

may not decrease the ACCR/TW/C⁷ Conductor's remaining tensile strength (test conductor after the breaking load test is shown in Figure 3-13).

ACCS Celanese (2016)

This section describes testing performed in 2016 on T13 aluminum conductor, composite supported trapezoidal wire conductor with a carbon fiber thermoplastic composite core (ACCS/TW/C⁷). This 995 kcmil conductor has an equivalent diameter as ACSR "Drake" conductor.

It consists of a core of seven carbon fiber thermoplastic composite (Celstran® CFR-TP) strands covered by twenty trapezoidal-shaped 1350-O aluminum wires stranded in two layers. The carbon fiber thermoplastic composite core consists of heat-resistant polyphenylene sulfide (PPS) polymer matrix enclosed in high-performance polyetheretherketone (PEEK) capping layer. The organic composite core was manufactured by Celanese and the conductor was stranded by Southwire.

The outside diameter of the Celanese ACCS C⁷-TW conductor is 1.108 inches, and its rated breaking strength (RBS) is 35,800 lbs. The diameter of the individual core strands is 0.136 inches, and the overall core diameter is 0.408 inches. The continuous rating temperature of T13 ACCS/TW/C⁷ conductor is defined in the technical data sheet as 180 °C.

Results

The following observations were made with regards to the breaking load tests on the North and South halves of the Celanese ACCS C⁷-TW dummy assembly:

1. The North half of the dummy assembly experienced a pull-out failure at 31,232 lb. or 87.2% of conductor's RBS.
2. The South half of the dummy assembly experienced a pull-out failure at 33,656 lb. or 94.0% of conductor's RBS.
3. Both samples failed inside their respective compression dead-ends.
4. The appearance of both failures was like that experienced by the test assembly (i.e., "pull-out" failure exhibiting ductile fracture of aluminum strands and intact composite core strands).

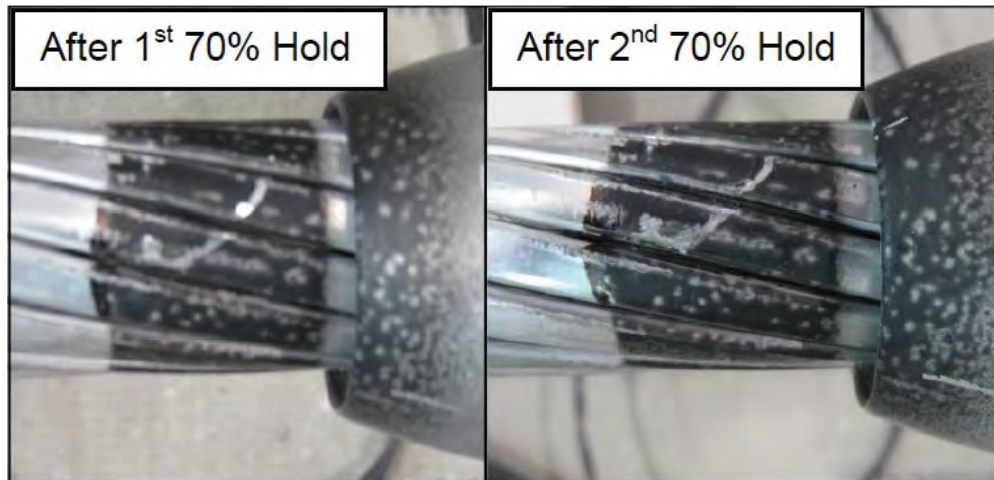


Figure 3-12. Movement at Mouth of North Dead-end Connector after 70% RBS Holds

The North and South mouths of the test dead-end connectors were marked to detect any slippage or conductor movement (Figure 3-14) during the Endurance Test. Movement of ~ 0.1 inches and ~ 0.06 inches (to a total of ~ 0.16 inches) was noticed at the mouth of both test dead-end connectors after the first and second 70% RBS holds, respectively. The test assembly experienced a failure at the North compression dead-end \sim forty (40) minutes into the third 70% RBS holding period (i.e., after 300 thermo-mechanical cycles). The appearance of the failure location is shown in Figure 3-15 through Figure 3-17.

