



Strål
säkerhets
myndigheten

Swedish Radiation Safety Authority

Regulator view on ageing of polymers in nuclear applications

COMRADE event 2018

Elena Calota

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2018-12-04



Contents

- Regulations concerning AM in general
- Specific requirements concerning polymers
- Investigations performed by the Swedish Radiation Safety Authority concerning AM
- Environmental qualification
- Topical Peer Review on AM
- Future regulatory changes
- Summary



The Swedish Radiation Safety Authority's Regulations concerning Ageing Management in general

Regulation	Area	Short description of contents
SSMFS 2018:1 <i>New!</i>	Basic provisions applying to licensed activities involving ionising radiation	Requirements for management system
SSMFS 2008:1	Safety in Nuclear Facilities	Design requirements, testing requirements on design principles and design solutions
SSMFS 2008:13	Mechanical components at certain Nuclear Facilities	Manufacturing, installation, inspection, testing and maintenance requirements
SSMFS 2008:17	Design and construction of nuclear power reactors	Environmental qualification



The Swedish Radiation Safety Authority's regulations and general advice concerning mechanical components at certain Nuclear Facilities - SSMFS 2008:13

For polymers, pay attention to...

- Chapter 4, Sections 6 and 7
 - Requirements on fulfilment of the Pressure Vessel Standardisation codes for thermoplastics
 - Requirements on joining of sections of plastic piping



The Swedish Radiation Safety Authority's regulations and general advice concerning the design and construction of nuclear power reactors - SSMFS 2008:17

For polymers, pay attention to...

➤ Chapter 17

- The barriers and equipment belonging to the safety systems of the nuclear power reactor shall be designed so that they withstand the environmental conditions that the barriers and equipment can be subjected to in the situations where their function is credited in the safety analysis of the reactor.



The Swedish Radiation Safety Authority's regulations and general advice concerning the design and construction of nuclear power reactors - SSMFS 2008:17

For polymers, pay attention to...

- General advice regarding Chapter 17 states the following:
 - This requirement means that structures, systems, components and devices included in safety systems shall be environmentally qualified.
 - Environments that can affect safety systems should be followed up as long as the systems are utilized for their purposes.



The Swedish Radiation Safety Authority's regulations and general advice concerning the design and construction of nuclear power reactors - SSMFS 2008:17

- The principles for ageing management should be applied as specified in IEC 60780, Reg. Guide 1,89 or IEEE 323.
- In connection with this, the following is recommended:
 - Acceleration factors for thermal ageing exceeding 250 times should be avoided
 - Ionizing radiation lasting less than 10 days should be avoided
 - A dose rate higher than 5 Gy/h should be avoided
 - Otherwise, the applicability of the results should be specially justified.

Investigations performed by The Swedish Radiation Safety Authority on long term safety of Swedish NPPs with regards to ageing



Strålsäkerhetsmyndigheten

Swedish Radiation Safety Authority

UTREDNINGSSRAPPORT
2012-10-31

Process: Utreda
Vår referens: SSM 2010/1557-4

Arbetsgrupp: Björn Brickstad, Peter Ekström, Fritz Maier, Åsa Rydén, Richard Sundberg, Kostas Xanthopoulos

Författare: Björn Brickstad

Fastställt: Lars Skånberg

Drift av kärnkraftreaktorer längre än ursprungligt analyserad eller konstruerad tid med hänsyn till åldringsfrågor

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Strålsäkerhetsmyndigheten

Swedish Radiation Safety Authority

UTREDNINGSSRAPPORT
2012-10-18

Vår referens: SSM2011-317-5

Författare: Fritz Maier

Samråd: Bo Litwång

Fastställt: Jan Hanberg

Åldrande el- och kontrollutrustning i svenska kärnkraftverk inför längre drifttider än de ursprungligt var konstruerade för

Investigations performed by The Swedish Radiation Safety Authority on long term safety of Swedish NPPs with regards to ageing



Strålsäkerhetsmyndigheten

Swedish Radiation Safety Authority

Promemoria

Datum: 2016-11-03
Diarie nr: SSM2016-4914
Dokumentnr: 16-2891

Handläggare: Lars Skånberg
Fastställt: Mats Persson

Redovisning av uppdrag avseende
Strålsäkerhetsmyndighetens tillsyn av åldrande
kärnkraftverk

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2018-12-04



Investigations performed by The Swedish Radiation Safety Authority on long term safety of Swedish NPPs with regards to ageing

➤ Conclusions

- The majority of cases where damage to mechanical components has occurred are found during In-Service-Inspections long before the safety is compromised
- More research may be needed with regards to the long term behaviour of the polymer materials used in the reactor containment. This gives important input to environmental qualifications
- Handling, follow-up and updating of environmental qualifications are important parts of licensee's AMP and thus important for future regulatory oversight



Equipment qualification – Some findings from regulatory oversight

- Incomplete analyses which demonstrate that components, where their function is credited in the safety analysis, can withstand the environmental conditions they will be subjected to during a pipe break (LOCA)
 - Insufficient environmental qualification
 - Qualified life has passed
 - Insufficient documentation for some components
 - Non environmentally qualified components



