KINECTRICS NORTH AMERICA INC. TEST REPORT
FOR 774-KCMIL 3M™ COMPOSITE CONDUCTOR

Test Name:	**SUSTAINED LOAD TEST ON COMPRESSION DEADEND FITTING FOR 774-KCMIL 3M™ COMPOSITE CONDUCTOR AT HIGH TEMPERATURE**
Test Date:	September 16-26, 2005
Cable Supplier:	3M Company
Laboratory:	Kinectrics Inc. 800 Kipling Avenue Toronto, Ontario M8Z 6C4 CANADA
Standard:	Based on ANSI C119.4-2003, Paragraph 7.3.3.1
Kinectrics Staff:	Mr. Craig Pon **Mr.** Mike Kastelein Mr. Gord Hale

OBJECTIVE

3M contracted with Kinectrics under PO # 1600000 to conduct a high temperature sustained load test on a full tension, compression deadend clamp manufactured by ACA Conductor Accessories (formerly Alcoa-Fujikura Ltd). The objective of the test was to verify the high temperature sustained load carrying capability of the compression deadend clamp on a 774-kcmil 3M™ Composite Conductor. The ACA catalog number of the deadend is B9178-L (special design for 3M Composite Conductor). The rated breaking strength (RBS) of the conductor is 32,210 kgf (71,010 lbf). The specifications for the conductor are shown in Appendix A and an engineering drawing of the deadend is shown in Appendix B. 3M owns all data and copyright to this information.

There is no ANSI requirement for high temperature sustained load testing. However, a sample was subjected to a test designed to demonstrate sustained load performance of the connector system at extreme high temperature. AC current was used to raise the conductor temperature to 240˚C for the duration of the 168 hour test. Tension for the high temperature sample was

15% RBS. Lower tension was used for the high temperature test to simulate the expected field tensions, where 15% RBS is considered an upper limit for tension at extreme conductor temperatures.

TEST SAMPLE

A compression deadend clamp was installed on one end of the conductor sample. This was done by ACA Conductor Accessories at their facilities and then shipped to Kinectrics. The other end of the sample was terminated with an epoxy-resin clamp by Kinectrics.

TEST SET-UP

The sample was installed in a hydraulically-activated horizontal test machine. The length of exposed conductor between the inboard face of the epoxy-resin clamp and the edge of the ACA Conductor Accessories compression deadend was about 12.6 m (41 ft).

The temperature in the sample was increased by circulating an AC current supplied by a current transformer through the sample. Three(3) thermocouples measured the temperature of the conductor. The current was cycled on and off to maintain the temperature of the highest reading thermocouple at the desired target of 240°C. The set-up is shown in Figure 1.

INTRUMENTATION

The load cell (#17356-0) in the test machine (MTS 3156/MTS 493.01DC) that measured the the tension was last calibrated in May 2005 and is due for calibration in May 2006. The data logger (#CA1C1A) that recorded the load cell measurements was last calibrated in January 2005 and is due for calibration in January 2006. The load measuring system has an accuracy of ± 2%.

TEST PROCEDURE

A test machine having a load accuracy of ± 2% was used for this test. The tension in the sample was increased to 10,652 lbf or 15% of the rated tensile strength (71,010 lbf) of the 774-kcmil conductor. The tension was maintained at this level for 168 hours. The temperature of the sample was maintained at approximately 240^{o}C during the test. On completion of the sustained load test the sample was cooled and unloaded, and then the tension in the sample was increased at a rate of 14,202 lbf/minute (6,442 kgf/min) until failure.

TEST RESULT

The conductor temperature and tension are plotted vs. time in Figure 2. The temperature plotted was from the thermocouple pinched between the core and inner aluminum layer. The thermocouple at this location was the hottest of the three thermocouples on the conductor. The sample failed at 70,252 lbf (31.866 kgf) or 98.9% of the rated tensile strength of the cable. The conductor failed approximately 8.2 feet (2.5 m) from the ACA Conductor Accessories deadend. The failure is shown in Figure 3. The ACA Conductor Accessories deadend is shown in Figure 4.

DISCUSSION

The high temperature sustained load test is not required by ANSI C119.4, but was performed to demonstrate connector performance during extreme high temperature operation. The sustained load sample exhibited a residual strength higher than the 95% RBS minimum used to qualify the residual strength of connectors under ANSI C119.4. This suggests that the extreme load and temperature does not degrade the strength of the deadend connectors.

ACKNOWLEDGEMENT

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DISCLAIMER

Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the Department of Energy.

