DC Resistance for 995.0 kcmil ACCS/TW/C7® Overhead Conductor

NEETRAC Project: 24-151

Final Report

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National Electric Energy Testing, Research, and Applications Center

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1.0 BACKGROUND

Resistance is an important property for a conductor because it determines the energy loss (called line loss) caused by heating as the current flows in the conductor. Lower resistance means lower line loss. Data tables for conductors list both AC resistance values and DC resistance values. Both are computed based on the conductor nominal dimension and the maximum allowable volume resistivity of the metal, typically aluminum or copper. The computation includes stranding increments based on the increased length of the helically wound strands.

AC resistance is difficult to measure, and highly specialized equipment is required. DC resistance is easily measured by passing a known DC current through the conductor, and measuring the voltage drop over a defined length, 15 ft in the case of the NEETRAC measurements. The DC resistance is defined as the ratio of the voltage to the current (V/I). Per industry practice, the measured DC resistance is corrected to a 20 °C reference temperature using industry standard resistance temperature coefficients.

2.0 TEST SAMPLE

A test sample was removed from a reel provided by the Lower Colorado River Authority circa November 2024. The designation on the reel identified the conductor as 995.0 kcmil ACCS/TW/C7. Table 1 shows the resistance and ampacity values per the manufacturer.

Table 1: Resistance and Ampacity per Manufacturer's Literature

Conductor Temperature		RESISTANCE (ohm/mi)		AMPACITY			
°C	°F	DC	60 Hz AC	Sun No Wind	No Sun No Wind	Sun Wind	No Sun Wind
20	68	0.0892	0.0910				
25	77	0.0911	0.0928	****	****	****	****
50	122	0.1003	0.1019	****	354	199	517
75	167	0.1096	0.1111	543	710	818	937
90	194	0.1152	0.1166	735	860	1007	1101
100	212	0.1189	0.1202	838	946	1110	1194
125	257	0.1282	0.1294	1051	1133	1322	1388
150	302	0.1374	0.1386	1225	1291	1493	1548
175	347	0.1467	0.1478	1375	1431	1639	1686
180	356	0.1486	0.1497	1403	1457	1666	1712
200	392	0.1560	0.1570	1509	1557	1769	1811
225	437	0.1653	0.1662	1632	1675	1888	1925

3.0 PROCEDURE

A bolted clamp (see Figure 1) was applied at each end of the sample before cutting the sample from the reel. This ensures the as-manufactured position of each strand and each layer. To ensure all strands have the same current density, the composite core is removed outboard of the bolted clamp to permit puddle-welding of all strands into an aluminum plate that ensures an equipotential plane at the current terminals, which ensures balanced current flow in each of the 20 aluminum strands.

Voltage terminals were applied inboard of the current terminals. Per industry practices, a length of #20 AWG solid copper wire is wrapped around the conductor and the ends twisted to form an electrical connection used as voltage terminals. The location of the voltage terminals defines the gage section over which the resistance is measured. The voltage leads from the digital low resistance ohmmeter (DLRO) are connected to the voltage terminals of the conductor sample. The conductor is placed under nominal tension of 200 lb, and the distance between the copper terminals is measured using a metal tape.

The DLRO employs a four-wire measurement method, where the current is applied at the equalizers located at each end of the sample, and the voltage is measured between the voltage terminals. Three readings were recorded with the current direction in a nominally positive polarity, and three measurements with the polarity reversed. No sensitivity to current direction was noted, and all readings were repeatable within the 0.0001 mΩ sensitivity of the DLRO. After each reading, the conductor temperature was measured to provide the temperature data to normalize the resistance value to the industry-standard 20 °C reference. Figure 1 shows one end of the actual sample during the test. The opposite end had a similar appearance.

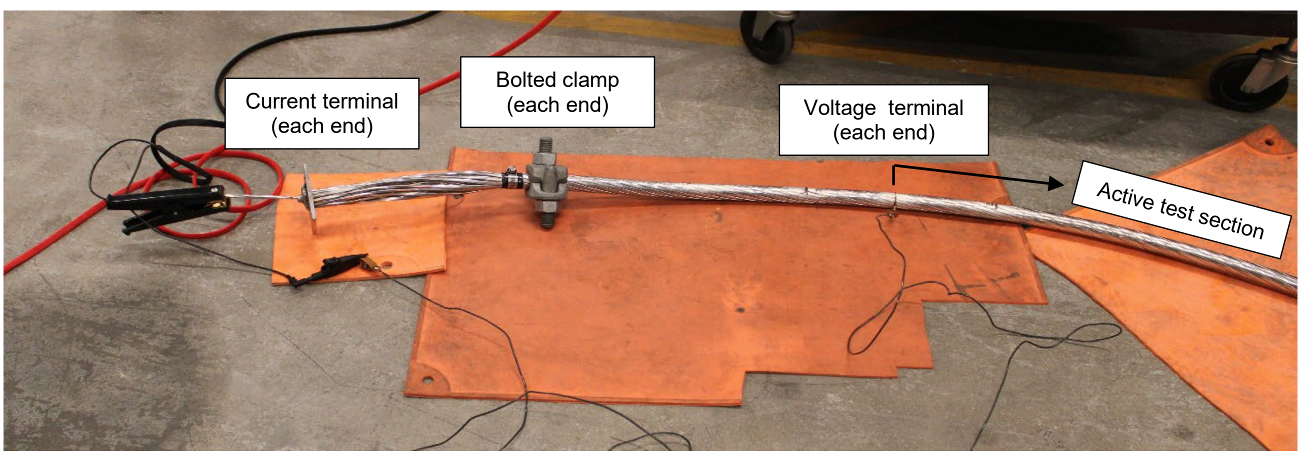

Figure 1: Voltage and Current Terminals, Typical Each End of the Sample

4.0 RESULTS

Table 2 shows the raw resistance reading and the values used to convert to the resistance to Ω/mi at 20 °C.

Table 2: Resistance Values and Conversions

Measured Resistance @ Temp. (mΩ)	Current Direction	Cond Temp (°C)	Resistance @ 20 °C (mΩ)*	Test Section (ft)	DC Resistance (Ω/mile @ 20 °C)
0.2594	(+)	20.8	0.2585	14.869	0.09181
0.2595	(+)	20.8	0.2586	14.869	0.09184
0.2595	(+)	20.8	0.2586	14.869	0.09184
0.2594	(-)	20.7	0.2586	14.869	0.09185
0.2594	(-)	20.7	0.2586	14.869	0.09185
0.2595	(-)	20.8	0.2586	14.869	0.09184
			*Resistance/ temp. Cx: 0.00416		

The average of the six (6) resistance measurements is 0.09184 Ω/mi with a standard deviation of 0.0000149 Ω/mi. The ± three-sigma confidence interval is 0.09180 Ω/mi to 0.09188 Ω/mi.

5.0 DISCUSSION / CONCLUSIONS

DC resistance is computed based upon the nominal strand area, the maximum allowable volume resistivity, and some stranding factors to account for the extra length of the helix strands. In the event of a discrepancy, a laboratory direct measurement is authoritative. As of this writing, there is no consensus standard covering polymer composite core conductors.

6.0 EQUIPMENT

VALHALLA Digital Low Resistance Ohmmeter, calibration control #CQ2209

Hewlett Packard 3468A Digital Multimeter, calibration control # CQ0106

OMEGA HH378 Thermocouple Reader, calibration control # CQ6766

Calibration Reference Resistor, 10A/100mV