Overview of TLAAs

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Contents

• Borssele LTO Assessment Project
  • Selection of TLAAs
  • TLAA list
  • Revalidation of TLAAs
  • Examples in Borssele

• Ringhals LTO Assessment project
  • Selection of TLAAs
  • TLAA list

• Summary
LTO project overview

- **LTO “bewijsvoering” KCB**
  - Feasibility (3.1)
  - Verification of preconditions (3.2)

- **IAEA Safety report Nr 57 Safe Long Term Operation of Nuclear Power Plants**
  - IAEA guidelines

- **IAEA NS-G-2.12 (ch 6) Ageing Management for Nuclear Power Plants**

- **Regulatory framework**
  - VROM

- **Scoping (4.1)**
  - Screening (4.2)

- **Documentation of basis for LTO**

- **AMR (5) Passive**
  - Mechanical A (barrier concept)
  - Mechanical B
  - Electrical
  - Civil / structural

- **TLAAs (6)**
  - RPV
  - Fatigue
  - LBB
  - EQDBA

- **Phase LTO assessment (SR57, fig 1)**

- **Phase prior to LTO assessment (SR57, fig 1)**
  - Check of existing plant programmes

- **Active**
  - Mechanical
  - Civil / structural
  - Electrical

- **Civil / structural VROM Regulatory Oversight**

- **Implementation of plant commitments for LTO**

- **Phase LTO approval & implementation (SR57, fig1)**
TLAA selection according to SR57

- Safety analyses that are to be revalidated for LTO are those that:
  a) Involve SSCs within the scope of LTO;
  b) Consider the effects of ageing degradation;
  c) Involve time limited assumptions defined by the current operating term;
  d) Were determined to be relevant in making safety determinations as required by national regulations;
  e) Involve conclusions or provide the basis for conclusions related to the capability of the SSC to perform its intended functions;
  f) Are contained or incorporated by reference in the CLB.
TLAAs at Borssele NPP

- Reactor Pressure Vessel (RPV)
- Fatigue
- Leak Before Break (LBB)
- Qualification of Design Base Accident resistant electrical Equipment (EQDBA)
For safe LTO to be allowed, the evaluation needs to demonstrate that the safety analyses meet one of the following criteria:

i. The analysis remains valid for the intended period of LTO;

ii. The analysis has been projected to the end of the intended period of LTO;

iii. The effects of ageing on the intended functions of the structure or component will be adequately managed for the intended period of LTO.
Revalidation RPV TLAA

- RPV embrittlement

- MOX fuel
- Verification and review of fluence calculations by NRG
- Fluence calculations
- Manufacturing SOP 0a SOP 3 and SOP 4
- Testing SOP 0a
- KCB RPV safety assessment assuming 60 years of operation
- Status report
- PTS report
- Thermal hydraulics
- PTS limits check
- Tüv review

IAEA Safety report Nr. 57 Safe Long Term Operation of Nuclear Power Plants
IAEA NS-G-2.12 (ch. 6)
Ageing Management for Nuclear Power Plants
Mechanical A (barrier concept)
Mechanical B
Electrical
Civil / structural
VROM Regulatory Oversight
IAEA Draft Safety Guide No. 426 Periodic Safety Review of Nuclear Power Plants
SF 10 & 12
Civil / structural
LTO "bewijsvoering"
KCB
Feasibility (3.1)
Verification of preconditions (3.2)
Scoping (4.1)
Screening (4.2)
AMR (5) Passive
Mechanical A
Mechanical B
Electrical
Civil / structural
EGGER
Documentation of basis for LTD
Phase prior to LTO assessment (SR 57, fig. 1)
Phase LTO assessment (SR 57, fig. 1)
Phase LTO approval & implementation (SR 57, fig. 1)
Revalidation RPV TLAA

$RT_{NDTj} = 18 \degree C$ (55 full power years)

$RT_{T0j} = 3 \degree C$
Revalidation fatigue TLAA

- Determination of TLAA fatigue scope
- Implementation FAMOS 2010
- Preliminary proof (LTO license) based on conservative data
- Environmental fatigue issue, new KTA rule awareness thresholds used in preliminary proof
TLAA Fatigue programme

Fatigue demonstration (LTO license) based on conservatism in loads and number of loads

Implementation of Fatigue Monitoring (FAMOS)

LTO demonstration
License change application
Environmental fatigue
KTA awareness thresholds used

TLAAs

KCB
Feasibility (3.1)
Verification of preconditions (3.2)
Scoping (4.1)
Screening (4.2)
Check of existing plant programmes
TLAAs (6.5)