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Date: September 26, 2005

Figure 1 Set-up for Room Temperature Sustained Load Test of an ACA Conductor Accessories Dead-end connected to a 774-kcmil 3M™ Composite Conductor (Looking South)

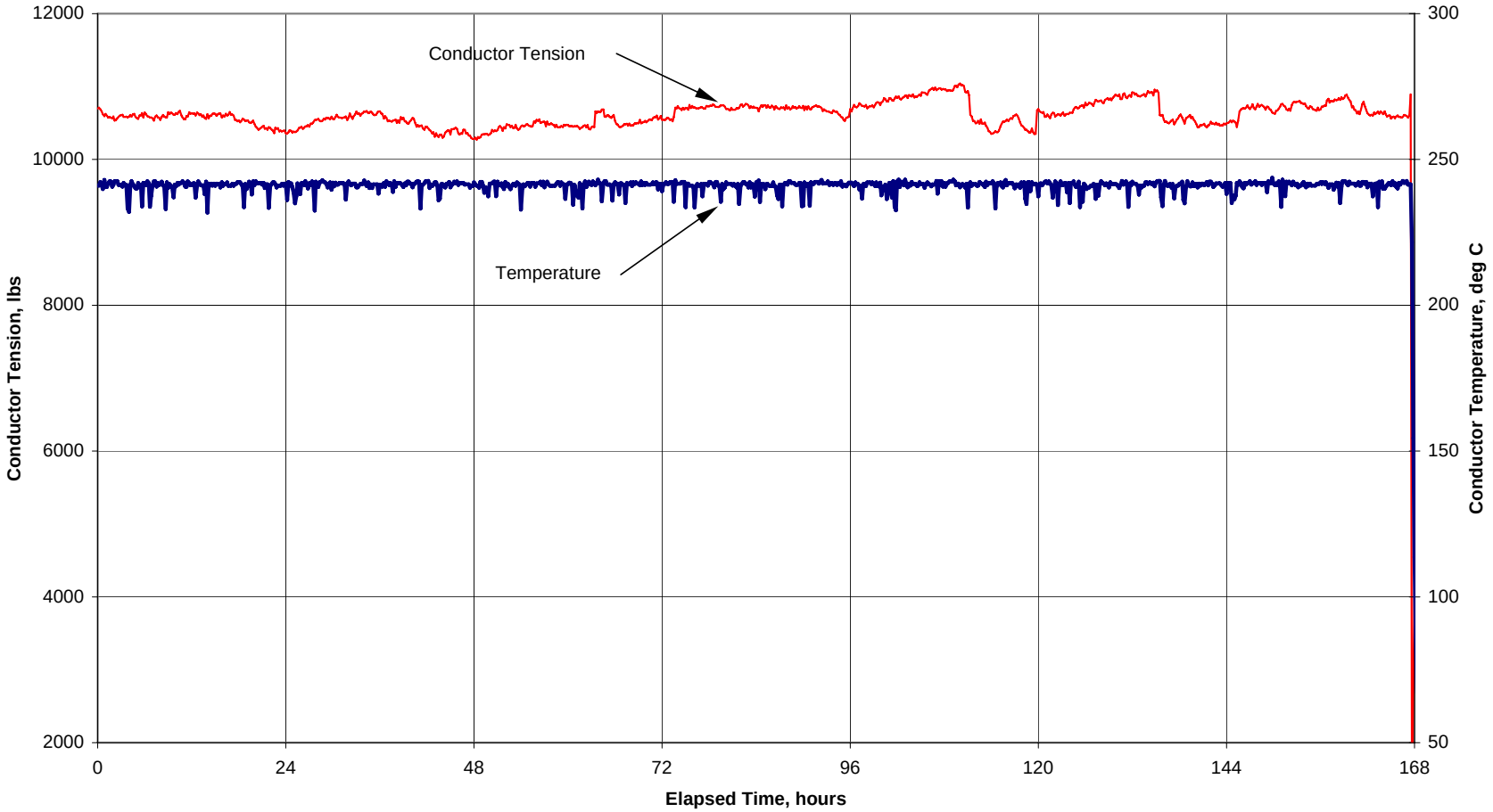

Figure 2: Conductor Tension and Temperature vs. Time

Figure 3 774-kcmil 3M™ Composite Conductor failure point after tensioning to failure. Conductor and Dead-end were stressed for 168 Hours while under Sustained Load at 240°C (Looking South)

