Experiences and Challenges of Combined HV & EHV Qualifications to IEC, AEIC and IEEE 48 & 404

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ABSTRACT

This paper focuses on the issues associated with bringing one or more of the IEEE cable accessory standards into the AEIC / IEC combination approach for cable system qualification. It first highlights the similarities and differences associated with the testing methods, test limits, and number of components/lengths of cable required by each standard. NEETRAC's experience with the AEIC / IEC combination approach from 2005 – 2014 is then reviewed with respect to the overall failure rate of each component type. Finally, the risks / benefits of combined qualification programs containing either complex test loops (i.e. number of components) and / or combined standards requirements is presented.

KEYWORDS

Cable qualifications, cable systems.

INTRODUCTION

The use of XLPE cable systems continues to increase in the Americas due to the economies that are achieved and high reliability of modern installations. As use of these systems increases in the utility space, so do the importance of qualification procedures. Currently US utilities are comfortable with the cable system approaches implemented in the latest iterations of the AEIC (CS-9 2006) & IEC (60840-2011 & 62067-2011) standards. However, the IEEE standards (48-2009 & 404-2012) are still seen to have some benefit and are used in some applications.

As described in the last Jicable Conference the combined AEIC / IEC [2] test approach (intercalation of the most searching/stringent elements of two separate standards) is well accepted by users. The use of the combined AEIC / IEC approach has led to the speculation that it may be possible to make further combinations, for example IEEE 48 [5] with IEEE 404 [6] or IEEE 48 & 404 with AEIC / IEC, etc. The attraction is the potential for reduced time and cost, on a per component basis, when compared with approaching the standards separately. Since Jicable11, the IEEE 404 standard was significantly updated; such that even if a combination may previously have been attractive, the current embodiments might make it much more difficult.

Thus, this paper focuses on the issues associated with bringing one or more of the IEEE standards into the combination approach. Each IEEE standard includes quite different test orders, philosophies on Pre & Post tests as well as requirements for test temperatures. Although, on paper, it is feasible to add an IEEE test to the well established IEC / AEIC combination (sometimes described as a *"Super Combo Test")* the technical elements are very stretching for the laboratory and cable system. Consequently, this presents an interesting Risk / Benefit optimization for those using this route. The optimization includes effects, which increase the risk, such as: number of cycles, likelihood of missed cycles due to the complexity of the requirements, increased number of accessories, elevated voltages, etc.

The paper focuses on three areas

1 Review of the current (2010 to 2014) test experience, similar to that previously reported by Pultrum et al [7] in CIRED09, with the combined (AEIC / IEC) and separate (IEEE) tests {to the recently revised standards}. The authors find higher success rates in tests than noted in those previously reported.

2 Consider the impact of the differing test factors in the standards (e.g. 2 h vs 6 h hold requirements for AEIC and IEEE, respectively, during load cycling) on test laboratories and cable systems. There will be particular focus on the impact of the temperature transients on accessories imposed by the required currents.

3 Use of available test experience (Figure 1) to quantitatively estimate the increased risks associated with added combinations of tests and components (i.e. typical 1-2 joints in IEC vs minimum of four required by IEEE), thereby more clearly understanding the value optimization scenario.

COMPARISON AND DEVELOPMENT OF COMBINED TESTS

Component vs System Style Tests

IEC adopts a cable system test approach requiring minimum quantities of cable and one of each accessory type to be included in the test. The user is then provided with some level of assurance that the whole system can work together. The IEC approach may conveniently be described as having three elements: Electrical Pre-Tests (PD and Tan δ), Load Cycle Tests, and Electrical Post-Tests (PD, Impulse, ac). There are optional Annexes, most commonly E & G that augment the main type test with assurance against water ingress for cable and joints.

IEEE and ICEA are component tests and only assign requirements to the specific component referred to in the specification, even though other components are required for the test. The user assumes that the component tests are sufficiently searching that when components are assembled in a utility system the components that may never have been integrated before will work reliably.

ICEA takes a similar elemental approach to IEC but without the Annexes.

The IEEE 48 approach may conveniently be described as having four elements: Electrical Pre-Tests (PD, Impulse, AC), Load Cycle Tests, Electrical Post-Tests (PD, Impulse, AC), and Leak / Pressure Tests. IEEE 404 is