IAEA Safety report Nr. 57
Safe Long Term Operation of Nuclear Power Plants
IAEA NS-G-2.12
Ageing Management for Nuclear Power Plants
Mechanical A (barrier concept)
Electrical
Civil / structural
Mechanical B

Implementation of plant commitments for LTO

AMR (5.5)
Passive
Regulatory framework
IAEA guidelines

Phase prior to LTO assessment (SR 57, fig 1)
Phase LTO assessment (SR 57, fig 1)
Phase LTO approval & implementation (SR 57, fig 1)

Non technical requirements
IAEA Draft Safety Guide No. 426
Periodic Safety Review of Nuclear Power Plants
SF 10 & 12
Civil / structural
VROM
Regulatory Oversight

Using up-to-date models, Load catalogue and Fatigue Monitoring (FAMOS)
Revalidation LBB TLAA

- **Leak Before Break**
  - The goal of the review is the answer to the question:
  - Is the concept Break Preclusion (Bruchausschluß) as entered in 1997 still valid in case of plant life extension to 2034?
  - Scope: Primary Piping and Main steam and Feedwater Lines within the secondary containment
Figure 1  Concept of Break Preclusion as schematic block diagram (from [4])
Break Preclusion

Figure 2  Realisation of Break Preclusion as schematic block diagram (from [4])
## TLAA Leak Before Break

<table>
<thead>
<tr>
<th>Initial defect size</th>
<th>Crack growth 1RLs</th>
<th># RLs surface cr.</th>
<th>Through wall defect</th>
<th>Crack grow through wall</th>
<th>Detectable leak rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
<td>Step 2</td>
<td>Step 3</td>
<td>Step 4</td>
<td>Step 5</td>
<td>Step 6</td>
</tr>
</tbody>
</table>

**Time dependency 2034 in Step 3:**
- 40 years = 1 RLs
- 60 years = 1.5 RLs

**Therefore:**
- Step 3 #RLs > 1.5
Results assessment LBB

LBB calculations will also be valid for 60 years of operation

Some recommendations:

Stratification (MCL, Feedwater lines & verification of Surge Line) to be taken into account when FAMOS results are available

Compare the Leak Before Break method used to the state-of-the-art (no LTO but PSR-issue)
Revalidation EQ TLAA

Qualification of Design Base Accident resistant electrical Equipment (EQDBA)

Step 1 Monitoring of environmental conditions at KCB

Step 2 Is KCB-component in AUREST-library?

Step 3 Residual lifetime calculations

Step 4 Residual lifetime ≤ 2034?

Step 5 Action required.

Preservation environmental qualification successful

Step 6 Requalification Replacement Alternative qualification method

Standard component library in AUREST

KCB specific component library

Aurest Database

IAEA Safety report No. 57 Safe Long Term Operation of Nuclear Power Plants IAEA NS-2.12 (ch 6) Ageing Management for Nuclear Power Plants

Implementation of plant commitments for LTO

Active AMR

Passive

Regulatory framework IAEA guidelines

Phase prior to LTO assessment (SR 57, fig 1)

Non technical requirements IAEA Draft Safety Guide No. 426 Periodic Safety Review of Nuclear Power Plants

SF 10 & 12

Civil / structural

VROM

Regulatory Oversight
EQ of E&I components with harsh environment requirements

Monitoring program environmental conditions (2007-2009)

AUREST

Automated Residual Lifetime Estimation (1st phase finished in 2009)

Components with insufficient qualification data or a limited qualified life:

- Requalification program
- Replacement program
TLAAs at Borssele NPP

- Reactor Pressure Vessel (RPV)
- Fatigue
- Leak Before Break (LBB)
- Qualification of Design Base Accident resistant electrical Equipment (EQDBA)
Ringhals TLAA approach

• Based on IAEA Safety Report 57
• Based on IGALL Safety Report 82
  – TLAA list for
    • Mechanical
    • Electrical
    • Civil
• Ageing Analyses
  – (RPV, Environmental Fatigue, Structural verification, LBB, CASS, EQ etc.)
• Resulting in a list of relevant TLAA
  – Existing document or program for all TLAA
Ringhals TLAA approach

Flow schedule for LTO of Ringhals 2
Summary

• **Borssele**
  – TLAA selection based on IAEA Safety Report 57
  – Revalidation of TLAA:
    • RPV
    • Fatigue
    • LBB
    • EQ

• **Ringhals**
  – TLAA selection based on IAEA guidelines
    • Safety Report 57
    • IGALL
  – List of relevant TLAA:
    • Existing document or program for all TLAA
Ďakujem vám za vašu pozornosť

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Thank you for your attention