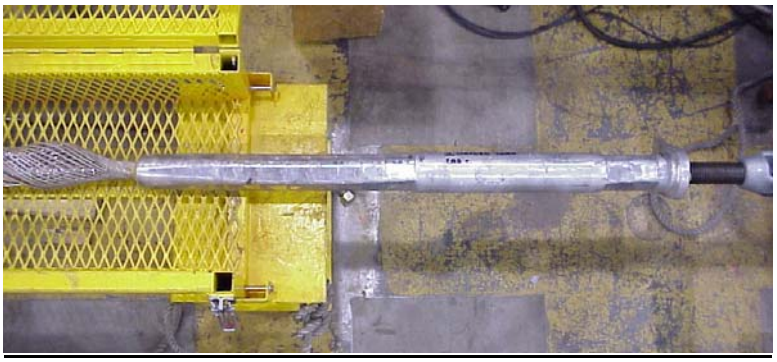

Figure 4 ACA Conductor Accessories Dead-end connected to a 774-kcmil 3M™ Composite Conductor after Tension to Failure. Conductor and Dead-end were stressed for 168 Hours while under Sustained Load at 240°C.

APPENDIX A

Specifications for 774-kcmil 3M™ Composite Conductor

Specification for 774-kcmil 3M™ Composite Conductor

Conductor Physical Properties

Designation		ACCR_774-T53
Stranding		46/37
kcmils	kcmil	774
Area Fraction Core	%	34.52%
Weight Core	lb/ft	0.48
Diameter		
indiv Core	in	0.105
indiv Al	in	0.130
Core	in	0.735
Total Diameter	in	1.254
Area		
Al	in^2	0.6077
Total Area	in^2	0.9280
Weight	lbs/linear ft	1.202
Breaking Strength		
Core	lbs	57,885
Aluminum	lbs	13,125
Complete Cable	lbs	71,010
Modulus		
Core	msi	32.9
Aluminum	msi	8.8
Complete Cable	msi	17.1
Thermal Elongation		
Core	$10^{-6}/C^{o}$	6.35
Aluminum	$10^{-6}/C^{o}$	23.00
Complete Cable	$10^{-6}/C^{o}$	11.96
Heat Capacity		
Core	W-sec/ft-C	84
Aluminum	W-sec/ft-C	272

Conductor Electrical Properties

Resistance		
DC @ 20C	ohms/mile	0.0970
AC @ 25C	ohms/mile	0.0993
AC @ 50C	ohms/mile	0.1091
AC @ 75C	ohms/mile	0.1190
Geometric Mean Radius	ft	0.0366
Reactance (1 ft Spacing, 60hz)		
Inductive Xa	ohms/mile	0.4013
Capacitive X'a	ohms/mile	0.0876

B9178

BILL OF MATERIAL

ITEM	DESCRIPTION	MATERIAL	METAL AREA PER	REQ'D	REMARKS
1	EYE DEADEND SUB-ASY.	NOTE 2	SEE TABLE	1	
2	DEADEND BODY SUB-ASY.	ALUM.	SEE TABLE	1	
3	TERMINAL	ALUM	SEE TABLE	1	
4	CLEVIS DEAD END SUB-ASY	NOTE 2	SEE TABLE	1	
5	ADJ. EYE-DEAD END SUB-ASY	NOTE 2	SEE TABLE	1	

