

5-10-2012



Gesellschaft für Anlagen-
und Reaktorsicherheit
(GRS mbH)

**Enhanced Technical Support to EL&I in the Field of Nuclear Safety
of Existing Nuclear Facilities**

WP 2 "Long-term operation of KCB"

Summary Report

GRS B61, Cologne, 1 October 2012

Contract No.: VA 3889

Report No.: EL&I-WP2-T11

Note:

This report has been prepared by GRS by order of EL&I. The report reflects the opinion of GRS which does not necessarily have to agree with the opinion of the customer.

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1 Introduction

This report gives an overview of the activities performed by GRS regarding the review of documents on long-term operation (LTO) of the Borssele Nuclear Power Plant (KCB) and summarises the results obtained thereby.

1.1 Background and objective

LTO of KCB is intended up to the end of the year 2033. Against this background N.V. Elektriciteits-Productiemaatschappij Zuid-Nederland (EPZ) has launched the project "LTO Bewijsvoering". The objective of this project is to ensure that safety and safety-relevant systems, structures and components (SSCs) continue to perform their intended functions during LTO. The outcomes of this project are to be used for a license change application for approval of prolonged operation of KCB beyond 2013.

1.2 Scope and contractual framework

The documentation of the "LTO Bewijsvoering" project by EPZ comprises a series of documents which have been prepared either by EPZ or by NRG or AREVA on behalf of EPZ and which deal with the following topics:

- Concept of "LTO Bewijsvoering"
- Verification of preconditions
- Scoping and screening activities
- Ageing Management Reviews (AMRs) including catalogues of ageing mechanisms (CAM)
- Time Limited Ageing Analyses (TLAAs) for the reactor pressure vessel (RPV), fatigue, break preclusion, and equipment qualification of design base accident resistant electrical equipment (EQDBA).

GRS has reviewed these documents on behalf of the Dutch Safety Authorities

- Kernfysische Dienst (KFD) and the
- Dutch Ministry for Economic Affairs, Agriculture and Innovation (EL&I).

The reviews were performed in the time span between February 2010 and September 2012 within the framework of 3 contracts in a timely succession, namely the

- Contract „Bewertung von Unterlagen zum Langzeitbetrieb des KKW Borssele“ between MinVROM / KFD and GRS /GRS 10a/
- 2010/2011 work programme of the co-operation contract between MinVROM / KFD and GRS /GRS 10b/, work package 4
- 2012 technical work programme for the “Enhanced Technical Support to EL&I in the Field of Nuclear Safety of Existing Nuclear Facilities” /GRS 12/, work package 2.

Thereby, the majority of documents were reviewed in the first half of 2012 within the framework of /GRS 12/.

Table 1 provides an overview of the individual documents reviewed and the review reports provided by GRS. The documents are sorted according to the topics mentioned above. Overall, 51 reports have been reviewed by GRS experts. Moreover, 6 of these reports have been reviewed again after their revision. The review results are documented within 41 separate review reports including revision notes.

Table 1 Overview of documents reviewed

Title	Author	Reference-No. / Rev. / Date	GRS Report / Date
Concept			
Conceptual document LTO "Bewijsvoering" KCB	NRG	NRG-22701/ 10.103460 / September 9, 2011	KFD-WP4-WS2-T2.1-R / January 2012
Verification of preconditions			
IAEA Safety Report 57 - Verification of preconditions - Maintenance	EPZ	KTE/Adj/RBn/ R106151 / January 21, 2011	EL&I-WP2-T1.3 / March 2012
IAEA Safety Report 57 - Verification of preconditions – In-Service Inspections	EPZ	KTE/Adj/RBn/ R106153 / January 21, 2011	
IAEA Safety Report 57 - Verification of preconditions – Water chemistry	EPZ	KTE/Adj/RBn/ R106155 / January 21, 2011	
IAEA Safety Report 57 - Verification of preconditions – Surveillance and monitoring	EPZ	KTE/Adj/Rnh/ R106188 / January 21, 2011	
IAEA Safety Report 57 - Verification of preconditions – Equipment qualification	EPZ	KTE/Adj/Rnh/ R106190 / January 21, 2011	
Scoping and Screening			
Definition of the Scope of KCB Systems, Structures and Components to be Taken into Consideration for the Long-Term Operation Process	AREVA	NEPS-G/2008/ en/0056 / Rev. A / December 18, 2008	KFD-LTO-WP3 / July 2010
Screening of relevant Structures and Components in the frame of the KCB Long-Term Operation Process	AREVA	NTCM-G/2009/ en/0144 / Rev. A / May 11, 2009	
Definition of the scope of KCB systems, structures and components to be taken into consideration for the long-term operation process	AREVA	NEPS-G/2008/ en/00056 / Rev. B / July 27, 2011	EL&I-WP2-T1.1/2 / March 2012
Screening of relevant Structures and Components in the frame of the KCB Long-Term Operation Process	AREVA	NTCM-G/2009/ en/0144 / Rev. B / October 6, 2011	

