IEEE 383 White Paper Changes 2003 to 2015

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Introduction

- IEEE 383 was First Published in 1974
  - First Revision in 2003
  - Current Revision is 2015
- This Presentation Reviews Major Changes From 2003 to 2015
  - Provides Some Insight as to Why the Changes Were Made
- Many Changes Were Made to Update IEEE 383-2105:
  - **Considering Life Extension from 40 years 60 years**
  - **New Plant Designs for Cables and Splices Starting at 60 year Qualified Life**
  - **Subsequent Life Extension From 60 year to 80 years and Beyond**
  - **Lessoned Learned in The Past 12 Years**

Next Revision

- Many Items Considered
  - Items Where Consensus was Established were Added
- The Following are Some Items Discussed That will be Considered for the Next Revision:
  - Information on Condition Monitoring
  - How to Handle High Beta Radiation
  - Jacket Sump Issues as They Pertain to Qualification
  - Splices and Cables Being Qualified Together as a System

Class 1E

- IEEE 383-2015 Title: *IEEE Standard for Qualifying Electric Cables and Splices for Nuclear Facilities*
- Class 1E was Deleted From the Title, Scope and Purpose
  - **Deleting Class 1E is Consistent With Changes in IEC/IEEE 60780-323 That use the Term "Important to Safety"**
  - **This also Recognizes that this Standard has also Been used for Cables that are Not Class 1E**

Field Splices to Splices

- "Field Splices" was Changed to "Splices" in the Title and Throughout the Document
  - **There is a Caveat on Qualification of Cables and Splices Within Equipment that Allows them to be Qualified with Equipment**
- In the Scope "field" was Deleted before Splice, Factory Splices and Factory Rework as no Longer Being Required as These are Covered by the More Generic Term of Splice and Cable
  - **These all Still Require Qualification as Noted in the Body of the Document if they are Used**

Nuclear Power Generating Stations to Nuclear Facilities

- 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 That has also Been Changed to use Nuclear Facilities in the Title**

Direction

- The Word “direction” was Deleted in the Scope
  - Similar Change in Purpose Changing “direction” to “standard methodology”
  - **This Recognizes that IEEE 383 is over 40 years old now and Provides More than Direction for Qualifying Cable**
    - **It Should be Noted Though that this does not Mean that Everything is a Cookbook and Additional Testing may not be Required in Special Cases**
- Purpose was Modified in a Similar Manner as Scope Changing “specific direction” to “standardized methodology”

Simplified Scope

- Scope was Simplified
  - Includes Changes to be Consistent with Title
- The sentences:
- “Categories of cables covered are those used for power, control, and instrumentation services, including signal and communication cables.
- Field cables, wires, and splices are within the scope of this standard.”
- Were Deleted as this was Considered not to be Required

IEEE 323 Date

- The Date was Updated on IEEE 323 to the Latest Date at the Time IEEE 383-2015 was Written
  - A New Version (IEC/IEEE 60780-323:2016) is out and This Will be Reviewed for Changes in the Next Version
  - Note, this was Done Throughout the Document

As Appropriate

- Cable, wire, and splices within or integral to other devices (e.g., instruments, panels, motors) should be qualified using the requirements in the applicable device standard or IEEE Std 323-2003~~, as appropriate~~.
- The Term "as appropriate" was Deleted as an Editorial Change
  - **This is Implied, and Noted in the Next Sentence that this Standard may be used for Those Cases (However, this standard's requirements may be applied to the cable, wire, and splices within these deices.)**
- IEEE 572, States that Qualification of Cable with Connectors to this Standard does not Replace Qualification to IEEE 383
  - It Further States that the Cable Part of the Connection Assembly Shall be Qualified in Accordance to IEEE 383

Fiber Optic Cables

- IEEE 383 is to Qualify Electric Cables, To be Clear Added:
  - For Qualification of Fiber Optic Cable Refer to IEEE Std 1682.
    - This is to Cite the Document for Fiber Optic Qualification

References

- References Changed to Normative References
  - Per the Style Manual with the Required Text
- Limited to Those used as Requirements in Body of Document
  - Other Documents Moved to the Bibliography
- IEEE 627 not Listed as a Normative Reference Since this is an Upper tier to IEEE 323
  - IEEE 627 was Added a Reference in the Bibliography
- Titles and Dates Updated to the Latest Published Standard

References

- ICEA T-27-581 Added as this was Added in the Document
- ICEA T-22-294 Added as this was Added in the Document, but without a date.
  - It was Known that a Revision was in Process but had not Been Published, so Date was left off to Refer to Latest Version
    - Note the Document has Since Been Issued
- ICEA S-97-682 Added as this was Added in the Document
- NFPA 262 Deleted as this is no Longer Referenced
- UL 44 and UL 2556 Added
  - These were Added in the Document