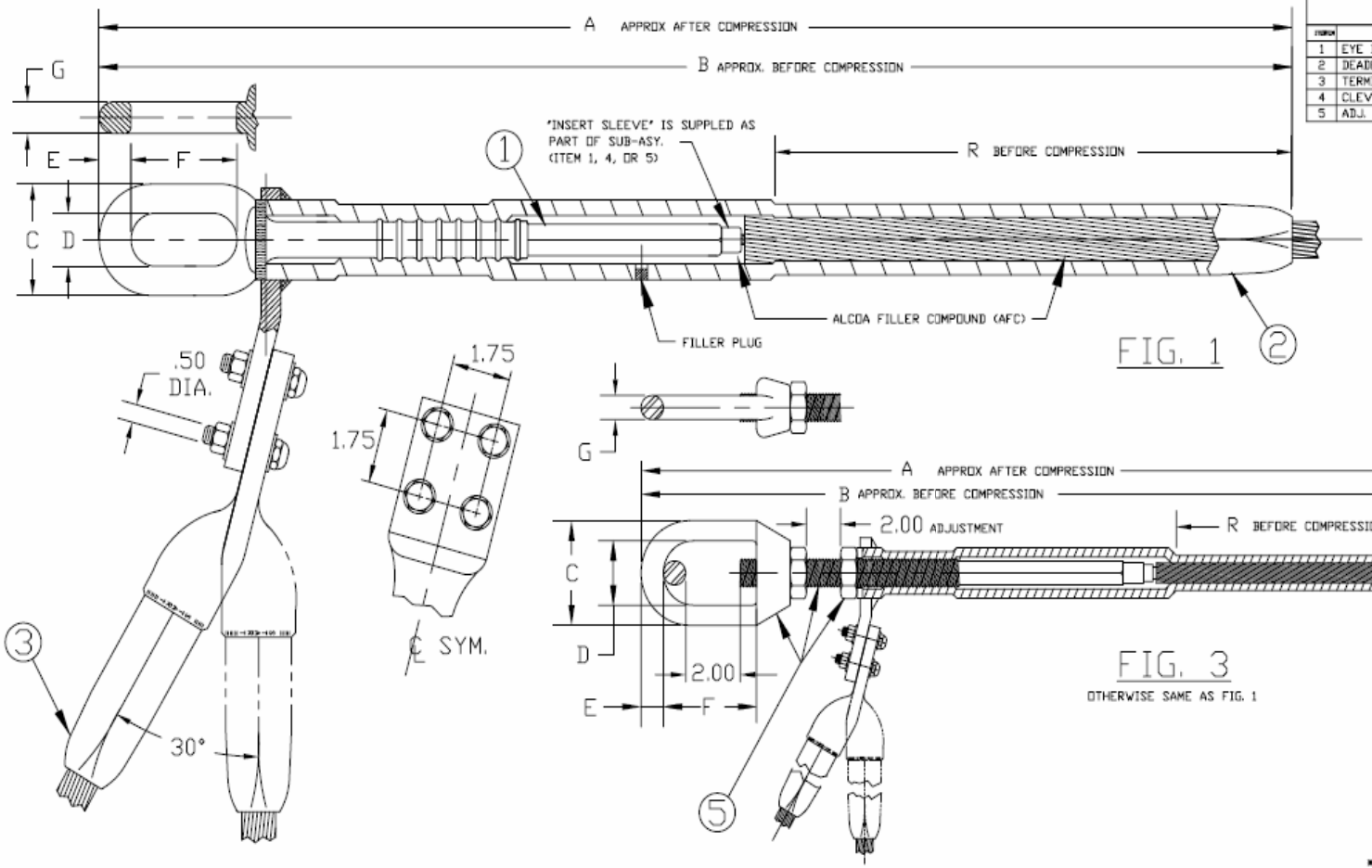

FIG. 1

FIG. 3

OTHERWISE SAME AS FIG. 1

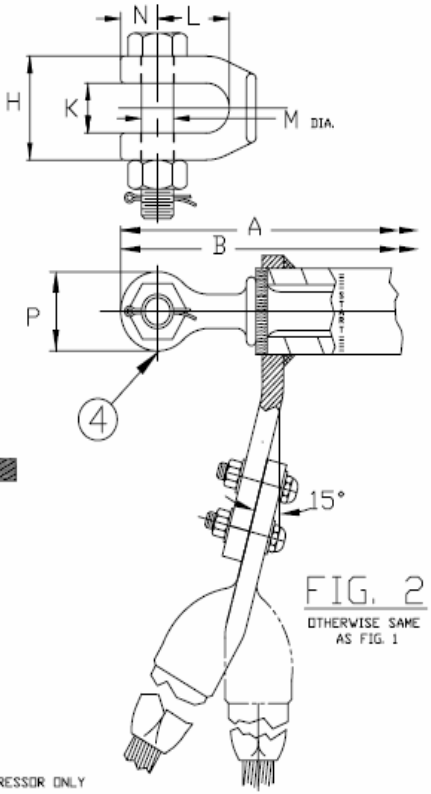

FIG. 2

OTHERWISE SAME AS FIG. 1

*USE 100A COMPRESSOR ONLY

ASY. LTR.	CONDUCTOR SIZE	CONDUCTOR DIA.	FIG.	DIMENSIONS IN INCHES A	B	C	D	E	F	G	H	K	L	M	N	P	R	ITEMS PER BILL OF MATERIAL 1	2	3	4	5	*DIE SIZE ALUM.	*DIE SIZE STEEL	'AFCHT' COMPOUND DEAD END LBS.	DEAD END APPROX. AMT. OF 1# TUBE	TERMINAL LBS.	TERMINAL APPROX. AMT. OF 1# TUBE	TOTAL LBS.	TOTAL APPROX. AMT. OF 1# TUBE	WEIGHT IN POUNDS ALUM.	WEIGHT IN POUNDS TOTAL
A	477M 26/7 ACCR	.858	1	31.56	29.06	2.62	1.25	.88	2.69	.75	—	—	—	—	—	—	12.00	B9098-A	B9099-A	B9102-A	—	—	10030AH	10014SH	.67	2/3 TUBE	.30	1/3 TUBE	1.0	1 TUBE	5.6	8.6
B	795M 26/19 ACCR	1.108	1	33.31	30.56	3.25	1.25	1.12	2.62	1.00	—	—	—	—	—	—	13.75	B9098-B	B9099-B	B9102-B	—	—	10040AH	10018SH-LG	1.0	1 TUBE	.54	1/2 TUBE	1.5	1-1/2 TUBES	10.5	16.5
C	1272M 54/19 ACCR	1.381	2	39.00	36.38	—	—	—	—	—	3.69	1.56	2.88	1.25	1.44	2.88	16.88	—	B9099-C	B9102-C	B9118-A	—	10048AH	10020SH-LG	1.3	1-1/3 TUBE	.66	2/3 TUBE	2.0	2 TUBES	15.4	27.7
D	477-T13 ACCR/TW	.860	1	31.56	29.06	2.62	1.25	.88	2.69	.75	—	—	—	—	—	—	12.00	B9098-A	B9099-D	B9102-D	—	—	10030AH	10014SH	.67	2/3 TUBE	.30	1/3 TUBE	1.0	1 TUBE	5.5	8.5
E	675-T11 ACCR/TW	.902	1	32.56	29.94	2.62	1.25	.88	2.69	.75	—	—	—	—	—	—	12.88	B9098-A	B9099-E	B9102-E	—	—	10034AH	10014SH	.67	2/3 TUBE	.30	1/3 TUBE	1.0	1 TUBE	7.3	10.3
F	954-T13 ACCR/TW	1.200	1																													
