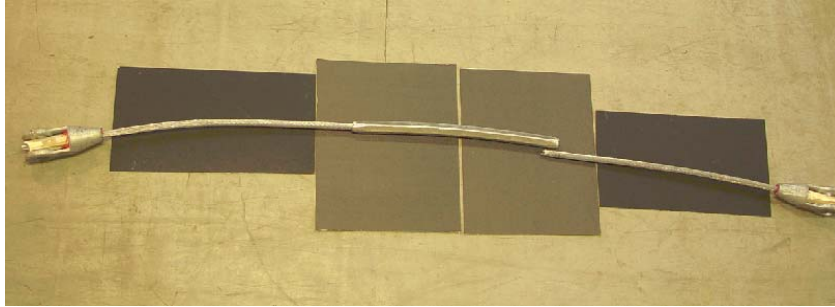
Section through a repair sleeve showing the cut Al strands at the center of the sleeve.

The following table summarizes load to failure, failure location and comments:

Accessory Type	Failure Load		% RBS	Comments
	(Lbs)	(kN)		
Repair sleeve C9121-A	19120	85.05	98%	Failed near tapered end of sleeve
Repair sleeve C9121-A	19680	87.54	101%	Failed at tapered end of sleeve
Repair sleeve C9121-A	19470	86.61	100%	Failed at resin termination

RBS = 19,476 Lbs

Tested repair sleeves produced good results, testing above the 95% RBS requirement set forth in ANSI C119.4, and thus are deemed capable of supporting the required load of a damaged conductor. The following picture is an example from one of the tests where failure occurred in the conductor at the end of the sleeve taper, where the highest stress concentration exists.



Sample failed at 19680 Lbs at the end of the sleeve taper.

### **Conclusions:**

Alcoa Conductor Accessories compression repair sleeves were designed, manufactured, and fitted to 477-kcmil 3M Composite Conductor and then pulled to failure in a tension test. The joints held  $> 98\%$  RBS. This exceeds the requirement set forth by ANSI C119.4 (1998) – section 4.4.3 for full tension connectors, that states the connector should hold at least 95% of the conductor's rated breaking strength.

## Appendix A: 477 kcmil, 3M Composite Conductor Specification

### Conductor Physical Properties

Designation		477-T16
Stranding		26/7
kcmils	kcmil	477
Diameter		
indiv Core	in	0.105
indiv Al	in	0.135
Core	in	0.32
Total Diameter	in	0.86
Area		
Al	in <sup>2</sup>	0.374
Total Area	in <sup>2</sup>	0.435
Weight	lbs/linear ft	0.539
Breaking Load		
Core	lbs	11,632
Aluminum	lbs	7,844
Complete Cable	lbs	19,476
Modulus		
Core	Msi	31.4
Aluminum	Msi	8.0
Complete Cable	Msi	11.2
Thermal Elongation		
Core	10 <sup>-6</sup> /F	3.5
Aluminum	10 <sup>-6</sup> /F	12.8
Complete Cable	10 <sup>-6</sup> /F	9.2
Heat Capacity		
Core	W-sec/ft-C	13
Aluminum	W-sec/ft-C	194

### Conductor Electrical Properties

Resistance		
DC @ 20C	ohms/mile	0.1832
AC @ 25C	ohms/mile	0.1875
AC @ 50C	ohms/mile	0.2061
AC @ 75C	ohms/mile	0.2247
Geometric Mean Radius	ft	0.0290
Reactance (1 ft Spacing, 60hz)		
Inductive Xa	ohms/mile	0.4296
Capacitive X'a	ohms/mile	0.0988