

Ageing Management and LTO of NPPs – Swedish perspective

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Swedish nuclear facilities





Age of Swedish NPPs









Physical ageing of components and structures

The "bath tube curve" as basis for NPP lifetime



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Service time

Some data from the OECD-NEA OPDE



Figure 8: Pipe Degradation & Failure by Calendar Year

Inspection and control have worked well – so far



- No major safety consequences
- Most degradation events have been detected by ISI
 - but some misses have been reported
- Detection of degradation have often led to extensive replacement measures
 - o to prevent further failures

Research is important

- Research activities and operating experience world wide
 - have led to a situation where substantial knowledge has been accumulated about degradation mechanisms that can affect components and structures in NPPs
- However, degradation history shows clearly that our knowledge base must be continuously updated based on
 - further research, and detailed damage analyses, which often reveal other circumstances than those expected
- Continued international cooperation will be important
 - such as the IAEA IGALL, OECD-NEA OPDE/CODAP

Long-term operation (LTO)

IAEA definition of LTO is

"operation beyond an established time frame set forth by, for example, license term, design, standards, license and/or regulations, which has been justified by safety assessment, with consideration given to life limiting processes and features of systems, structures and components"

This means that both the formal and real conditions for LTO varies between NPPs and countries

Internationally recommended practice

- to have a formal process with the clear position on longterm operation either through
 - a License Renewal process, or
 - by a PSR process focusing on LTO

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Challenges in Long-term Operation of Nuclear Power Plants	for protecting people and the environment.	nad kalanda z filozofen en systemáticken filozofen energyina esterezeginenetépese, tiltelte elittez 11 anb 32. nad kalanda z filozofek la societytezet bieleg, spytiter dire arise genesia etilite felt ne prope or possere ner ar vendelegin a dicha kala kalandi sociation tested vendeleging a sport i childranatore, ned balanda ze filozopatickoven genesia (5) mad balanda ze filozopaticka adi antolia kale nelak kaonistine genesia (5) må	Introduction Based on the Atomic Energy Act, the Nuclear Regulatory Commission (NRC) issues licenses for commission (NRC) issues there are a second and the second and the second and the second and the another 30 years. Economic and anthrust considerations on langituding and and the second a
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		(3) Failing device 20 Section 20 mediantements distributions in their and separated in the transmittion of the transmittion	Nuclear power plants are subject to a systematic and therough NRC oversight program to ensure taclear plant equipment contained to meet safety standards. This constant NRC oversight ensures a plant will operate safely throughout its life. Background In 1987, hund one subjects workshow on nuclear source resource data areas the NRC established a
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LTO involves some new challenges for both licensees and authorities

- Organisations, resources and expertise must be adaptable to manage new safety issues that might arise
 - e.g. in terms of design bases used, ageing / degradation mechanisms that can affect the long term
- Effective programs for ageing management must be in place
 - Inspection, testing, monitoring, maintenance, replacements
 - Is important before LTO, but even more as NPPs becomes older
- Legal and supervisory framework needs to be reviewed
 - with more focus on ageing issues and ageing management activities

LTO is not only about physical ageing

- Technological ageing (obsolete equipment)
 - for example I&C
 - Difficulties in obtaining spare parts, problems with maintenance and repair
- Generation shifts within organizations
 - Important tacit knowledge may disappear from organizations
 - It can relate to specific maintenance practices, applied but undocumented design bases for certain equipment, etc.
- Plant documentation
 - Poor archiving of detailed design and manufacturing documentation
 - Detailed design and manufacturing documentation has been left with suppliers and manufacturers who have gone out of business

Validity of operating licenses - the formal situation in Sweden

- An operating license for a Swedish nuclear power reactor under both the Nuclear Activities Act and the Environmental Code is a favouring permit without time limitation
- It can not be withdrawn as long as
 - the provisions of laws, government ordinances and SSM's regulations are met, and
 - the conditions and obligations under the license are met

How will the conditions for LTO of Swedish NPPs be examined?

- By a PSR process specifically addressing LTO
- It must be shown that the plant with its SSCs can be used / operated beyond the time originally planned for and with the assumptions which were made when designing the SSCs
 - including revalidation of design analyses, other verifying analyses (TLAA) and environmental qualifications for the extended period
 - and that there are no degradations and deteriorations of various types
- or make the necessary replacements

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Investigation of long-term safety in the Swedish nuclear power industry

- Conclusions in SSM's reporting of the government assignment (2012):
- Safety can be maintained over the long term, provided that
 - additional safety improvements are made
 - the licensees apply effective ageing management,
 - this is examined regularly in the time ahead in the form of in-depth PSR

> Furthermore, it is essential that

- a good safety culture is maintained
- also ensuring that other safety-related conditions pertaining to organisations and human resources are maintained and developed

Recommendation from SSM reporting / Special attention on:

- Irradiation embrittlement of reactor pressure vessels, taking account of effects that can substantially increase the rate of embrittlement
- Fatigue, taking account of impact from the reactor water environment on areas
 sensitive to fatigue
- The condition of tendons and steel liners in reactor containments Michael Knochenhauer

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- Degradation mechanisms that can influence reactor containments' concrete and metal parts
- Possibilities for reliable inspections and testing of reactor containments
 - The validity of environmental qualifications of electrical, instrumentation and control equipment as well as parts with polymer construction materials

More can be read on: www.ssm.se



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Legislation and regulations

- A major review of legislation and regulations for nuclear installations and other activities involving radiation is in progress
- SSM will in this context clarify and define both the regulations and general advice about
 - ageing management
 - safety assessments and TLAA
 - the role and content of PSR
- in the light of the licensees' plans for LTO of the Swedish NPPS



- Ringhals NPPs
 - Pre-SALTO Ringhals 1 and 2 in 2014
 - Follow-up SALTO in 2016
 - Full-scope SALTO for Ringhals 3 and 4 in 2018
- Forsmark NPPs
 - Pre-SALTO planned for 2016
- Oskarshamn NPPs
 - In preparation to request SALTO review

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Conclusions

- Experience shows that effective ageing management must continuously be taken into account
 - from the design phase and throughout the planned period of operation
- In regulatory evaluation of potential for LTO focus on ageing management is necessary but not sufficient
- Other aspects that must be considered are
 - implemented and need for additional safety improvements
 - application of lessons learned from operating experience
 - adequate licensee staff resources and performance
 - security at the plant

Conclusions

- The Swedish licensees have announced that they intend to operate the NPPs longer than originally planned
 - 3 for 50 years and 7 for 60 years (currently under reconsideration!)
- SSM will take position on LTO within the framework of a PSR for each plant
 - Efforts are under way to analyse and evaluate several PSR involving transition to LTO
- Work is also underway to revise and clarify SSM's regulations, including the requirements for
 - ageing management
 - safety assessments and TLAA
 - PSR as a basis for decisions on LTO