DC Resistance for TS Ruddy 1098 kcmil Overhead Conductor

NEETRAC Project: 24-151

Final Report

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NEETRAC
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1.0 BACKGROUND

Idaho National Lad (INL) requested NEETRAC perform DC resistance tests on multiple advance transmission line conductors. This report is for TS Ruddy, 1098 kcmil overhead conductor.

DC resistance is easily measured by passing a known DC current through the conductor, and measuring the voltage drop over a defined length. 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 Electric Power Research Institute (EPRI) circa December 2025. The conductor is identified TS “Ruddy” M3 1098 kcmil. Table 1 shows the resistance and ampacity values per the manufacturer.

Table 1: TS Ruddy M3 Manufacturer’s Electrical Specifications

Electrical Specifications	Metric		Imperial	
DC Resistance at 20°C (Fully Annealed Al 63% IACS)	0.0501	ohm/km	0.0806	ohm/mile
DC Resistance at 25°C	0.0511	ohm/km	0.0823	ohm/mile
DC Resistance at 75°C	0.0615	ohm/km	0.0990	ohm/mile
Temperature Coefficient of Resistance at 20°C	0.00416	1/°C	0.00231	1/°F
Frequency	60	Hz	60	Hz
AC Resistance at 25°C	0.0526	ohm/km	0.0847	ohm/mile
AC Resistance at 75°C	0.0628	ohm/km	0.1011	ohm/mile
AC Resistance at 180°C	0.0842	ohm/km	0.1354	ohm/mile
Ampacity 4)		1846	@180°C, & A	
		1948	@200°C, & A	
GMR (estimated)	11.58	mm	0.0380	ft
Inductive Reactance	0.2466	ohm/km	0.397	ohm/mile
Capacitive Reactance	0.1458	Mohm-km	0.091	Mohm-mile

3.0 PROCEDURE

A bolted clamp (see Figure 1) was applied at each end of the 25-ft sample before cutting the sample from the reel. This preserves the as-manufactured position and pre-stress of each strand and each layer. All strands, including the aluminum core sheath, were puddle-welded into an aluminum plate that ensures balanced current flow to each strand including the aluminum cladding around the carbon-fiber core.