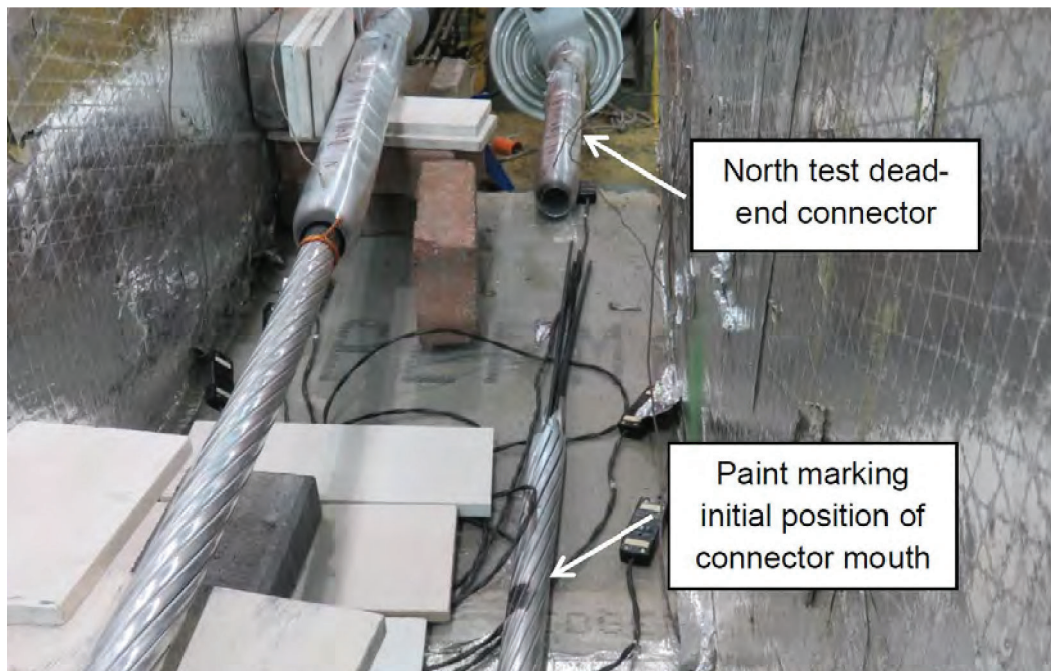


Figure 3-13. Failure at north test dead-end during 2016 Celanese ACCS C⁷-TW endurance test



Figure 3-14. Appearance of Celanese ACCS C⁷-TW aluminum strands after failure



Figure 3-15. Surface Condition of Organic Composite Core Strands from Celanese ACCS C⁷-TW after Failure

The organic composite core strands remained intact except for the PEEK capping layer in contact with the inside surface of the connector (Figure 3-17). All aluminum strands displayed a ductile fracture surface ~9 inches from the mouth of the North connector. The Celanese ACCS C⁷-TW test assembly appears to have “slipped” or “pulled-out” of the compression connector during the failure. This may have been caused by insufficient radial gripping strength of the dead-end connector on the organic composite core. Since there was no evidence of tensile failure in the core strands, the result may not represent the true breaking strength of the

Celanese ACCS C⁷-TW conductor after the completed number of thermo-mechanical cycles. All compression dead-ends were installed as per AFL's instructions, including the use of high temperature inhibiting compound. All four (4) connectors showed slight temperature increases overall (~5 °C to 8 °C) during the first 150 cycles. All four (4) connectors then showed good thermal stability during the last 150 cycles completed.

The Endurance Test was performed to demonstrate the performance of the ACCS/TW/C⁷ Conductor with Celstran® CFR-TP core when exposed to combined thermal and mechanical stresses. All steady-state temperature measurements taken along the Celanese ACCS C⁷-TW conductor and connectors of the test and dummy assemblies (i.e., conductor-connector system) showed good overall thermal stability during the three hundred (300) thermo-mechanical cycles. Failure of the test assembly occurred during the third 70% RBS holding period (i.e., after 300 cycles). The appearance of the Celanese ACCS C⁷-TW conductor components indicates that the cause of failure may have been due to insufficient radial gripping strength of the dead-end connector on the organic composite core.

The dummy assembly was cut in half to evaluate its remaining tensile strength. The North and South samples of the dummy assembly reached 87.2% and 94.0% RBS, respectively, during the Breaking Load Tests before pull out occurred. Both dummy samples exhibited similar "pull-out" failure modes to the failure observed on the test assembly.

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The Celanese ACCS C⁷-TW conductor was de-rated in 2017 after failing the previous set of endurance tests from a rated breaking strength (RBS) of 35,600 lb. to 33,500 lb. Therefore, this test is meant to evaluate the Celanese ACCS C⁷-TW conductor using the new de-rated RBS.

Results

The Celanese ACCS C⁷-TW test conductor passed 500 thermo-mechanical cycles and underwent the breaking load test afterwards.

The following observations were made with regards to the Breaking Load Tests on the Endurance Test assemblies: