IEEE 323-2003 to IEC/IEEE 6078-323: 2016 Changes

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***Abstract*—IEC/IEEE 60780-323 latest revision was approved in January of 2016. This is a revision to the 2003 edition of IEEE 323 and harmonized with IEC 60780 dated 1998. This paper reviews the major changes and provides some insight as to why the changes were made.**

***Index Terms*—Equipment, Class 1E, IEEE 323, LOCA qualification, nuclear facility, qualified life.**

I. Introduction

IEEE 323 was first published in 1971 as a trial use standard. The first revision was in 1974 that included aging with subsequent revisions in 1984 and 2003. The 2003 version of IEEE Std 323 also expanded on its use in mild environments, updated margins (only recommending one transient), addressed electromagnetic interference (EMI) and radio-frequency interference (RFI) for new digital and advanced analog systems and added information on qualified condition. IEC 60780 was based on IEEE 323 and was first published in 1984 with a subsequent revision in 1998. There were a few years of initial work to harmonize the two documents with this being completed in 2016.

The primary driver for this revision was to harmonize IEEE and IEC. This revision also took into account the need to reassess and extend the qualified life of electrical equipment regarding projects to extend the operating life of nuclear facilities. This revision incorporates current practices and lessons learned from the implementation of previous versions of this standard by the nuclear industry. There were more than 40 changes to previous revision.

Several issues are clarified or changed in this revision:

This standard defines the methods for equipment qualification when it is desired to qualify equipment for the applications in the environments to which it may be exposed. This standard is generally utilized for qualification of all electrical equipment important to safety in accordance with IAEA terminology. The documentation and test requirements are, however, more rigorous for equipment located in a harsh environment.

The test margins have been updated to better identify the parameters that achieve test margin on design basis event profiles.

An important concept in equipment qualification is the recognition that significant degradation could be caused by ageing mechanisms occurring from the environments during the service life, and therefore equipment important to safety should be brought to the end of qualified life (operating ageing) prior to imposing design basis event simulations. Previous versions recognized that the period of time for which acceptable performance was demonstrated is the qualified life. The qualified life does not include the time during or after the accident conditions for which qualification is demonstrated (mission time). The concept of qualified life continues in this revision. This revision also recognizes that the condition of the equipment for which acceptable performance was demonstrated is the qualified condition. Thus, new license renewal and life extension options are available by ensuring that qualified equipment continues to remain in a qualified condition.

There were many items considered and the items where consensus was established were added. Some items were discussed, but not added. Future activities of the working group to update this standard will consider the following:

1. Experience and knowledge gained by using condition monitoring techniques.
2. Knowledge gained on ageing mechanisms and kinetics.
3. Significance of refinements in ageing mechanisms, equipment sealing, interfaces, extrapolation, similarity, test sequence and parameters (such as ramp rates, time duration,

timing of spray initiation and its duration), and qualification documentation.

II. Title

The number was change from IEEE 323-2003 to IEEE 60780-323: 2016 to indicate the harmonization of the two standards.

The title was change from IEEE Standard for Qualifying Class 1E Equipment for Nuclear Power Generation Stations to Nuclear Facilities – Electrical Equipment Important to Safety – Qualification. This expanded the scope to Nuclear Facilities

Class 1E equipment was changed electrical equipment important to safety in the title. The definition of Electrical equipment important to safety includes the base definition of class 1E for use in IEEE standards. The title was changed from nuclear power generating stations to nuclear facilities. This is consistent with IEEE 627 *IEEE Standard for Qualification of Equipment Used in Nuclear Facilities* which is the parent document to IEC/IEEE 60780-323.

III. Scope

The scope changed to scope and object per style manual. Added "Other aspects, relating to quality assurance, selection and use of electronic devices, design and modification of digital systems are not part of this standard."

IV. General

Throughout the document "Class 1E equipment" was changed to "electrical equipment important to safety". "Safety related electric equipment" was changed to "electrical equipment important to safety".

Note – Class 1E definition has been retained and definition of Electrical equipment important to safety includes base definition of class 1E for use in IEEE standards.

V. References

References were changed to normative references as per the style manual with the required text. Documents were limited to those used as requirements in the body of the document. Other documents were moved to the Bibliography. Note IEEE 344 and IEC 60980 are being harmonized now.

VI. Terms and Definitions

Definitions were changed to terms and definitions as per the style manual with required text. Definitions were reviewed per IAEA Safety Glossary as per the agreement with IEC.

1. Age conditioning was modified using portions of the definition of accelerated aging from IEC 60780.
2. Definition of aging was taken from IAEA safety glossary.
3. The note under Class 1E was deleted. This note is correct for this standard, but was deleted since it could be misinterpreted in general Also electric equipment was changed to electrical equipment.
4. Common cause failure was added from IAEA.
5. Definition of components was modified from IAEA.
6. Condition indicator was modified from the IAEA definition. Note information that was in IEEE definition is contained in the text
7. Design life definition was deleted (Note, this is in IEEE 572-2006).
8. Design extension conditions was added based on IAEA Safety standards series SSR2/1:2012.
9. A note was added to equipment to add some examples.
10. A definition of equipment important to safety was added. This is in 2 parts to take into account how IEC standards interpret this and how IEEE standards interpret this.
11. The note was deleted under equipment qualification. Definition is original definition from IEEE. This is similar to the IAEA definition, but modified.
12. Definition of Equipment similarity was added.
13. Definition of harsh environment was modified. The modification is considered editorial but is different from Annex C in IEEE 572.
14. The definition of interfaces was updated. The modification is considered editorial.
15. Definition of Mild Environment changes normal operated occurrences to anticipated operated occurrences.
16. Definition of qualified condition has an added sentence. This is editorial
17. Definition of qualified life is from IAEA instead of the latest IEEE definition. This is an earlier version of the IEEE definition and is different from Annex C in IEEE 572.
18. Service conditions definition was modified from the IAEA definition.
19. Service life was modified to be in accordance to the IAEA definition. Change is considered editorial
20. Severe accident definition from IAEA was added.
21. Symbols and abbreviations were added. Note, may now use these in the text such as DBE for design basis event