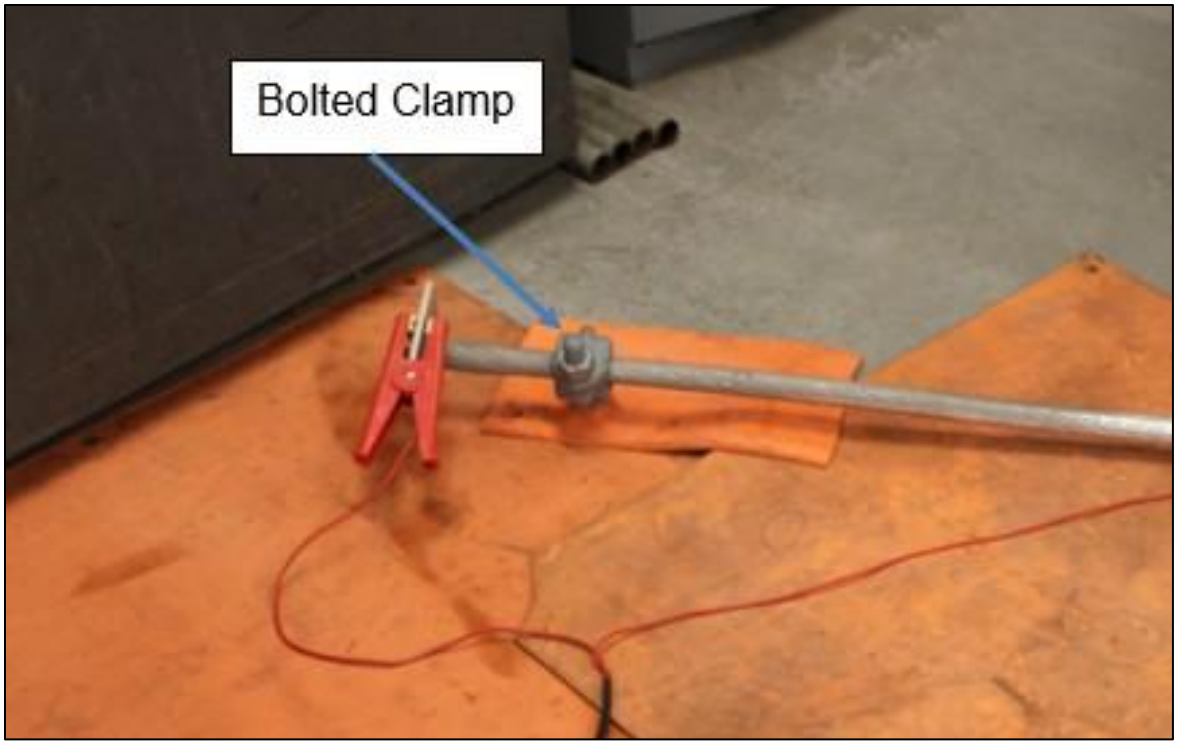

Figure 1 Bolted Clamp

Voltage terminals were applied inboard of the current terminals. Per industry practice, 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 distance between the copper terminals is measured using a metal tape to establish the gage section.

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 2 shows the four-wire test used to measure DC resistance.

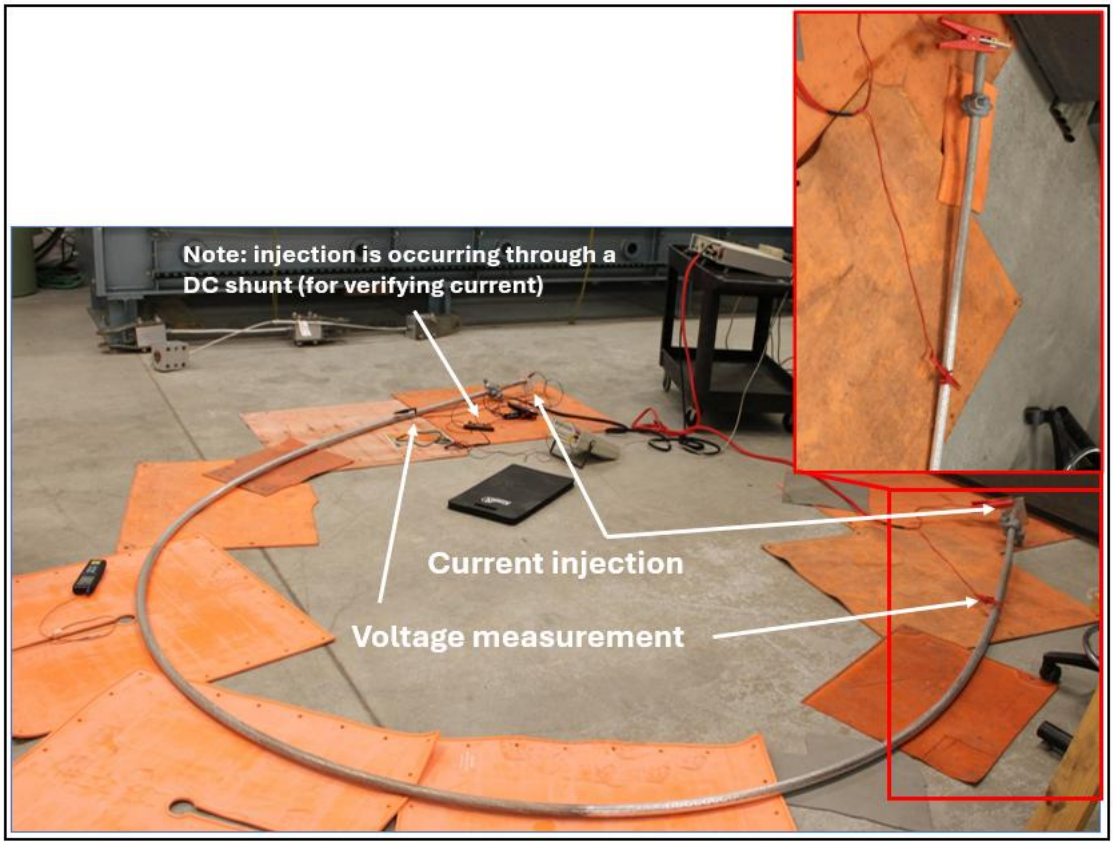

Figure 2: Four-wire measurement

4.0 RESULTS

Table 2 shows the DC resistance measurement taken, R-20 adjusted resistances using a coefficient of 0.00416 ohm/degree-C, and a comparison against the manufacturer's specification of 0.0806 ohm/mile. The average of all measurements is 0.0803 ohm/mi. A t-test was performed, comparing the measured resistance to the manufacturer's specification, and the manufacturer's specification is outside the 95% confidence upper bound of 0.0804 ohm/mi, as seen in Figure 3.