G	1033-T13 ACCR/TW	1.240	1																													
H	590-T13 ACCR/TW	.860	1	31.56	29.06	2.62	1.25	.88	2.69	.75	—	—	—	—	—	—	12.00	B9098-A	B9099-H	B9102-H	—	—	10030AH	10014SH	.67	2/3 TUBE	.30	1/3 TUBE	1.0	1 TUBE	5.5	8.5
K	1113-T13 ACCR/TW	1.290	1																													
L	774-T53 ACCR/TW	1.254	3	52.00	49.38	5.56	3.12	1.25	4.00	1.25	—	—	—	—	—	—	18.00	—	B9099-L	B9102-L	—	B9225-A	10050AH	10024SH-LG	4.0	4 TUBES	.76	3/4 TUBE	4.75	4-3/4 TUBES		

ORDERING INFORMATION

CUSTOMER TO ORDER BY ASSEMBLY DRAWING & LETTER. i.e. B9178-A

NOTES:

1. IDENTIFICATION SHALL CONSIST OF THE WORD 'ACA', CONDUCTOR SIZE, DIE SIZE, AND ASSEMBLY DRAWING AND LETTER.
2. EYE DEADEND (ITEM 1) SHALL CONSIST OF A STEEL EYE FORGING, FELT WASHER, AND ALUMINUM INSERT SLEEVE. CLEVIS DEADEND (ITEM 4) SHALL CONSIST OF STEEL CLEVIS FORGING, FELT WASHER AND ALUMINUM INSERT SLEEVE. ADJUSTABLE EYE DEAD END (ITEM 5) SHALL CONSIST OF A THREADED SHAFT, EYE NUT, JAM NUTS, FELT WASHER AND ALUMINUM INSERT SLEEVE.
3. DEADEND BODY (ITEM 2) SHALL CONSIST OF THE FOLLOWING ALUMINUM PARTS; BARREL, TONGUE, AND FILLER PLUG.

DATE	NO.	REVISION RECORD	BY	CK	ZONE
03/29/05	1	GENERAL REVISIONS ADDED FIGS 2 & 3 AND TABLE	AA	WG	

SUPERSEDES | SUPERSEDED BY | REV. DWG. NO.

AMERICA FUJIKURA TELECOMMUNICATIONS DIVISION || ACA

DEADEND

FOR 3M COMPOSITE CORE CONDUCTOR (ACCR)

ASSEMBLY

DESIGNED BY	DRAWN BY	CHECKED BY
	A. ALAIMO	W. QUESNEL

SCALE	DATE	APPROVED BY
N.T.S.	02-15-05	

B9178

DISTRIBUTION

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