Title	Author	Reference-No. / Rev. / Date	GRS Report / Date
AMRs			
Ageing management review – Methodology Report	AREVA	PESS-G/2010/en/0041 / Rev. A, August 11, 2011	EL&I-WP2-T1.4 / March 2012
Catalogs of ageing mechanisms			
Catalog of ageing mechanisms for mechanical components (CAM-MC)	AREVA	PTCM-G/2010/en/0043, Rev. A / May 04, 2011	KFD-WP4-WS2-T2.2 / January 2012
Catalog of Ageing mechanisms for structural components (CAM-SC)	AREVA	PEEC-G/2010/en/0084 Rev. A / June 10, 2011	EL&I-WP2-T8.1-R / April 2012
Catalog of ageing mechanisms for electrical components (CAM-EC)	AREVA	PTLQ-G/2010/en/0031 Rev. A / July 26, 2011	EL&I-WP2-T9.1 May 2012
Mechanical A			
Ageing management review to support long-term operation for KCB reactor pressure vessel	AREVA	PESS-G/2010/en/0042 / Rev. A, May 3, 2011	KFD-WP4-WS2-T1.1; Rev.1 / April 2012
Ageing management review to support long-term operation for KCB pressurizer	AREVA	PESS-G/2010/en/0043 / Rev. A / December 22, 2011	EL&I-WP2-T4.3 May 2012
Ageing management review to support long-term operation for KCB steam generators	AREVA	PESS-G/2010/en/0044 / Rev. A / October 7, 2011	EL&I-WP2-T4.1 May 2012
Ageing management review to support long-term operation for KCB main coolant pumps	AREVA	PESS-G/2010/en/0045 / Rev. A / October 7, 2011	EL&I-WP2-T5.1-R / April 2012
Ageing management review to support long-term operation for pressure housings of KCB control rod drive mechanisms	AREVA	PESS-G/2010/en/0046 / Rev. A / September 23, 2011	EL&I-WP2-T2.1 / April 2012
Ageing management review to support long-term operation for KCB main coolant lines and pressurizer surge line	AREVA	PESS-G/2010/en/0047 / Rev. A / August 31, 2011	EL&I-WP2-T7 May 2012
Ageing management review to support long-term operation for KCB steel containment structure	AREVA	PESS-G/2010/en/0048 / Rev. A / December 6, 2011	EL&I-WP2-T8.2 May 2012
Mechanical B			
Ageing management review to support long-term operation for KCB nuclear safety systems	AREVA	PESS-G/2010/en/0049 / Rev. A / December 22, 2011	EL&I-WP2-T5.2 / June 2012
Ageing management review to support long-term operation for KCB safety-related auxiliary systems	AREVA	PESS-G/2010/en/0051 / Rev. A / December 21, 2011	EL&I-WP2-T6.3 / June 2012

