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TECHNICAL MEMORANDUM
ON
OPERATING SUBSTATION CONDUCTORS AT 90°C

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ANDERSON™ CHANCE® FARGO® HUBBELL® OHIO/BRASS®

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The question of operating substation conductors at 90°C is becoming more prevalent. From a historical standpoint, past experiences generally relate to a 30°C rise over a 40°C ambient, or a 70°C operating temperature. The performance of substation connectors has been outstanding, in the overview, with relatively few problems being reported over the years (40 or more).

The various types of connectors involved provide a way to discuss the factors involved, as follows:

Welded Alum Connectors

This grouping of welded cable and tubular bus connectors allows the highest confidence that the conductors could be operated at a 90°C temperature. The aluminum conductors begin to anneal at 93°C, and this should be the only limitation. We have never had a question on the current carrying ability of a welded connection in service.

Bolted Brass Connectors

These connectors are used only with copper base conductors and questions related to thermal ratcheting, due to dissimilar metals, are not present. In addition, the connectors are designed and tested to run cooler than the associated conductors.

Of course, the bolted tubular connections should be the most stable, due to the close mating fit between the conductor and connector groove.

Bolted Aluminum Connectors for Tubular Bus

These connectors are designed to run cooler than the associated bus. Due to the close fit between the bus conductor and the contact grooves, coupled with the rigidity of the bus, it is believed that these connectors are satisfactory for use with conductors operating at 90°C.

Compression Connectors

Substation compression connectors are generally heavy duty, when compared to distribution connectors. The overhead distribution connectors were also initially designed for a 70°C (30°C rise over 40° ambient), but it is recognized that operation at higher temperatures has been fairly common over the years. Indeed, the companion UL 486 testing qualifies some of the connectors for use with 90°C conductor.

Accordingly, it is believed that the heavier duty substation/compression connectors can be recommended for the 90°C conductor operating temperatures.

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Bolted Aluminum Connectors for Cable

These connectors are also designed to run cooler than the associated conductors in a standard heat rise test. The existing NEMA Standard, CC-1, does not require any heat cycling tests. This is in contrast to the ANSI C119.4 overhead standard which includes a 500 cycle test. In the latter case, an extensive test program has been undertaken during the past few years, and a new AA class of connector is evolving. The test temperature has increased from a 100°C rise to a 175°C rise over ambient.

Some heat cycling tests have been performed on substation connectors. Although the testing has been limited, the results raise some questions on the cable connectors in the larger conductor sizes. Of course, there is no correlation between the heat cycle tests and field service in the substations, at this time. History and experience would suggest that the need for a heat cycling test may not be as critical for the stations, since it has not been required in the past and yet overall performance has been satisfactory.

Sealants

It is believed that the existing sealants are adequate for the 90°C class rating. The CC-1 heat rise tests are conducted at 100%, 125% and 150% of the conductor ratings. This increases the test temperatures to above the 90°C level. In addition, the base sealants are generally the same as those used in the ANSI C119.4 heat cycle tests, which bring the test conductors up to approximately 125°C. At conductor temperatures above the 90°C level, however, less confidence exists. The properties of the grease bases are affected by time and temperature and it is believed to be accumulative.

Heavy Duty Connectors

A heavy duty line of bolted connectors for aluminum stranded conductors is available. High confidence in operating these at the 90°C level exists. The connectors are massive, have extra clamping hardware and a special groove for clamping the conductor.

Summary

Based on our present knowledge, we believe that existing welded connectors can be recommended for use with conductors which are operated at temperatures up to 90°C. In addition, copper base connectors are adequate, along with aluminum tubular bus connectors. A heavy duty bolted line is available for aluminum stranded conductors. Compression connectors are also available and should operate satisfactorily with conductors at the higher 90°C temperatures.



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