3M

477-kcmil, 3M Brand Composite Conductor Compression Dead End Evaluation Mechanical Holding Strength

Principal Investigator: Dr. Kamal Amin

Reviewed by: Dr. Colin McCullough

Date of Report: June 1, 2003

477-kcmil, 3M Brand Composite Conductor
Compression Dead End Evaluation
Mechanical Holding Strength

Summary:

Two-piece steel and aluminum compression fittings developed by Alcoa Conductor Accessories were successfully installed and tensile-tested on 477-kcmil 3M Brand Composite Conductor. Tests showed the conductor attained the full Rated Breaking Strength.

Samples;

477-kcmil 3M Brand Composite Conductor cut to lengths of 10ft (3.05m), having one end terminated with an Alcoa Conductor Accessories compression dead-end fitting catalogue number B9085-A, and the other end fitted with a resin termination.

Equipment Used:

An Alcoa Conductor Accessories two-piece steel forging and an 1100 aluminum dead end were pressed onto the conductor using a 100-ton press. The dead-end catalogue number was B9085-A, and 10030AH dies were used for the aluminum sleeve and 10014SH dies for the steel. 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 were cut to lengths of 10ft (3.05m). Dead end sleeves were installed at one end and a resin fitting at the other end. Samples were preloaded to about 25% RBS and left under load for 10 minutes before reloading at a rate of approximately 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.

Dead-End Design

The design drawing for an Alcoa Conductor Accessories dead-end, catalogue number B9085-A, is shown in Appendix B. It shows both the core and overall conductor gripping. The steel forging contains an aluminum insert to cushion the core material. Otherwise the assembly is similar to Alcoa Conductor Accessories ACSR-type compression dead-ends.

An example of a fully assembled, compression dead-end ready for testing, using the Alcoa Conductor Accessories two-piece dead-end approach.

Test Results:

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

Accessory Type	Failure Load		%RBS	Comments
	(Lbs)	(kN)		
Dead-end B9085-A	20340	90.48	104	Failed inside dead end
Dead-end B9085-A	19860	88.35	102	Failed inside dead end
Dead-end B9085-A	20860	92.79	107	Failed at resin end
Dead-end B9085-A	19680	87.54	101	Failed inside sleeve, core failed and pulled out
Dead-end B9085-A	21360	95.02	110	Failed near tapered end of sleeve

RBS = 19,476 Lbs

An example of an Alcoa Conductor Accessories compression dead-end which, failed at 19680 Lbs (101%RBS) inside the sleeve, near the tapered barrel.

Conclusions:

An Alcoa Conductor Accessories two-piece steel forging and 1100 aluminum dead end body was successfully designed, fabricated, and tested on 477 kcmil 3M Composite Conductor. The terminations supported more than 100% RBS, thus proving the capability to support the designed load of the conductor. 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^2	0.374
Total Area	in^2	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^-6/F	3.5
Aluminum	10^-6/F	12.8
Complete Cable	10^-6/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

Appendix B: Alcoa Conductor Accessories Dead-End B9085