Title	Author	Reference-No. / Rev. / Date	GRS Report / Date
Ageing management review to support long-term operation for KCB secondary systems that are important to safety	AREVA	PESS-G/2010/en/0050 / Rev. A / December 9, 2011	EL&I-WP2-T2.2 / June 2012
Ageing management review to support long-term operation for KCB HVAC systems that are important to safety	AREVA	PESS-G/2010/en/0052 / Rev. A / December 21, 2011	EL&I-WP2-T6.1 / April 2012
Ageing management review to support long-term operation for KCB reactor pressure vessel internals	AREVA	PESS-G/2010/en/0109 / Rev. A / October 7, 2011	EL&I-WP2-T3.1 / April 2012
Ageing management review to support long-term operation for KCB primary component supports	AREVA	PEER-G/2011/en/00071 / Rev. A / December 22, 2011	EL&I-WP2-T6.2 / May 2012
Ageing management review to support long-term operation for remaining in-scope supports and hangers	AREVA	PESS-G/2010/en/0110 / Rev. A / December 22, 2011	EL&I-WP2-T4.2 / June 2012
Ageing management review to support long-term operation for KCB mechanical fasteners	AREVA	PTCM-G/2011/en/0092 / Rev. A / October 26, 2011	EL&I-WP2-T3.2 / May 2012
Structures			
Ageing Management review to support Long-Term operation of KCB Structural Scope	AREVA	PEEC-G/2010/en/0083 / Rev. A / July 25, 2011	KFD-WP4-WS2-T5, Rev 1 / May 2012
Electrical and I&C			
Ageing management review to support long-term operation of KCB electrical and I&C systems, structures and components	AREVA	PTLQ-G/2010/en/0038 / Rev. B / November 23, 2011	EL&I-WP2-T9.2 / June 2012
AMR Summary			
Summary report Ageing Management Review	NRG	NRG-22503/11, 109273 / June 2012	EL&I-WP2-T6.4 / September 2012
TLAAs			
RPV			
Programm zur Überwachung der Strahlenbeeinflussung des KCB-Reaktordruckbehälters, Bestrahlungssätze SOP 3 und SOP 4	AREVA	NTM-G/2007/de/0255 / Rev. A, September 30, 2007	KFD-LTO-WP1 / July 2010
Bestrahlungüberwachung KCB-RDB: Ermittlung von mechanischen- und bruchmechanischen Kennwerten an unbestrahlten RDB – Grundwerkstoff 22NiMoCr3.7 der Ringe 03 und 04 und Schweißgut, Probensatz SOP 0a	AREVA	NTCM-G/2008/de/0031 / Rev. A / January 24, 2008	
Bestrahlungüberwachungsprogramm KCB - Zusätzliche Nullerprobung Prüfung des unbestrahlten Probensatzes SOP 0a	AREVA	NTM-G/2007/de/0256 / Rev. B / May 14, 2008	

Title	Author	Reference-No. / Rev. / Date	GRS Report / Date
KCB Fast neutron fluence ($E > 1$ MeV) calculation for the reactor pressure vessel and the irradiation capsules SOP 2.3 and 4	AREVA	NEPR-G/2008/en/3532 / Rev. B / February 16, 2009	KFD-LTO-WP2 / July 2010
Quality assurance of fluence calculations on the RPV - Borssele NPP	NRG	NRG-22181/09.93089/E / March 31, 2009	
PTS-Analyse Borssele: Thermohydraulische Analysen	AREVA	NEPR-G/2009/de/0010 / October 1, 2009	KFD-WP4-WS1-T1 / May 2011
Evaluation of the thermohydraulic scenarios for PTS calculations	EPZ-KTO	KTO/Adj/Bec/R106082 / March 26, 2010	
RPV brittle failure safety assessment assuming 60 years of operation	AREVA	NTCM-G/2009/en/0466 / July 16, 2009	KFD-WP4-WS1-T2.1 / April 2011
Review of the pressure-temperature limit curves for the reactor coolant pressure limitation system	AREVA	NTCM-G/2009/en/0514 / October 30, 2009	KFD-WP4-WS1-T2.2 / April 2011
KCB: Fast neutron fluence ($E > 1$ MeV) for the scraping samples from the reactor pressure vessel	AREVA	PEPA-G/2010/en/3519 Rev. A / November 17, 2010	EL&I-WP2-T10 / May 2012
Bestimmung der spezifischen Mn-54/Fe- und Nb-93/Nb-Zerfallsraten in den Materialproben der Reaktordruckbehälterinnenwand aus dem Kraftwerk Borssele nach dem 36. Betriebszyklus	AREVA	PTCC-G/2010/de/0200 Rev. C / November 16, 2010	
KCB RPV safety assessment assuming 60 years of operation	AREVA	NTCM-G/2009/en/0549 / March 17, 2010	KFD-WP4-WS1-T3 / May 2011
KCB RPV safety assessment assuming 60 years of operation	AREVA	NTCM-G/2009/en/0549 Rev. B / July 12, 2010	KFD-WP4-WS2-1.2 / March 2012
Fatigue			
Inspection Report SW2009 – FAMOS Installation	AREVA	NEEA-G/2009/en/0168 Revision D / May 12, 2010	KFD-LTO-WP4 / December 2010
Fatigue Monitoring System FAMOS, FAMOS Manual	AREVA	NEEA-G/2007/en/0410, Revision D / May 20, 2010	
Lastfallkatalog für das Nukleare Dampferzeugungssystem (NDES) für eine Betriebszeit von 60 Jahren	AREVA	NESS-G/2009/de/0154, Rev. A / Nov. 24, 2010	KFD-WP4-WS2-T3.1 / January 2012
International experience of fatigue TLAA	NRG	NRG-22488/11.106372 / April 14, 2011	KFD-WP4-WS2-T2.3 / January 2012

