

Condition -Based Qualification

Thomas Koshy, Working Group Chairman Branch Chief, Mechanical & Electrical Engineering Office of Research, USNRC Thomas.Koshy@nrc.gov

Outline



- Qualification Procedure
- Condition-based Qualification
- Benefits of Condition-based Qualification

IAEA Work



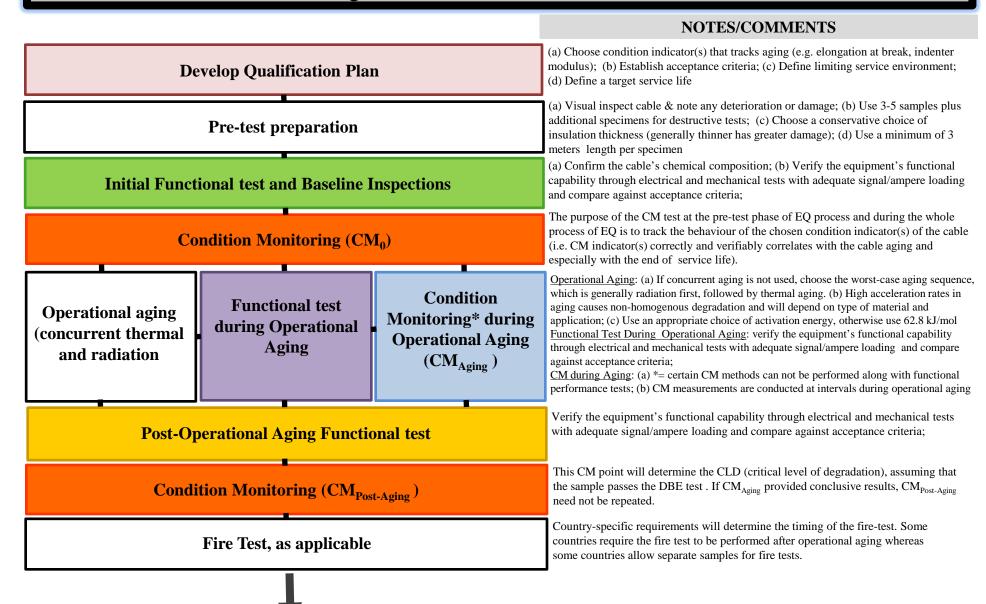
- Preparing a "Nuclear Energy series Report"
 Assessing and Managing Cable Aging in NPPs
- Title of the Publication : Guidelines for Qualification and Aging Management of Electric Cables in Current and Future Nuclear Power Generating facilities

Qualification Procedure



- Visual inspection
- Measurement of initial functional properties
- Simulation of normal operational ageing
- Functional properties testing-continues through next step
- Simulation of accident and post-accident period
- Final properties measurement
- Final visual inspection

QUALIFICATION PROCESS





Seismic/Vibration/Aircraft Impact simulation test, as applicable Post- Seismic/Vibration/Aircraft Impact Functional test, as applicable Condition Monitoring (CM_{Post Seismic/Vibration/Aircraft}) Condition **DBE Radiation Functional test** Monitoring* during during DBE testing **DBE Testing** DBE Test (Temp., Press., (CM_{DRE}) Chem Spray) **Post DBE-Simulation Functional test Condition Monitoring (CM**_{Post DRE}) Simulation of Post-accident period Functional test After Post-Accident Period **Documentation Requirements and Test Report Contents**

NOTES/COMMENTS

Country-specific requirements will determine the what specific tests are necessary.

After the seismic/vibration/aircraft impact test, verify the equipment's functional capability through electrical and mechanical tests with adequate signal/ampere loading and compare against acceptance criteria;

After the seismic/vibration/aircraft impact test, all selected CM properties shall be measured and an assessment of the equipment to withstand further testing.

<u>DBE Radiation</u>: High dose rate is acceptable, but the maximum is 10 kGray/hour <u>DBE Test</u>: (a) Apply thermodynamic profiles (temperature, pressure); (b) Oxygen supply to emulate actual service environment that contributes to oxidative reactions; (c) Chemical spray, if applicable, should be included in the test;

<u>Functional Test During DBE testing</u>: verify the equipment's functional capability through electrical and mechanical tests with adequate signal/ampere loading and compare against acceptance criteria;

<u>CM during DBE testing</u>: *= certain CM methods can not be performed along with functional performance tests;

After the simulation of a DBE, verify the equipment's functional capability through electrical and mechanical tests with adequate signal/ampere loading and compare against acceptance criteria;

This is an optional test to identify the remaining life. This information could be helpful in considering further increases in service life.

