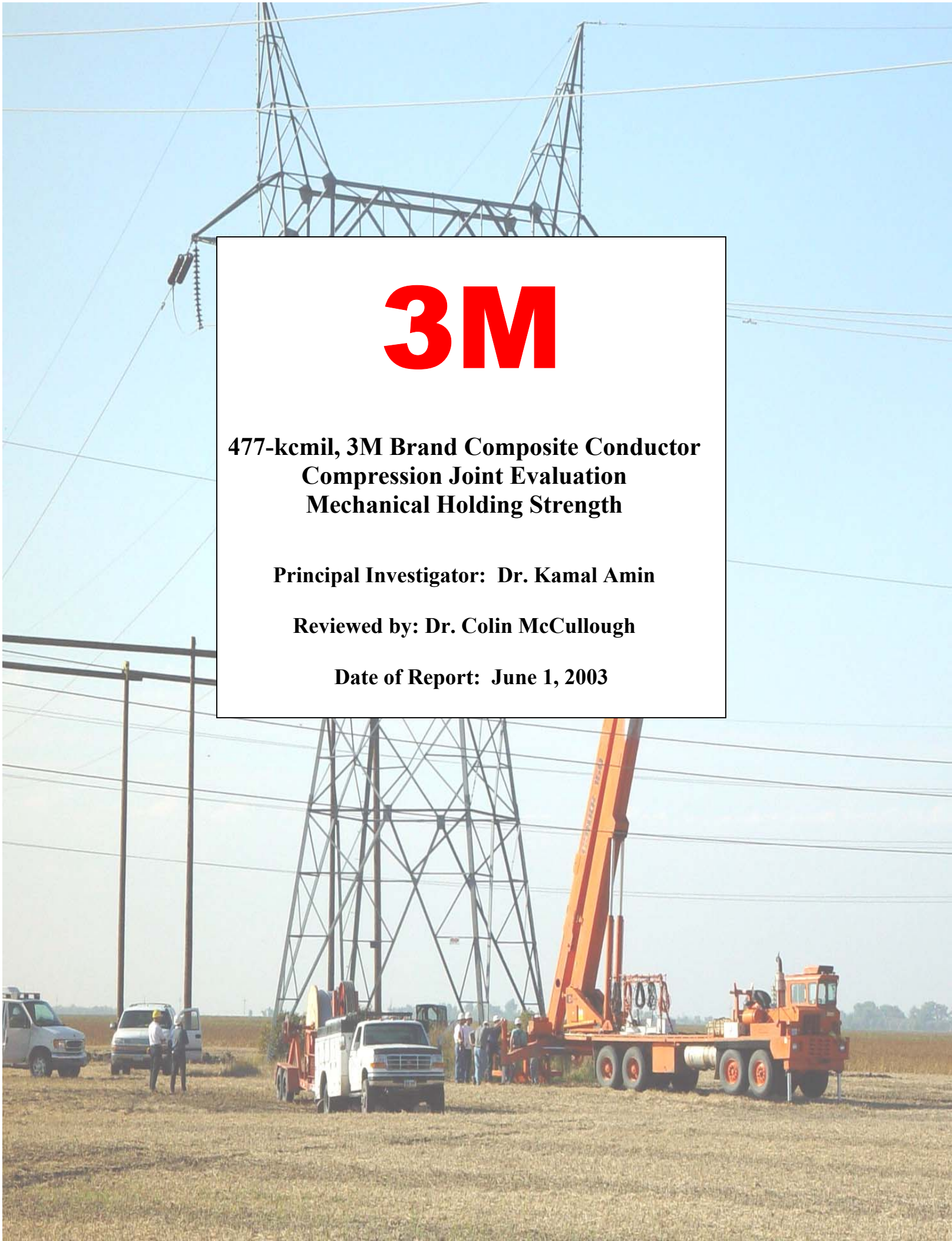

3M

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

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Reviewed by: Dr. Colin McCullough

Date of Report: June 1, 2003

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

Summary:

Alcoa Conductor Accessories two-piece compression joints were fitted to 477-kcmil 3M Brand Composite Conductor and then pulled to failure in a tension test. Measured Joint strengths met the strength requirements of 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 then further cut in half and spliced together using an Alcoa Conductor Accessories compression Joints. The two free ends were fitted with resin terminations.