Title	Author	Reference-No. / Rev. / Date	GRS Report / Date
LTO demonstration for fatigue TLAAAs	NRG	NRG-22488-11.106369 / April 14, 2011	KFD-WP4-WS2-T3.2 / March 2012
Scope of fatigue TLAAAs	NRG	NRG-22488-11.106370 / April 14, 2011	
Assessment of fatigue TLAAAs	NRG	NRG-22488-11.106371 / April 14, 2011	
LTO demonstration for fatigue TLAAAs	NRG	NRG 22488/11.106369 / Rev. 1, May 30, 2012	EL&I-WP2-T4.4, September 2012
Assessment of fatigue TLAAAs	NRG	NRG 22488/11.106371 / Rev. 1, May 30, 2012	
International experience of fatigue TLAAAs	NRG	NRG 22488/11.106372 / Rev. 1, May 30, 2012	
Break Preclusion			
Review time dependency break preclusion for Borssele NPP to 2034	NRG	NRG-912192/ 09.97298 / November 26, 2009	KFD-WP4-WS1-T4 / April 2011
EQDBA			
Methodology and approach of the Long Term Operation Bewijsvoering subproject: Qualification of Design Base Accident resistant electrical Equipment	EPZ	KTE/Adj/SAL/ R106299 / January 7, 2011	EL&I-WP2-T9.3 / May 2012

2 Approach

An approach was developed by GRS in close coordination with the Dutch safety authorities for the review of the documents provided, which comprises in particular

- an understanding of the hierarchy of documents to be reviewed,
- the evaluation criteria to be applied,
- the structure of the documentation of the reviews, and
- the discussion procedure.

2.1 Hierarchy of documents to be reviewed

At the very beginning, the documents were reviewed in the order of their availability. However, it soon became clear that there is a document hierarchy which has to be followed by the review process. Accordingly, the documents were reviewed taking into account the following order / hierarchy levels, starting from the top: Conceptual document, Verification of preconditions, Scoping report, Screening report, AMR methodology report, CAM reports, AMR reports. That means that it was checked for all documents as part of the GRS review process if they were in agreement with the requirements / outcome of the higher level documents already reviewed before.

The TLAA reports are exceptions from the procedure described above. The four topics for the TLAA (RPV embrittlement, fatigue, break preclusion and EQDBA) are specified in the conceptual document. The corresponding individual documents are listed there. For the review of these documents the interrelationship between several documents related to one topic, e.g. fatigue, had to be considered.

Moreover, an AMR summary report was provided summarising the results of the AMR procedure (see **Section 2.2**).

2.2 Evaluation criteria to be applied and existing limitations

The reviews performed by GRS are based on the general knowledge of GRS on the state of the art in science and technology related to ageing management and LTO of nuclear power plants (NPPs) as well as on the specific knowledge on the degradation mechanisms and ageing management of structures and components (SCs) in NPPs.