Definitions

- Text Under Definitions was Updated Based on Style Manual
  - Reference to IEEE 100 online now, so Bibliography Reference was Deleted
- Definition of Nuclear Facilities Added Since There is not one in IEEE
  - **This is Adapted from the IAEA Safety Glossary 2007 Edition**
- Definition of Representative Cable Revised to Change Same or Higher Service Rating to the Same Voltage Class
  - Also “same or higher volts per mil operating level” changed to “same or higher operating electrical stress level”
    - **This is Consistent with Original Intent, but does Change this Section**
  - Same Changes Made to the Definition of Representative Splice
- Definition of “wire” was added Since this is Listed in the Scope
  - **Definition was the Consensus of the Group for use in this Document**

Type Test Selection – Thermoplastic

- A Variety of Changes Regarding Type Test Selection
- In 6.2.2 added:
  - "When the insulation and jacket are thermoset, the qualification shall proceed as outlined in this subclause. If one or more of the materials are thermoplastic, or if radiation can improve the performance of the materials, additional samples that have not been thermally aged or irradiated shall also be included in DBE testing."
    - **Generally Thermoset Materials used for Nuclear Applications in the US**
    - **This Section Added Based on Experience Using Thermoplastic Material that was Crosslinked by Irradiating the Cable First, but Without this the Material Would have Melted in the High Temperature of the Test and Failed**
- In 6.5.3 Information added for Additional Samples as above.

Type Test Selection – Colors & Power Cable

- In 6.2.2 added:
  - "Reasoning for choice of colors tested shall be documented."
    - **Generally in the US Testing Would be Done by the Manufacturer to Ensure Proper Choice of Colorant but this May not be True in Other Parts of the World**
- In 6.2.2 added:
  - "Separate power cable sample (s) may be needed because power cable shall be at rated voltage and rated current when tested. Determination of rated current should consider the cable test configuration and design ambient temperature."
    - **Added Since 1974 Version had Specific Cables called out Including Power Cables**
    - **In the 2003 Version it Could be Interpreted that a Small Gauge Cable with Little Current Flow Could Qualify a Power Cable**

Type Test Selection – Samples

- In 6.2.2 the Following was Modified:
  - "Qualification of a type test sample cable shall qualify cable with the same insulation thickness and with heavier thickness without regard to voltage rating, but within the same voltage class (e.g., 5 kV qualifies 15 kV, and 600 V wall thickness qualifies 1000 V walls) if and only if the same or higher operating voltage stress level is maintained. For low voltage cables, the same or higher average voltage stress (e.g. V/mil or kV/mm) at the operating level voltage is required. For medium-voltage cables and coaxial cables, the applied peak voltage stress (e.g. V/mil or kV/mm) during the test shall be equal to or greater than the peak voltage stress that a test sample of the higher voltage rating would require."
    - **This is Consistent with the Changes in the Definitions**

Type Test Selection – Splices

- In 6.2.4 Wording was Added to Clarify Splice Sample Selection that Includes Representative Number of Conductors, Functional Configurations and Components Shall be Used
  - “To qualify a multiconductor splice (i.e., electrically interconnecting three or more conductors) ~~shall qualify splices with~~), similar design characteristics., including a representative number of conductors, functional configurations, and components, shall be used.

Additional Information

- Additional Information for Documentation was Added
  - **It was not Considered that all the Information was Significant, but it was Considered that Additional Information may be Useful in the Future**
- In 6.3.2.1 added:
  - "and the stranding configuration (i.e., round, compressed or compact)."
    - **Get More Detail on the Conductor Used**
- In 6.3.2.2 Semiconducting was Changed to
  - "stress control layers/".
    - **This is Because not all Stress Control Layers are Semiconducting per ICEA**
- In 6.3.2.4 "and percent coverage for braided shields, percent overlap and lay of tape shields, and information on other shields such as insulation or overall static shield" was added
  - **Get More Detail on the Shielding used**

Additional Information – More Details

- In 6.3.2.5, Modified Wording Editorially to be Clear on Information Needed to Identify Fillers and Binders
- In 6.3.2.8,"the date of applicable manufacturing standards, and the date of manufacture" was added
- In 6.3.3.4 "shields (e.g., in medium-voltage splices)," was added
- In 6.3.3.5 "Other examples of pertinent service requirements include, but are not limited to, voltage, current, frequency, conductor temperature, and ambient conditions." was added
- In 6.3.3.6, "the date of applicable manufacturing standards and the date of manufacture" was added

Aging – 5000 Hours Minimum

- A lot of Information on Aging is Contained in IEEE 98, but Many People Have Missed Information in this Standard
  - **Critical information was put in IEEE 383**
- In 6.4, Arrhenius Method Changed to just Method and Shall Conform to IEEE 98 and 101 plus Guidance in IEEE 1 are required
  - **This is to note that any method chosen shall be to these standards**
- In 6.5.1, "The lowest exposure temperature shall give a life of more than 5000 hours." was added
  - **Always Been in IEEE 98 but is Repeated to Emphasize This Point**