Equipment Used:

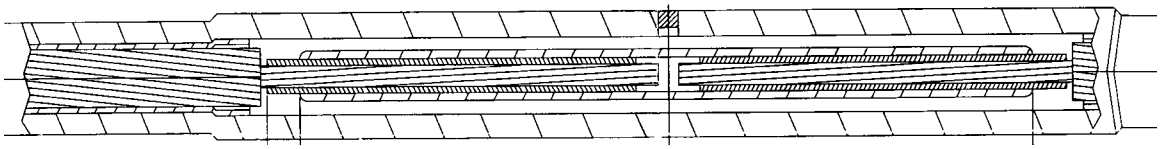
An Alcoa Conductor Accessories two-piece steel sleeve and 1100 aluminum Joint was pressed onto conductor using a 100-ton press. The Joint catalogue number was B9095-A. The dies used for the aluminum sleeve were 10030AH and for the steel were 10014SH. Tension tests were performed at the Xcel Energy test 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:

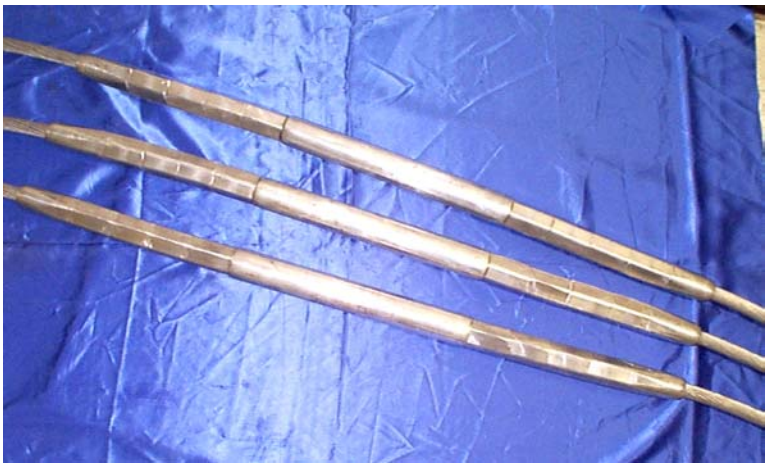
See Appendix A.

Procedure:

Samples of 477 kcmil 3M Composite Conductor each 10ft (3.05m) were cut from a spool supply. The conductor samples were cut in half at their center and then reconnected using a Compression Joint. At the two free ends resin fittings were installed. Samples were preloaded to 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 Joint should hold at least 95% of the conductor's rated breaking strength.



A section view through an Alcoa Conductor Accessories compression joint. Details are shown in the drawing in Appendix B.



Alcoa Conductor Accessories compression joints prior to testing

Test Results:

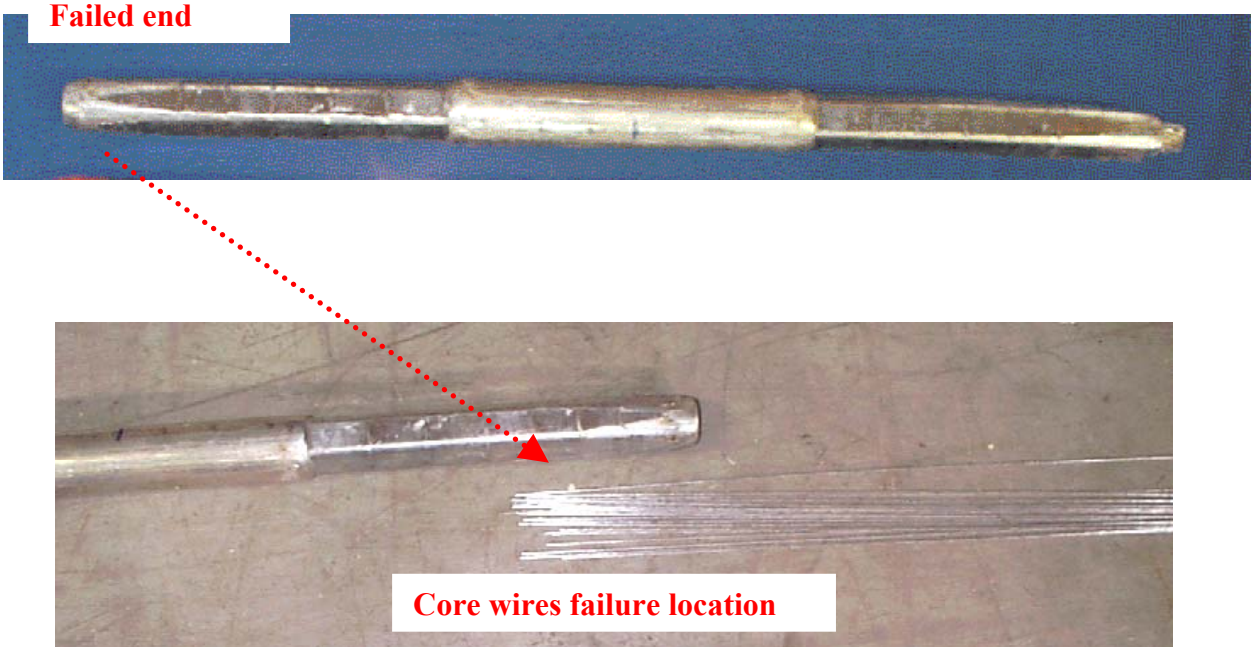
The following table summarizes load to failure, failure location and comments:

Termination Type	Failure Load		% RBS	Comments
	(Lbs)	(kN)		
Joint B9095-A, epoxy ends	19140	85.14	98%	Failed inside resin
Joint B9095-A, epoxy ends-	19580	87.1	101%	Failed within gage length
Joint B9095-A, epoxy ends Some "banana" shape	19380	86.21	100%	Failed at Joint tapered end

RBS = 19,476 Lbs

The only sample that tested less than 100% RBS failed in the resin termination, and so the Joints are deemed capable of supporting the full design load of the conductor.

Additionally the Joints satisfy the ANSI C119.4 strength requirement, since they hold >95% of the conductor strength,



A typical example of conductor failure inside the sleeve near the tapered end - failure load was 19,380 Lbs (approximately 100% RBS).

Conclusions:

