# IMPACT OF FILLED-STRAND CONDUCTOR ON CONNECTOR TEMPERATURES FOR MEDIUM VOLTAGE JOINTS

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***ABSTRACT***

*The authors have investigated issues with connectors installed in medium voltage joints that were reportedly attributed to the use of conductors with different methods of water blocking and / or strand fill materials. Tests completed on connectors for 1/0 AWG conductor indicate that the currently used test for evaluating connectors for use in joints is insufficient. Therefore, some connectors installed on joints in underground cable systems are likely to reduce the ability of the system to operate at rated temperature, even for short periods of time.*

***KEYWORDS***

Cable, Accessory, Connector, Reliability

## INTRODUCTION

In recent years, reports have surfaced from both the field and laboratories in the US indicating possible problems with conductor connectors within medium voltage underground cable joints. The reported problems appear to be particularly severe in applications such as feeders that are heavily load cycled from low load to full load on a regular basis, especially when using conductor containing water blocking strand fill materials.

The impact of installing a compression connector on strand-filled conductor is not easily determined in a controlled and reproducible manner. There are many other additional factors that may influence the connector performance including size of connector, die and tool used to install the connector, wire brushing the conductor prior to connector installation, inhibitor, fill material used in the conductor strands, and skill of the installer.

In order to address these concerns, two connector / joint combinations were subjected to an in-air IEEE 404™ style load cycle test with the connectors installed in joints. Additional factors investigated in this test program included the issue of wire-brushing the conductor, and connector installation on conductor without a fill material and on conductors with two different fill materials. The same connectors were also evaluated using the ANSI C119.4 CCST (connector only) currently used to qualify connectors for use in medium voltage joints in the USA.

## IMPACT OF FILLED STRAND CONDUCTOR

### Test Materials

The components used to construct the test samples consist of two different compression connectors for 1/0 AWG (53.49 mm$^2$) aluminum conductor, three different conductors and cable, and two different joint installation kits. The "small" connector was approximately 55 mm in length and had an approximate diameter of 18 mm. The "large" connector was approximately 75 mm in length and had an approximate diameter of 24 mm. The 25 kV joint kits were obtained from two different manufacturers. One of the kits used a cold-shrink joint /small connector, and the other used a molded joint / large connector.

The medium voltage cable was a 25 kV class cable with a 1/0 AWG aluminum conductor, 260 mils (6.6 mm) of TRXLPE insulation, sixteen #14 AWG (2.08 mm$^2$) concentric neutrals, and an extruded LLDPE jacket. The cable was obtained from three different cable manufacturers resulting in cable samples that contained conductor having no strand fill material, and two different strand fill materials. Manufacturers of the medium voltage cable also supplied uninsulated (bare) lengths of the same conductor for use in the ANSI C119.4 tests.

### ANSI C119.4 Connector Tests

Samples including cable & connector were prepared according to the ANSI Standard and assembled into test loops. Due to the large number of connectors, the test samples were constructed in two loops that were tested separately. Welded equalizers were installed on the conductor between connectors as required by the ANSI standard. Sample resistance was measured between the equalizers on each side of the connector during the test. Changes in the conductor type were also made at the equalizers. A non-filled conductor was used for the control conductor.

In order to monitor the temperature of the connectors, probe-type thermocouples were installed in holes drilled into the center of each connector after the connector was crimped. Figure 1 shows a completed loop ready for test. Figure 2 shows a typical connector installed in the loop with the probe-type thermocouples in place.

**Figure 1: ANSI C119.4 Test Setup – Current Cycle Submersion Test (CCST)**

The test program consisted of 100 cycles of load current passed through the test loop to achieve a 100 ℃ rise over