Table 2: Resistance Values and Conversions

Measured Resistance @ Temperature (mΩ)	Current Direction	Cond Temp (°C)	Resistance @ 20 °C (mΩ)	Test Section (ft)	DC Resistance Reading (ohm/mile)	Specification (Ω/mile)
0.0002944	(+)	23.0	0.0002908	19.07	0.08049	0.0806
0.0002939	(+)	23.0	0.0002903	19.07	0.08035	0.0806
0.0002938	(+)	23.0	0.0002902	19.07	0.08032	0.0806
0.0002938	(-)	23.0	0.0002902	19.07	0.08032	0.0806
0.0002935	(-)	23.0	0.0002899	19.07	0.08024	0.0806
0.0002936	(-)	23.0	0.0002900	19.07	0.08027	0.0806

5.0 DISCUSSION / CONCLUSIONS

All six DC resistance measurements met the manufacture's provided specifications, and the manufacturer's specified resistance was higher than the 95% confidence interval upper bound for the data, as seen in Figure 3.

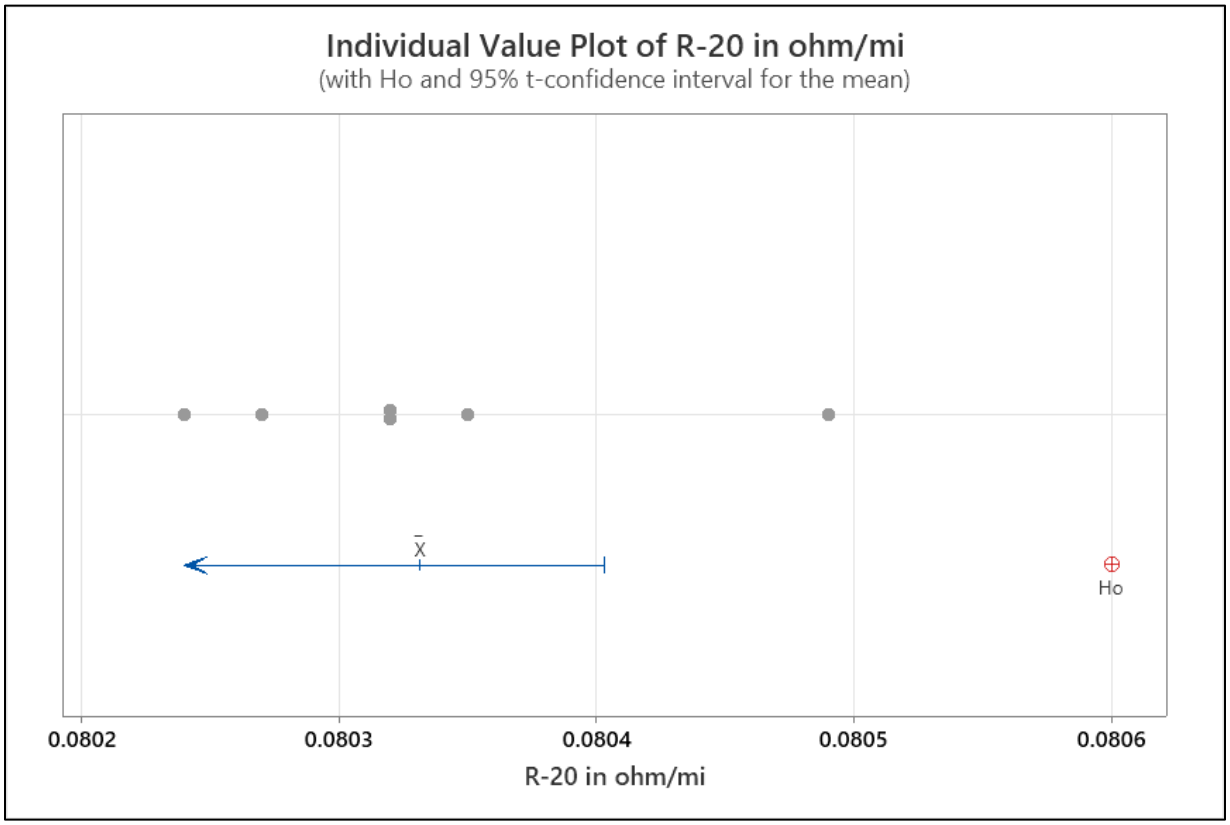

Figure 3 Individual Value Plot of R-20

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

Impro Calibration Reference Resistor, 501.183403 μΩ, calibration control number CN7843