For evaluation of the general approach, mainly the IAEA safety reports / guides on LTO /IAE 08/ and ageing management /IAE 09/ were applied. Specific requirements were used to evaluate ageing management of individual SCs, as documented in several codes and standards (e.g. KTA, ASME) and corresponding technical documents. Moreover, GRS benefits from data and knowledge bases as well as insights gained from more than 35 years of evaluating operating experience with SCs in NPPs.

Following consultation and agreement with the customers, the evaluation is exclusively based on the review of the original documents. I.e., sources mentioned therein were not evaluated by GRS due to the given contract and time frame as well as the fact that many of these documents are written in Dutch. Therefore, it was mainly reviewed whether the individual documents provide comprehensible information and meet the requirements of the corresponding guidelines. In some cases, particularly for some more complex documents such as the reports on scoping and screening as well as the reports on the mechanical B AMRs, the given restrictions were explicitly addressed in the individual GRS review reports.

An exception from the evaluation procedure described above forms the review of the AMR summary report. As requested by EL&I, this report was reviewed with regard to completeness and consistency with the individual AMR reports only.

2.3 Structure of the documentation of the reviews

Each GRS review report starts with a short description of the background, objective, scope and approach of the review. After this, the results of the individual reports are first summarised and then commented on and evaluated chapter by chapter. Based on this process, conclusions were drawn, and recommendations and comments were given.

The conclusions include a general evaluation of the report reviewed. Main findings are given as recommendations. These recommendations focused on the enhancement of the reviewed report as well as on measures which should be implemented at KCB itself. Minor findings, mainly editorial aspects, are considered as comments.

It should be noted that this structure was elaborated during the review of several documents, i.e. the structure of the very first review documents may deviate from the structure described above.

2.4 Discussion procedure

The majority of draft review reports were discussed with representatives of EPZ, NRG and AREVA in the presence of representatives of the Dutch safety authorities. For this reason, a series of technical meetings were held. At the meetings in particular the recommendations given by GRS were discussed. The results of the discussions are fixed in so called discussion sheets in tabular form. These sheets contain the draft GRS recommendations, the position of EPZ prepared in advance of the meeting as well as the final results of the discussion. The discussion sheets are documented as part of the minutes of the meetings.

3 Conclusions and recommendations

3.1 Conclusions

The procedure chosen by EPZ for "LTO Bewijsvoering" complies with the procedure given in IAEA Safety Report SR 57 /IAE 08/ for demonstrating the safety of nuclear power plants during LTO, i.e. for demonstrating that safety and safety relevant SSCs continue to perform their intended functions during LTO. The approach applied is described sufficiently detailed to pin down the reasoning in the decision making.

As described in the conceptual report /NRG 11/, the documentation for the "LTO Bewijsvoering" consists mainly of individual documents which can be assigned to the phase "LTO Assessment". These are documents which provide information on the approach and results of

- the scoping and screening process,
- the ageing management reviews for passive mechanical, electrical and civil / structural SCs as well as
- so-called Time Limited Ageing Analyses (TLAAs) for selected topics components and ageing mechanisms.

Moreover, some individual documents on the verification of preconditions were provided which can be assigned to the phase "Prior to LTO Assessment".

The documentation provided by EPZ for "LTO Bewijsvoering" so far is comprehensible to a large extent. It basically demonstrates that the necessary conditions for a safe LTO of KCB are met. However, it has to be noted that some restrictions exist with respect to the comprehensibility of the reports. This is mainly the case for the AMR reports for mechanical B components. The objective of covering all relevant ageing mechanisms of all the systems in scope and their systematic management in one AMR report appears to be very ambitious. For instance, it was impossible for the reviewers to check the reports for comprehensiveness and consistence with the systems in place at KCB within the given framework.

The ageing management reviews performed resulted in a number of recommendations by AREVA regarding the specific areas in which KCB plant practices and policies

should be augmented to align KCB with accepted nuclear industry practices and to demonstrate that the effects of ageing on in-scope components and subcomponents will be adequately managed. This is to assure that the intended functions will remain consistent with the NPP licensing basis during LTO. These recommendations are mostly summarised in the AMR Summary Report /NRG 12/. Moreover, information is given in /NRG 12/, how EPZ intends to implement these recommendations. The recommendations given by AREVA are supported by GRS.

