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Comparison of IEEE383-2003 and IEC60505-2004 standards for harmonization of environmental qualification procedure of electric cable

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1. Introduction

Needs for harmonization of international equipment qualification(EQ) standards have been raised several years due to purchasing problem of nuclear equipments supplied from abroad country. To meet the regulatory requirement of domestic nuclear power plant, manufacturers have to qualify their equipments in accordance with each standard such as IEEE, IEC and RCC-E. Double qualification increase the equipment cost, which result in high construction cost. Even the unification of each standard have been discussed several years, we have got the long way to go yet. Comparison and harmonization of each international standard will give help to purchase the equipments qualified by not endorsed standard.

Environmental qualification, seismic qualification and EMI/EMC qualification are major targets for harmonization. Since concern about cable qualification of 60 years life has been raised recently, harmonization of cable qualification standard also needs to be discussed.

KEPRI launched a project for harmonization of EQ relative standards such as IEEE, IEC and RCC-E[1, 2]. A study for harmonization of IEEE323 and IEC60780 is known in progress by IEEE committee[3].

In this paper, harmonization of international standards for cable qualification will be discussed. IEEE383 standard is qualification standard for electric cable broadly used in Asian pacific area while IEC60505 is mostly used in European area. Since these two standards have different requirements for environmental qualification of cable, problem can be happened in the plant site when they purchase cable qualified by not endorsed standard. IEEE383-2003 and IEC60505-2004 is the latest version of each standard. Comparison results and recommendations for harmonization of these two standards are introduced herein.

2. Methods and Results

2.1 Introduction of IEEE383-2003 and IEC60505-2004

2.1.1 IEEE383-2003

IEEE383-2003 is a standard published by the institute of electrical and electronics engineers Inc. IEEE383-2003 was the first revision after IEEE383 was first issued in 1974. This standard provides general requirements, direction, and methods for qualifying class 1E electric cables, field splices, factory splices, and factory rework for service in nuclear power generating stations. Categories of cables covered are those used for power, control, and instrumentation services, including signal and communication cables. The purpose of this standard is to provide specific direction for the implementation of IEEE 323-1983 as it pertains to the qualification of electrical cables and field splices.

2.1.2 IEEE60505-2004

IEC60*505-2004* is a standard published by international electrotechnical commission. This International standard establishes the basis for estimating the ageing of electrical insulation systems(EIS) under conditions of either electrical, thermal, mechanical, environmental stresses or combinations of these multifactor stresses. It specifies the principles and procedures that should be followed, during the development of EIS functional test and evaluation procedures, to establish the estimated service life for a specific EIS.

2.2 Comparison of IEEE383-2003 and IEC60505-2004

2.2.1 Scope

Scope of IEEE383-2003 is bounded for electric, cables, field splices, factory splices, and factory rework for service in nuclear power generating stations while IEC60505-2004 is applicable to electrical the ageing of electrical insulation systems(EIS) under conditions of either electrical, thermal, mechanical, environmental stresses or combinations of these (multifactor stresses). Scope of IEEE383-2003 is Class 1E electric cables and splice while the scope of IEC60505-2004 is electrical insulation systems. Since the qualification of cable is basically focused on electric insulation system(EIS), the scope of these two standards are not quite different.

2.2.2 Principle of qualification

IEEE383-2003 uses the method of type testing, operating experience, analysis, extending qualified life and combined method for qualification. IEC60505-2004 describes the methods of functional ageing tests, evaluation by service experience data only. Requirement of these two standards for safety function test, representative of test sample, severe test condition are similar. IEC60505-2004 requires five test samples for test while IEEE383-2003 requires random selection of 2 sample(aged and unaged). IEC60505-2004 requires that the service experience data shall be restrict to very similar system and IEEE383-2003 limit the use of operating experience for DBE qualification. There is no description for extending qualified life, combined qualification in IEC60505-2004. When we combine the general qualification requirement of IEC60780 with IEC60505, IEC60505 is not quite different from IEE383 for principle of qualification. To solve the difference of test sample amount in IEEE383-2003 and IEC60505-2004, study for background of test amount is required.

2.2.3 Age conditioning

Both IEEE383-2003 and IEC60505-2004 have Age conditioning requirement pertains to temperature and radiation, applied either simultaneously or sequentially, in an accelerated manner. Consideration of synergistic effects and application of arrhenius method for accelerated aging is same. IEEE383-2003 use two samples(aged and unaged) for test while IEC60505-2004 use a minimum of five test samples aged.

Requirement of aging time and temperature interval is different between IEEE383-2003 and IEC60505-2004. IEEE323-2003 has 100 hour aging requirement while IEC60505-2004 has a minimum of 5000 hour aging requirement. Requirement for separated test specimen of insulation and jacket material is similar

2.2.4 Type test procedure

IEEE383-2003 has requirements for single, multi conductor, multiplex cable, coaxial, tri-axial, twin-axial cables and field splices while IEC60505 has no description for above. IEEE383-2003 has 3.05m length requirement of test cable while IEC60505 has no length requirement. IEC60505-2004 has no requirement for cable coiling and straightening during the aging test which is crucial for cable test in accordance with IEEE383-2003. Voltage withstand test requirement is different between IEEE383-2003 and IEC60664-1(Insulation coordination for equipment within low-voltage systems part 1: principles, requirements and tests) IEEE383-2003 has voltage requirement based on insulation thickness(80Vac/mil) while IEC60664-1 describe that it is not appropriate to specify the minimum thickness of solid insulation to achieve long-term electric withstand capability. Overvoltage requirement of IEC60505-2004 for each category of nominal voltage is shown on fig.1. Equipment of overvoltage category I is equipment for connection to circuits in which measures are taken to limit transient overvoltage to an appropriately low level. Equipment of overvoltage category II is energy-consuming equipment to be supplied from the fixed installation. Equipment of overvoltage category III is equipment in fixed installations and for cases where the reliability and the availability of the equipment is subject to special requirement. Equipment of overvoltage category IV is for use at the origin of the installation.

For flame test qualification, IEEE383-2003 authorizes IEEE Std 1202-1991 or NFPA 262-2002 while IEC60505-2004 has no description.

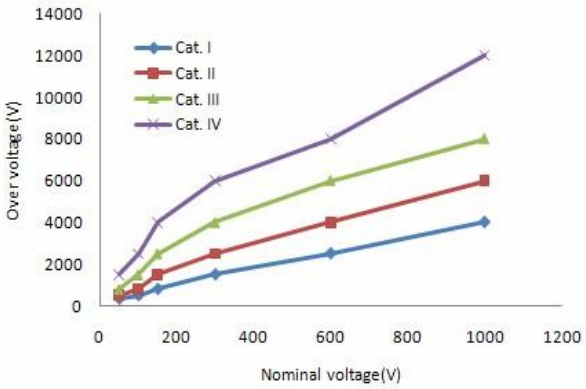

Fig. 1 Overvoltage for nominal voltage

3. Conclusions

Comparisons of scope, principle of qualification, age conditioning, type test procedure for IEEE383-2003 and IEC60505-2004 were implemented.

IEEE383 and IEC60505 have similar scope of electric insulation system. Application of arrhenius equation, consideration of synergistic effects are same. Sample amount, minimum aging time, cable coiling & straightening requirement during the aging test and voltage withstand test requirement are quite different. For the harmonization of these differences, study on the background of each requirement is required.

REFERENCES

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