



Regulator view on polymeric materials in nuclear applications

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NPP's in Finland



Olkiluoto

- Operational OL1/2 1978 / 1980
- Construction License renewal
2018 => 2038
- OL3 in Operating License phase

Hanhikivi

- FV1 in
Construction
License phase



Loviisa

- Operational LO1/2 1977 / 1980
- Current Operating License
=> 2027 / 2030
- Periodic Safety Review 2017



Qualification to environmental conditions

- Guide YVL E.7 Electrical and I&C equipment of a nuclear facility
<https://www.stuklex.fi/en/ohje/YVLE-7>
- Qualification by type tests, analyses and operational experience feedback
 - Type tests required for electrical and I&C equipment and cables needed during or after accidents
- STUK inspects qualification specifications and suitability analyses
- Tests and analyses pursuant to standards
 - In practice: Accelerated thermal ageing using Arrhenius law (material specific E_a)
Accelerated radiation ageing (Radiation ageing term + Accident radiation term)

Qualification to environmental conditions

- Olkiluoto 3
 - Qualification families based on room conditions and accident scenarios
 - Qualification for 60 years (or less with replacement)
 - STUK approval before fuel loading (June 2019)

- Operational NPP's
 - Renewals / qualified lifetime extensions
 - E.g. cables inside the containment (LOCA-cable renewals recently both in Olkiluoto and Loviisa)



Inspection experiences

- In addition to the mandatory requirements, also non-mandatory recommendations are followed as feasible, however
 - Due to design changes, components may end up in more harsh conditions than originally planned
 - Earlier qualification tests did not necessarily follow all the current recommendations
 - Selecting parameter values (E_a , n) often not self-evident
 - Acceptance criteria relevant to functional requirement? (same criteria regardless of the conditions such as mechanical stress, contact with water, contact with oxygen?)
 - Component changes after the qualification tests
- Polymeric materials are challenging, as the resistance to radiation etc. varies a lot from one polymer to another

What can be considered "an adequate degree of confidence"?

YVL E.7: 551. *The artificial ageing of electrical and I&C equipment and cables shall be carried out in a way that represents actual ageing with an adequate degree of confidence.*

- Accelerated radiation ageing: $D_e = KD^n$
"n typically is in the range 0 to 0.3" *
- Accelerated thermal ageing: $k = A \exp(-E_A/RT)$
"Values of E_A can vary significantly for cable materials of the same generic polymeric material" *

* IAEA Nuclear Energy Series No. NP-T-3.6: *Assessing and Managing Cable Ageing in Nuclear Power Plants*

Challenges after qualification tests

- Technical changes to components after the qualification tests
 - Influence on qualification by analysis
 - Follow-up of technical changes
- Accident instrumentation
 - Condition monitoring, if most of the radiation and temperature stress takes place during the accident

Ageing management

- Guide YVL A.8 Ageing management of a nuclear facility
<https://www.stuklex.fi/en/ohje/YVLA-8>
- Plan for principles of ageing management (CLA phase)
- Ageing management programme (OLA phase)
- Ageing management follow-up report (operational phase, annually)
Includes e.g.
 - Needs to develop ageing management in the short and long term
 - Validity of qualifications (expected changes, possible expirations)
 - Cables inside the containment, inspections every 5 years at least

Ageing management

- Target: preventively recognise ageing mechanisms affecting the plant condition
- Ageing management of safety-classified electrical and I&C equipment: preventive maintenance, condition monitoring, assessment of renewal needs
- STUK's oversight: following operational experience, inspecting ageing reports, AM considered in the periodic inspection programme (KTO Plant maintenance every year)

- Polymer ageing indicators and condition monitoring methods most relevant to predict integrity in accident conditions?
- Polymeric materials are important research topic, as their ageing mechanisms are complex

STUK's strategic targets 2018-2022

- 1. The happiest civil servants in the world
- 2. Ability to understand complex entities
- 3. Cost-aware operations
- 4. Risk-informed and commensurable oversight

... Our oversight is based on safety requirements that are determined in proportion to the risks of the plant or the operations. ...

- 5. Flexible and efficient working methods
- 6. Effective national radiation safety research
- 7. Emphasising the responsibility of the operators

... The responsibility for safety falls strictly with the operators. ...

- 8. People understand the risks of radiation
- 9. Society is resilient to disturbances

- **COMRADE gives valuable support to STUK in realizing the strategic targets for 2018-2022 concerning qualification and ageing management of components with polymeric materials.**

THANK YOU

