138 kV Cable System Qualification to IEC 60840-2011 / ICEA S-108-720-2012 / AEIC CS-9-06

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ABSTRACT

Integration of conformance requirements from multiple standards remains akin to a high wire performance. Users express a preference for the cable system route via IEC and AEIC, whilst recognizing a value in the component approach (ICEA for cable and IEEE for accessories). This presents manufacturers with a considerable challenge. Consequently, a route to qualify two cable designs, outdoor terminations, oil filled and dry type GIS terminations, and straight and cross-bonded joints was developed by G&W and Viakable. An important factor in the design of the test loop for the manufacturers was the impact of the currents required to satisfy the thermal requirements of the relevant standards. The test program was conducted at NEETRAC. The cable system approach from the latest iterations of the AEIC and IEC standards as favored by Utilities is reinforced. Also, practical and critical limitations of IEEE 48 and IEEE 404 requirements that have been extended from the experience with Medium Voltage accessories are identified and discussed. These support current efforts underway to review the structure of these specifications.

KEYWORDS

Type test, Qualification test, XLPE cables, aluminum welded sheath, wire and tape sheath, outdoor terminations, oil filled and dry type GIS terminations, straight joints and cross-bonded joints

INTRODUCTION

To satisfy user needs, it is essential for manufacturers participating in national, regional and international markets for High Voltage Cable Systems to offer systems that meet the requirements of the most appropriate standards. The most common are the cable system standards IEC 60840:2011 [1] and/or AEIC CS-9-06 [2]. While both standards recognize the component approach to testing cable and accessories separately for cable systems rated up to 150 kV, most users require manufacturers to demonstrate satisfactory performance for a complete cable system. IEC 60840 provides requirements for both the component approach and system Type Approval Test (TAT) for cable systems rated up to 150 kV. On the other hand, AEIC CS9-06 refers to ICEA S-108-720-2012 [3] for cable, IEEE 48-2009 [4] for terminations, and IEEE 404-2012 [5] for joints for component testing and IEC 60840:2011 (with temperature modifications) for TAT on complete cable systems. The AEIC thermal cycles are performed at the emergency operation temperature for the system.

Many papers in previous JICABLE and Cigre conferences have presented qualification tests on HV and EHV systems in accordance with IEC or AEIC requirements. Papers [6,7] also describe a route to qualify a cable design rated at voltages above 150 kV to both IEC 62067 [8] and ICEA S-108-720.

A similar combination can be used for cable system designs rated up to 150 kV. However, the challenge becomes more complex, a high wire act, when manufacturers endeavor to combine the requirements from IEEE 48 and IEEE 404 with those of AEIC, IEC, and ICEA to create a “Super Combo Test” [9]. The boundaries of such a program are further stretched with the addition of system specifications needed to meet user needs: 2000 mm^2 segmental copper conductor for high transmission capacity, two sheath options for the cable core, multiple termination options including outdoor and GIS, and straight and cross-bonded joints. This paper describes the challenges encountered and addressed in the development of such a qualification test program for a 138 kV cable system. Experience from this work supports the efforts underway to revise the IEEE specifications.

DESIGN OF THE TEST LOOP

A “Super Combo Loop” (Figure 1) for IEEE/AEIC/IEC/ICEA Qualification Test that has the requisite length, number of accessories, and coverings (conduit) can be conceptualized. As shown in Figure 1, the resulting “Super Combo Loop” would also need to include the relevant component types for utilities discussed above. Considering all of the individual standard requirements, the resulting test loop is considerably longer than required by any one component standard with more accessories and cable (Figure 3 and Figure 4) typically 2-3 times the lengths of the minimum required by any of the cable system standards.