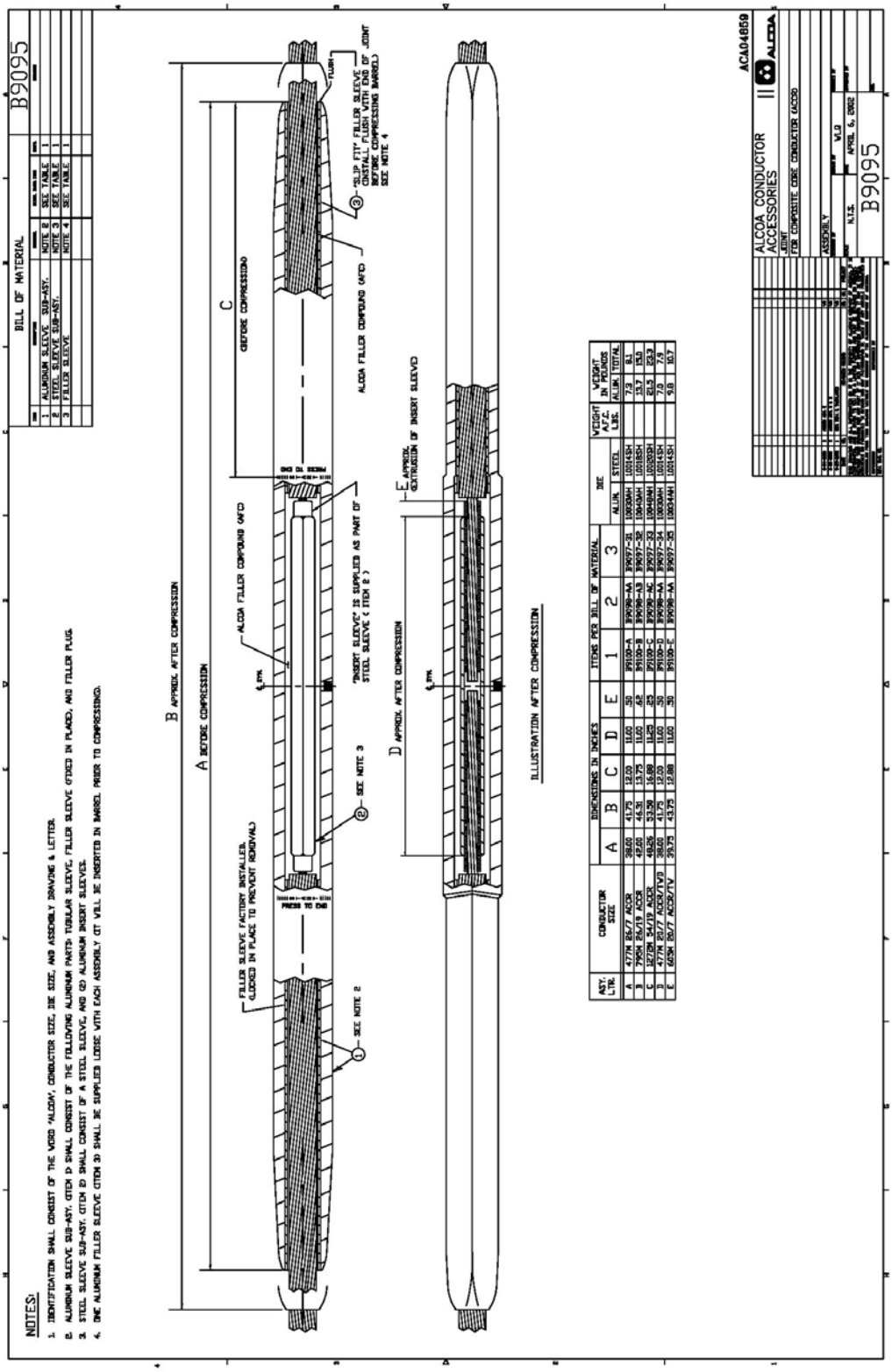
An Alcoa Conductor Accessories two-piece steel sleeve and 1100 aluminum compression Joint body was successfully designed, fabricated, and tested on 477-kcmil 3M Composite Conductor. The Joint supported >98% RBS, and thus exceeds the requirement set forth by ANSI C119.4 (1998) – section 4.4.3 for full 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 Joint B9095



ASY. LTR.	CONDUCTOR SIZE	DIMENSIONS IN INCHES A	B	C	D	E	ITEMS PER BILL OF MATERIAL 1	2	3	DIE ALUM.	DIE STEEL	WEIGHT A.F.C. LBS.	WEIGHT IN POUNDS ALUM.	TOTAL
A	477M 26/7 ACCR	38.00	41.75	12.00	11.00	50	B9100-A	B9096-AA	B9097-35	10600AH	10014SH		7.3	81
B	795M 26/19 ACCR	49.00	46.31	13.75	11.00	68	B9100-B	B9096-AB	B9097-36	10940AH	10018SH		13.7	150
C	927M 54/19 ACCR	49.25	53.50	16.88	11.25	25	B9100-C	B9096-AC	B9097-33	10940AH	10020SH		21.5	236
D	477M 27/7 ACSR/TW	38.00	41.75	12.00	11.00	50	B9100-D	B9096-AA	B9097-34	10600AH	10014SH		7.0	77
E	403M 20/7 ACSS/TW	39.73	43.75	12.88	11.00	50	B9100-E	B9096-AA	B9097-35	10854AH	10014SH		9.8	107