Powertech
MATERIALS ENGINEERING

TEST REPORT

Powertech Labs Inc.
12388 88th Ave., (604) 590-7500
Surrey, B.C., (604) 590-6611
Canada V3W 7R7 www.powertechlabs.com

EVALUATION OF MECHANICAL PROPERTIES AND ZINC COATING OF CARDINAL (954.0 KCM) ACSR CONDUCTOR

Report No.: PL-00068R0
Prepared for: EMTA Canada
#1500-885 West Georgia St.
Vancouver, B.C. Canada V6C-3E8

Dates Tested: May 13-15, 2013
Equipment Used: Mitutoyo 8" vernier calipers, serial no. 01602
Sintech 20GT universal test frame, serial no. 15541
MTS 5,000 load cell, serial no. 110777
IM01 1000g electronic precision balance, asset no. ME11092
Part Type: Cardinal ACSR Conductor
Part Data: 954.0 KCM, Class AA
Stranding Design: 54/7 (Aluminum/Steel)
Rated Strength: 33,800 lbs

RESULTS SUMMARY:

The mechanical properties and zinc coating of the Cardinal ACSR conductor exceed the requirements of its governing specification, ASTM B232.

TESTS CONDUCTED:

As requested, Powertech Labs performed the following tests and examinations on the sampled sections of Cardinal (954.0 KCM) ACSR conductor:

- Tensile strength and elongation testing
- Weight of zinc coating testing
- Wrap testing

The properties of the conductor were evaluated to the specifications of ASTM B232 "Standard Specification for Concentric-Lay-Stranded Aluminum Conductors, Coated Steel Reinforced (ACSR)".

TEST PROCEDURES:

Tensile Strength and Elongation Testing
For the aluminum wires of the ACSR conductor, the tensile strength and elongation were determined simultaneously, in accordance with ASTM B230M "Standard Specification for Aluminum 1350-H19 Wire for Electrical Purposes". A total of 10 randomly selected wires from the removed samples were tested.

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For the steel core wires of the ACSR conductor, the tensile strength and elongation was determined simultaneously, in accordance with ASTM B498M "Standard Specification for Zinc-Coated (Galvanized) Steel Core Wire for Aluminum Conductors, Steel Reinforced (ACSR)". A total of 10 randomly selected wires from the removed samples were tested.

All tensile testing was performed on a Sintech 20 G/T Universal Test Frame. Aluminum samples were tested at a crosshead extension rate of 5 mm/min, steel samples at 12 mm/min. Tensile strength was calculated by dividing the peak load by the cross sectional area of the wire, using individual diameter measurements for each strand. Elongation was calculated using an initial gage length of 250 mm for aluminum samples and 200 mm for steel samples.

Zinc Coating

Testing was performed in accordance with CSA Standard G162.1-M1977 "Methods of Determining Mass of Coating on Zinc-Coated Steel Wire. Four randomly selected specimens of wire 600 mm in length were cleaned with solvent, weighed, stripped of their zinc coating by means of a hydrochloric acid – antimony chloride solution, cleaned and re-weighed, and the mass of zinc coating calculated.

Wrap Testing

For the aluminum wires of the conductor, testing was performed in accordance with Section 8 (Bending Properties) of ASTM B230. Three wire specimens were selected, straightened and secured at one end. The specimens were then wrapped by the free end around a mandrel having the same diameter as that of the wire.

For the steel core of the aluminum conductor, testing was performed in accordance with Section 9 (Wrap Test) of ASTM B498. Three wire specimens were selected straightened and secured at one end. The specimens were then wrapped by the free end around a mandrel 2 times the diameter of wire in a close helix of at least eight turns at a rate not exceeding 15 turns/minute.

TEST RESULTS:

Tensile Testing

The tensile strength and elongation of the aluminum and steel core wires exceeded the requirements of the standard. The aggregate strength of the conductor was calculated with guidance from ASTM B232 Section 10.1, and was found to be 40.8 kips. The rated strength of the Cardinal ACSR conductor is 33.8 kips.

Tables 1 and 2 contain the tensile strength and elongation values obtained, with the average and standard deviation values calculated.

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Table 1: Tensile Test Data for Aluminum Wires

Sample #	Peak Load (lbs)	Diameter (inches)	UTS (ksi)	% Elong
1	361	0.133	26	1.7
2	371	0.133	27	2.2
3	379	0.132	28	2.3
4	345	0.133	25	1.9
5	409	0.133	29	2.0
6	365	0.133	26	2.1
7	378	0.133	27	1.9
8	342	0.133	25	2.2
9	365	0.132	27	1.8
10	371	0.133	27	1.8
		Average	**27**	**2.0**
		Standard Deviation	**1**	**0.2**
		Minimum Requirements (Average)	**25**	**1.8**
		Minimum Requirements (Individual)	**23.5**	**1.7**

Table 2: Tensile Test Data for Steel Core Wires

Sample #	Peak Load (lbs)	Diameter (inches)	UTS (ksi)	% Elong
1	3400	0.134	241	6.6
2	3440	0.134	244	6.3
3	3319	0.137	225	5.9
4	3378	0.134	240	n/a
5	3323	0.136	229	5.3
6	3378	0.135	236	5.6
7	3418	0.135	239	5.6
8	3348	0.135	234	6.6
9	3385	0.134	240	5.9
10	3319	0.133	239	6.6
		Average	**237**	**6.0**
		Standard Deviation	**6**	**0.5**
		Minimum Requirements (Individual)	**205**	**4.0**

Zinc Coating

The zinc coating of the steel core wires of the conductor was 454.8 g/m^2, exceeding the requirement of Class A (205 g/m^2) of ASTM B498. Table 3 contains the test data for all the samples.

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Table 3: Weight of Zinc-Coating Test Results

Sample #	Original Mass (grams)	Mass After Stripping (grams)	Mass Loss (grams)	Diameter of Stripped Wire (mm)	Mass of Zinc Coating (g/m^2)
1	20.64	19.51	1.13	3.24	367.8
2	20.12	18.84	1.28	3.25	432.8
3	20.16	18.59	2.17	3.23	534.7
4	20.97	19.40	1.57	3.23	512.3
5	20.85	19.57	1.28	3.23	414.1
6	21.04	19.59	1.45	3.22	467.1
				Average	**454.8**

Wrap (Ductility) Testing

All samples of the aluminum wires and steel core wires of the conductor passed their wrap test criteria, as seen in Table 4.

Table 4: Aluminum Wires from Conductor Wrap Test Results

Wire Type	Sample #	Mandrel Diameter (inches)	Number of Coils	Acceptance Criteria	Pass / Fail
Aluminum	1	0.133	8	The wire shall not fracture	Pass
	2				Pass
	3				Pass
Steel	1	0.265	8	The wire shall not fracture	Pass
	2				Pass
	3				Pass

Tested By:	Approved By:
Roger Trip, Materials Technologist	Darren Bromley, P.Eng.
Date Signed: May 15, 2013	