Equipment qualification – Some findings from regulatory oversight

- Cables
 - Acceptance criteria is not identified
 - AMP lacks surveillance or preventive measures
 - No programs for managing ageing mechanisms have been identified
 - The AMP for electrical cables does not consider hot spots

ENSREG Topical Peer Review of Ageing Management

- Electrical Cables
 - Description of AMPs for electrical cables
 - Licensee's experience of the application of AMPs for electrical cables
 - Regulator's assessment and conclusions on AM of electrical cables

* ENSREG – European Nuclear Safety Regulators Group

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2018-12-04

 Strålsäkerhetsmyndigheten
Swedish Radiation Safety Authority

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2017:36

Topical Peer Review 2017
Ageing Management
Swedish National Assessment Report



ENSREG Topical Peer Review of Ageing Management

- The Swedish Radiation Safety Authority's assessment and conclusions on AM of electrical cables
 - It is important to be proactive – do not wait until the cables are degraded and must be replaced through remedial actions
 - The utilities have to consider if there are any hot spots and ensure that these hot spots will not impact the basis of the components qualification



ENSREG Topical Peer Review of Ageing Management

- Cooperation between the Swedish utilities is important to understand and learn more about degradation mechanisms
- Experience of the application of AMPs is important and gives input to modification needs of the maintenance program as well as constant improvements regarding scope, methodology and frequency of existing AMP to ensure fulfilment of the objectives related to the AMP



Future regulatory changes

- Regulations currently being clarified with respect to requirements on
 - Materials selection during design phase of SSC - reliability and maintainability of items important to safety
 - Maintained availability of items important to safety through programs for
 - Maintenance, surveillance and in-service inspection
 - Environmental qualifications
 - Chemistry
 - Ageing Management
- Coming into effect during 2020



In conclusion

- Damage is usually found and actions are taken long before the safety is compromised
- More research may be needed with regards to the long term behaviour of the polymer materials used in the reactor containment
- Research on acceptance criteria may be needed, especially for long term behaviour
- Handling, follow-up and updating of environmental qualifications are important parts of licensee's AMP and thus important for future regulatory oversight
- Cooperation between the Swedish utilities is important



Thank you for listening!

Questions?

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Extra slides for information

The Swedish Radiation Safety Authority's
Regulations concerning Ageing Management



The Swedish Radiation Safety Authority's Regulations concerning Ageing Management

- SSMFS 2018:1 New!
- SSMFS 2008:1
- SSMFS 2008:13
- SSMFS 2008:17



The Swedish Radiation Safety Authority's regulations concerning basic provisions applying to licensed activities involving ionising radiation - SSMFS 2018:1

- Chapter 3, Section 4
Requirements for management system with regards to radiation safety – covering the organisation, management, control, evaluation and further development of the licensed activity



The Swedish Radiation Safety Authority's Regulations concerning Safety in Nuclear Facilities - SSMFS 2008:1

- Chapter 3, Section 1
Facility design requirements with regards to
 - component and system failures and events
 - conditions which can affect the safety functions of the barriers or those of the defense in depth system



The Swedish Radiation Safety Authority's Regulations concerning Safety in Nuclear Facilities - SSMFS 2008:1

➤ Chapter 3, Section 2

Design principles and design solutions shall be tested under conditions corresponding to those that can occur during their intended application in a facility.

If this is not possible or reasonable, the design principles and design solutions shall be subjected to testing or evaluation in a way demonstrating that they have the necessary durability, reliability and operational stability, taking into account their function and importance for the safety of the facility.



The Swedish Radiation Safety Authority's Regulations concerning Safety in Nuclear Facilities - SSMFS 2008:1

- Chapter 3, Section 4
Structures, systems, components and devices shall be designed, manufactured, installed, inspected and tested in accordance with requirements adapted to their function and importance for the facility's safety
- Chapter 5, Section 3
Structures, systems, components and devices of importance for safety at a facility shall be inspected, tested and maintained on a continuous basis in such a way that they meet the safety requirements.



The Swedish Radiation Safety Authority's regulations and general advice concerning mechanical components at certain Nuclear Facilities - SSMFS 2008:13

- No distinction made between metals and polymers or any other material used in the mechanical component unless there is a very specific need
- Chapter 2, Section 1
In order to be commissioned, a mechanical component must have been designed, manufactured, installed and inspected so as to maintain safety in connection with all events up to and including the event class 'unlikely events'. Before being allowed to apply a modification to the design of a facility or to its operating conditions, a new check must be performed on fulfilment of the provisions on the part of the mechanical components that might be affected by such modification. Before a component is allowed to be commissioned after modification, a certificate of compliance is required.



The Swedish Radiation Safety Authority's regulations and general advice concerning mechanical components at certain Nuclear Facilities - SSMFS 2008:13

- Chapter 3
Provisions concerning in-service inspection with regards to:
 - Classification into inspection groups
 - Grounds for inspections
 - Scope and intervals of inspections
 - Inspection programmes and performance
 - Measures following in-service inspections
- Chapter 4, Sections 6 and 7
 - Requirements on fulfilment of the Pressure Vessel Standardisation codes for thermoplastics
 - Requirements on joining of sections of plastic piping