GRS made a number of recommendations and comments when reviewing the individual documents. Here, one can distinguish between

- a large number of recommendations and editorial comments concerning the enhancement of the reports provided and
- some recommendations for the enhancement of KCB plant practices for LTO.

These recommendations and comments are documented in the individual GRS review reports. Moreover, the minutes of the technical meetings held contain discussion sheets documenting the results of the detailed discussions on the GRS recommendations and comments. These items are therefore not repeated here in detail. However, the main generic recommendations are listed and explained below.

3.2 Main generic findings and recommendations

The main generic recommendations by GRS concern the following aspects:

- Enhancement of the existing ageing management plant programmes
- Additional inspection measures for components of the Main Coolant Pressure Boundary (MCPB)
- Additional proof of the ageing behaviour of specific materials
- Compliance with the state of knowledge on ageing management of SCs
- Completion and further elaboration of fatigue analyses
- Completion and updating of documentation.

3.2.1 Enhancement of the existing ageing management plant programmes

For LTO of KCB, GRS recommends to enhance the ageing management plant programmes for safety-related SCs based on the insights gained from the ageing management reviews performed (R1).

Enhancement of the existing ageing management plant programmes for KCB means from the viewpoint of GRS, in particular:

- A more systematic overall approach should be implemented taking into account the relations between the different ageing management, inspection, and maintenance programmes.
- The recommendations given in the AMR Reports prepared by AREVA as well as in the corresponding Review Reports performed by GRS should be implemented in a consistent and timely manner.
- The ISI / maintenance schedule should contain in a systematic manner all activities to be performed including locations, intervals and test procedures and techniques to be applied.
- An appropriate computer-based administration system should be implemented in which all relevant information is collected and which allows a quick access to it, particularly on the design and operating parameters, actual state of SCs, ISI and maintenance programmes and results.

3.2.2 Additional inspection measures for components of the MCPB

For LTO of KCB, GRS recommends additional inspection measures for components of the Main Coolant Pressure Boundary (MCPB) beyond the current scope (R2).

The recurrent inspection programme for pressurised components at KCB largely follows the requirements set by the US American ASME Boiler and Pressure Vessel Code, Section XI. Some additional inspections are performed in response to requirements of the Dutch regulators and operating experience of other plants. For the components of the MCPB this scope of inspections is considered to be adequate as long as the plant is operated within its original design life and operating experience is supported by other plants of similar design and vintage.

However, GRS considers the information gained from these inspections not as a sufficient basis for another 20 years of LTO. Firstly, this is due to the fact that there is no other plant of the same design and vintage still in operation. Therefore, the growth in operating experience with components made of comparable design is rather limited, especially regarding their operating time. KCB cannot take credit from the world-wide operating experience in the same way as plants in the U.S can do for example where a great fleet of plants of comparable design is operating. Secondly, some degradation is known from operating experience of these components, in particular resulting from corrosion and fatigue, and the occurrence of new types of degradation in the future cannot totally be ruled out.

The general requirement to maintain a high level of safety for the KCB plant implies in particular the ability to assure the high quality of the MCPB with high confidence. For these components, failure during operation must be ruled out by preventive measures, suitable design and close surveillance of operating conditions, which are complemented by early detection of any serious degradation. Therefore, it appears necessary to gain more information on the current physical status of those components and to assure the early detection of any serious degradation by some additional inspections during operation in the next 20 years.

Against the described background, GRS recommends additional inspection measures beyond the current scope. This means:

- For LTO until 2034, it is recommended to enhance the knowledge on the current physical status and the condition of the components of the MCPB by one-time inspections of those components not inspected during the last inspection interval.
- Additional in-service inspections should be conducted for the verification of the assumptions made for long-term operation by representative spot checks.
- The methods and techniques applied have to be able to identify potential degradation due to plant ageing. In particular, changes of the inner surfaces of components should be identified at an early stage.

Detailed recommendations were given in the GRS review reports of the AMR reports on the different systems and components, i.e. the reactor pressure vessel /JED 12/, the main coolant and surge lines /ELM 12/, the pressurizer system /REC 12a/, and the steam generators /REC 12b/.