Aging – Sample

- In 6.5.1 added, “Sample form, size and shape shall be considered. The sample thickness shall be representative of what will be used in service.”
  - **This is also from IEEE 98 but is Repeated to Emphasize this Point**
- In the footnote it was noted that IEEE 1064 and 775 are withdrawn
- In 6.5.2 added, “if the orientation of compound, crystallinity, and thickness is representative of what will be used in service”
  - **Added Based Experience with High Temperature Thermoplastics where Extrusion can Orient the Polymer and how it is Cooled can affect Crystallinity of the Cable**
  - **Some Designs may be use Thin Insulation and if so Should be Tested That Way**

Aging

- In 6.5.2, the additional information on inert atmospheres was deleted since it may be misinterpreted to think aging was not required
- In 6.5.2 d), clarified that coiling was to be done around a mandrel
- In 6.5.2 d), changed as follows “80 Vac/mil (3.15 kVac/mm) of insulation thickness at a nominal line frequency of 50 Hz or 60 Hz or 240 Vdc/mil (9.45 kVdc/mm) of insulation thickness.”
  - **Highlight Based on Insulation Thickness at Nominal Frequency of 50/60 Hz**
    - Metric Equivalents also added

DBE

- In 6.5.4.1 added: “The qualification type tests for coaxial, triaxial, twinaxial and data/communication cables should include sufficient testing of cable’s critical electrical performance characteristics to permit an adequate analysis of the compatibility of the cables for the specific application, as appropriate.”
  - **This was Adopted from RG 1.211**

Section 7 Normal and Mild Qualification

- In Section 7, “and Section 6.5.2.” was added
  - **Added to Emphasize that Thermal and Radiation Exposure for Normal Service Testing to Section 6.5.2 is Required**
- Added, “Qualification of low voltages cables shall include long term water immersion testing to ICEA T-22-294 at 90°C with both ac and dc voltage at the cable’s rated voltage for at least one year without failure of the sample and with insulation resistance meeting the requirements of ICEA T-27-581/NEMA WC53-2008, section 2.15.”
  - **Consensus Minimum Test to Address Cable in a Wet or Submerged Environment**
- Added, “Qualification for submergence of medium voltage cables shall be ICEA S-97-682 for at least one year in the accelerated water treeing test”
  - **Consensus Minimum to Address MV Cable in a Wet or Submerged Environment**
    - ICEA is Being Updated to Add This as an Appendix

Section 8 Flame Testing

- Rewritten as follows:
  - “All cables shall not propagate flame and shall be rated as such by passing the vertical tray flame propagation test requirements of **IEEE Std 1202 and UL VW-1** as noted below. In addition the testing shall include samples which have been **aged and irradiated** to the normal thermal and radiation levels of the plant environment per 6.5.2. Change in **jacket color** is considered a new design and shall be tested. Switchboard cables, coaxial, twinaxial, and triaxial cables not installed in tray may only be required to pass the UL VW-1 flame test. **Single conductors** going into multiconductor cables rated 2000 volts or less shall pass the **UL VW-1** test. UL VW-1flame test shall be per UL 2556-2013 with the criteria in UL 44-2014 except that for coaxial, triaxial and twinaxial cables, the size tested shall be the actual cable size.”

Flame Testing

- **Clarify** Intention that **Singles** be Flame Retardant as well as Cable
  - Pass **VW-1**
- Information on **Jacket Color** Effecting Flame Testing Added Since has Been Issue on Low Smoke Zero Halogen Materials in the Past
- **Aged Flame Test** was Added Since Some Issues were Brought up with Low Smoke Zero Halogen Cables After Aging
- "For cables that need to a fire rating IEEE P1844 may be used."
  - Highlight New Standard Being Completed that Covers this Area
    - Note, this Standard was Published in 2015 after IEEE 383

Documentation

- In 9.1 added, “Documentation should also include manufacturer’s inspection and maintenance requirements”
  - Provides Addition Documentation

Section 10 Modifications

- Added, “Generally a change in a large portion of compound such as the base resin will require new qualification, but also small changes such as those of an antioxidant (which may only be 1% of the formulation) may also require new Arrhenius aging as well as DBE testing. Ingredient name changes will require a review, but may or may not require new testing depending upon the circumstance. Changes should always be documented, but effect on qualification is sometimes hard to judge. In this case it is conservative to requalify.”
  - **Added to Provide Some Additional Normative Guidance on Modifications**

Bibliography

- References Moved to the Bibliography
  - Reference to IEEE 100 no Longer Required by the Style Manual as this is an Electronic Dictionary
  - IEEE 627 was added as an Upper Tier Document to IEEE 323
  - IEEE 1205, 1682 and P1844 all added and are Referenced in the text, but not as Mandatory Requirements
  - NFPA 262 Deleted as it is no Longer used
  - IEC/IEEE 62582 will be Considered to be Added in the Next Revision

Annex and Editorial

- Added Annex B on Additional Information on Modifications
  - Added to Provide Some Additional Information on Modifications
- Editorial Changes were Made in Many Areas
- Changing Singular to Plural was Done in Some Areas, but unless Noted were only Meant to be Editorial

QUESTIONS