The post-accident period will depend on the application of the equipment (e.g. could range from several seconds to one year or more). However, for equipment whose service time is less than one hour, the minimum post-accident test period shall be the required duration plus one hour.

(a) After the simulation of the post-accident period, verify the equipment's functional capability through electrical and mechanical tests with adequate signal/ampere loading and compare against acceptance criteria; (b) a CM measurement may be performed after the post-accident period

The test report should document all elements of the test programme and shall be part of the auditable records for each equipment.

Qualification Procedure



- Aging for Normal Operation
 - Concurrent aging
 - Number of samples
 - Test Sequence
 - Thermal aging (80 to 130 C)
 - Activation Energy (62.8 kJ/mol)
 - Radiation exposure (100 Gy/hr Operational aging;
 10kGy per hr for accident)

DBE - Test condition



- Temperature
- Pressure
- Time
- Spray compensation and flow rate
- Radiation
- Operating conditions
- Margins

- Peak temperature: + 8 °C

- Peak pressure: + 10 % of gauge

- Radiation: + 10 % on accident dose

Power supply voltage: + 10 % but not exceeding cable design

limits

- Operating Time +10% min. 1 hr

Vibrations requirements +10% added to the acceleration

- Frequency + 5% of rated value



Margins in IEEE 323-1974

- The margins (8 Deg C, 10% psig. Etc.,) were intended for the following because a single successful sample test was considered adequate for qualification:
 - "Variations in commercial production"
 - "Reasonable errors in defining satisfactory performance"

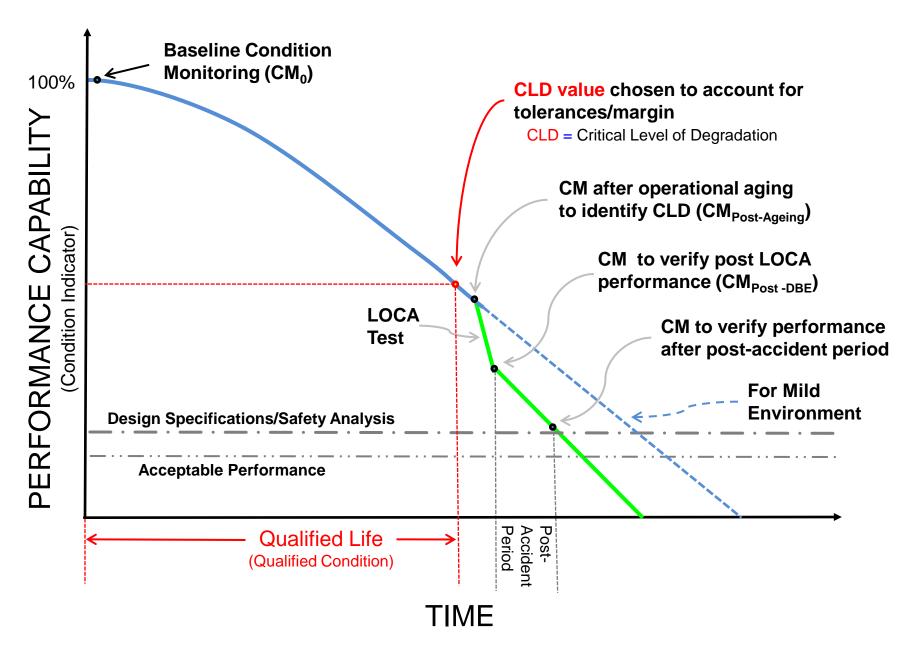
Condition-Based Qualification



(Qualification Monitoring)

- During the qualification test, conduct condition monitoring of critical parameters before and after operational aging
- Conduct the LOCA/accident environmental test and verify satisfactory performance again through condition monitoring
- Identify the Critical Level of Operational Degradation (CLD) that the equipment can endure LOCA test
- Manage the operational degradation to CLD with suitable condition monitoring (RG 1.211)

CONDITION-BASED QUALIFICATION



Condition-Based Qualification



- NRC currently requires qualified life for EQ components (10 CFR 50.49)
- Condition-Based Qualification can be implemented within the provisions of the existing US Regulations.



Benefits of Condition-Based Qualification

- Greater confidence in predicting cable performance
- Obtain increased service life without any additional qualification testing if ambient conditions are less severe than design assumptions or rate of degradation is lower