3.2.3 Additional proof of the ageing behaviour of special materials

For LTO of KCB, GRS recommends to provide additional proof of the ageing behaviour of specific materials based on research results or general industry experience and special tests (R3).

In the review of the AMR reports a few specific materials used for KCB components were identified for which the ageing behaviour is not well proven. This covers in particular

- Martensitic stainless chromium steel used for the latch housing of the control rod drive mechanisms (X10 Cr 13 corresponding to 1.4006),
- Low-alloy steels used for the pressurizer (Altherm NiMoV and Altherm AF NiMoV), and
- Cast ferritic-martensitic chromium steel used for the inner housing of the HP turbine (GX 8CrNi 12 corresponding to 1.4107).

For LTO, more information on the ageing behaviour of these materials under operating conditions is required. This information can be gained either by using the results of studies already made or still continuing in other countries, particularly in Germany, or by performing supplementary measurements such as hardness measurements. These activities should be completed within an operating period of ten years of LTO.

3.2.4 Compliance with the state of knowledge on ageing management of SCs

For LTO of KCB, GRS recommends to systematically follow the operating experience and insights from R&D relevant for the ageing management of safety-related SCs (R4).

In order to make sure that new insights on the ageing behaviour of safety-related SCs and measures to manage them can be considered for the safe LTO of KCB at an early stage, the ongoing world-wide activities on operating experience feedback and ageing management should be followed and evaluated in a systematic way. In this context, active participation within the framework of international co-operation is important. Therefore, the participation in relevant international working groups such as IGALL (IAEA) or CODAP (OECD/NEA) should be increased.

3.2.5 Completion and further elaboration of fatigue analyses

For LTO of KCB, GRS recommends to complete and further elaborate the fatigue analyses performed as soon as practically possible (R5).

From the GRS point of view, the fatigue analyses performed for LTO so far are comprehensible in principle but need some improvements. Detailed information for this is given in /REC 12c/. For three locations, the usage factors calculated for operation until 2034 exceeded the attention levels for the cumulative usage factors as defined in KTA 3201.4, i.e. possible environmental effects have to be taken into account by supplementary measures such as detailed state-of-the-art calculations, monitoring of locations concerned, or adequate experiments. Moreover, fatigue analyses for a lifetime extension until 2034 still have to be performed for a number of locations. The planned approach to specify the load cases during normal operation and their number on the basis of measurements with the FAMOS fatigue monitoring system is regarded to be appropriate and should in any case be implemented after five cycles as intended. Against the described background, recommendation **R5** comprises the

- further qualification of the already performed fatigue analyses,
- the completion of the still pending fatigue analyses, and
- the use of FAMOS data for further qualification of the load catalogue and individual load cycles under normal operation.

3.2.6 Updating of documents

For LTO of KCB, GRS recommends to update the documentation for "LTO Bewijsvoering" in an adequate manner (R6).

The recommendations and comments made by GRS regarding the enhancement of the individual documents are documented in the corresponding GRS review reports and the discussion sheets. GRS assumes that these individual items are considered and implemented in the updated reports. Moreover, it is important that the documentation elaborated for "LTO Bewijsvoering" is considered as a "living documentation" for LTO and is consequently updated in an adequate manner in order to reflect the current plant status and changes in the state of knowledge on ageing management. For this, appropriate procedures and tools should be developed and implemented at KCB.

4 Sources

- /ELM 12/ M. Elmas: Enhanced Technical Support to EL&I in the Field of Nuclear Safety of Existing Nuclear Facilities, WP 2 "Long-term operation of KCB" - Subject: Ageing Management Review to Support Long-Term Operation for KCB Main Coolant Lines and Pressurizer Surge Line. Report No.: EL&I-WP2-T7, Cologne, May 2012
- /JED 12/ U. Jendrich: Enhanced Technical Support to Nuclear Regulatory Authority of the Netherlands KFD in the Field of Nuclear Safety, WP 4 "Long-term operation of KCB" - Task: Ageing management review to support long-term operation for KCB reactor pressure vessel. Report No.: KFD-WP4-WS2-T1.1, Cologne, March 2012
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