VII. Qualification

There were a variety of changes regarding qualification.

In 5.1 “for which a qualified life or condition has been established” was deleted. This is editorial since the requirement to establish a qualified life is still there. A paragraph was added on design extension condition. Section on equipment located in a mild environment was rewritten.

In 5.2 common cause was deleted before failure. Consideration for post-accident conditions was added. Added last 2 paragraphs.

In 5.3 editorial edits. Some information moved to other areas

In 5.4 added: All activities that are required to maintain qualification during the qualified life shall be included in the documentation.

VIII. QUALIFICATION METHODS

Additional information for qualification methods was added.

In 6.1.1 some editorial and added “Equipment qualification testing shall be performed with equipment functioning in a state representative of its intended use in actual operation (including any software).”

In 6.1.2 added: “When qualification for mild environment is required,” before operating experience. This is to indicate that operating experience alone is only applicable to mild environments.

6.1.3 on Analysis was rewritten for clarity. Changes are editorial.

In 6.2 changed extension of qualified life to reassessment of qualified life. This is to highlight that change in qualified life may be longer or shorter. This section was re-written for clarity and broken into multiple methods.

6.3 on condition monitoring was expanded. “Since measurements for condition indicators may be taken at one temperature, additional data may be required to provide a correlation with time and temperature.” was added.

IV. QUALIFICTION PROGRAM

Information was added regarding the qualification program.

7.2.2 added additional information on equipment identification.

In 7.2.3 additional information on interfaces was added.

In 7.2.5 additional information to be specified was noted.

In 7.2.6.3 added information on design extension condition.

In 7.2.6.4 added information on electromagnetic conditions.

V. QUALIFICATION PLAN

In 7.3.2 aging factors to consider were revised to be consistent with other areas.

In 7.3.3 modified examples of significant aging mechanisms.

In 7.3.4 noted that margin should be considered as part of the qualified life objective.

In 7.3.5 noted that margins are to be preserved while utilizing provisions for reassessing qualified life. Additional information including hardware/software version (for programmable components) was added. Figure on margin was deleted.

VI. TYPE TESTING

In 7.4.1.6 on monitoring, accuracy was added. “Measurements performed during type testing shall be used to demonstrate acceptability of safety function(s) and to track relevant changes in the characteristics and degradation of the equipment occurring during the test program.” was added.

In 7.4.1.7 margin was consolidated into a table and some notes added.

In 7.4.1.8 noted EMI/RFI sample and samples for operational test under limit conditions can be performed on a separate sample. Paragraph on qualification testing of programmable equipment was added. The consistency in the product line shall be maintained through a nationally recognized quality assurance program was added. Added reference to IEC 62003 and IEC 60980. Additional editorial changes including noting end condition for condition monitoring only included normal thermal and radiation exposure.

In 7.4.1.9.1 added moisture to types of aging.

In 7.4.1.9.2 added: “For equipment located in mild environment applications,” before natural aging. This is to indicate that natural aging alone is only applicable to mild environments. This is similar to 6.12

In 7.4.1.9.3 added information, some of which was from IEC 60780 on additions cautions for aging. As an example added: It is not acceptable to exceed temperatures causing qualitative changes in the physical properties and chemical properties. Should the physical size of the equipment be too great for the available irradiation facility to handle, it is permissible for the radiation-sensitive components to be removed from the equipment and aged as individual equipment (before reassembling it) if the components are held in appropriate

fixtures representative of material content and configuration to simulate actual service conditions.

When determining the radiation dose and dose rate for radiation ageing, or temperature for thermal ageing, oxidation and gaseous diffusion effects should be taken into account. For radiation ageing, it is always better to apply a total dose higher than the dose corresponding to the expected service life, so as to obtain a margin taking all these elements into account.

VII. INFORMATION

7.4.1.10 was added that provides information on accident condition tests.

7.4.1.11 editorial changes.

7.5.1 editorial changes and to delete DBE.

7.6 additional information on similarity.

7.7 additional information on modifications including: Any modification to equipment shall be traced in a unique document referencing justification of acceptance regarding qualification issue.

Any change in design shall be done with respect to system, hardware and software verification and validation process regarding existing nuclear standards and with respect to safety classification of equipment.

VIII. DOCUMENTATION & BIBLIOGRAPHY

Section 8 on documentation has added information including: For digital devices, test cases shall be described in detail to demonstrate sufficient coverage regarding functional performance (for example, response time, accuracy) and electrical performance.

Annex A (that is referenced in the Scope of IEEE 572) is now the Bibliography. IAEA and IEC information was added to the bibliography. NUREG information was deleted.

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