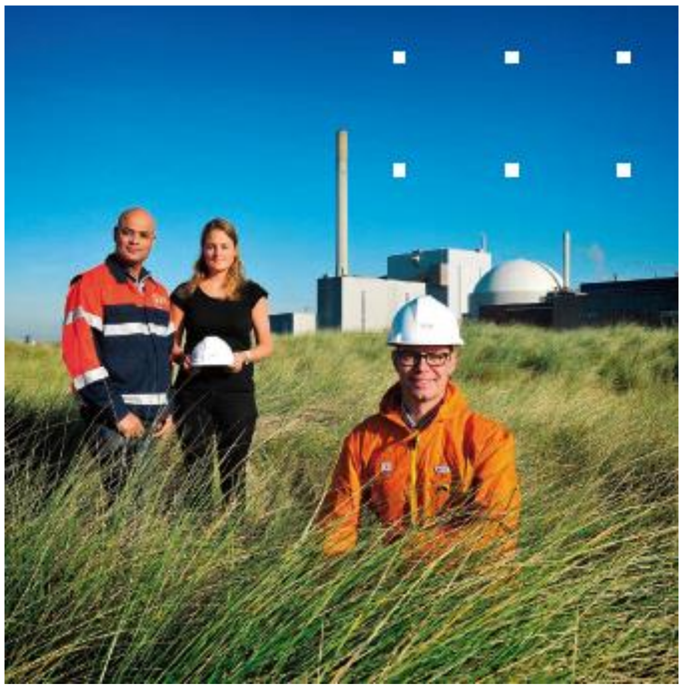
Unofficial Translation
In this document only relevant parts in relation to the complaint of Greenpeace to the Implementation Committee of the Espoo Convention are translated.
More information regarding this application and licensing can be found:
http://www.rijksoverheid.nl/documenten-en-publicaties/vergunningen/2012/10/24/inspraak-verlenging-bedrijfsduur-kerncentrale-borssele.html



Application for Amendment of the Nuclear Energy Act Licence

AMENDMENT TO THE SAFETY REPORT

LONG TERM OPERATION OF BORSSELE NUCLEAR POWER PLANT (LTO)

September 2012

EPZ
voortdurend verbeteren

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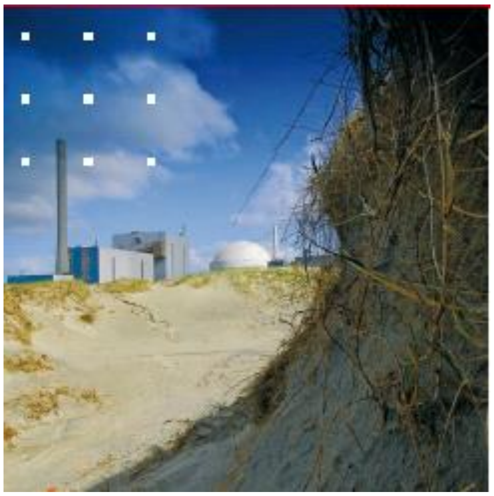
Chapter 3 INTRODUCTION



N.V. Elektriciteitsproduktiemaatschappij Zuid-Nederland (EPZ) is a joint venture between DELTA Energy B.V. (DELTA Energy) and Energy Resources Holding B.V. (ERH).

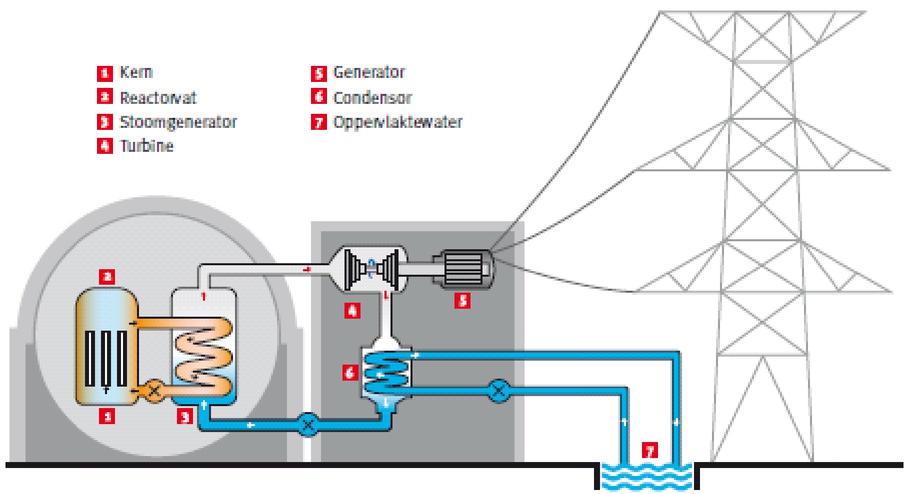
EPZ operates two production units: a coal-fired plant of 406 MWe and a nuclear power plant of 512 MWe. EPZ also operates a wind farm of 24 MWe. EPZ is established in Borssele, where the production units are also located.

Borssele nuclear power plant is a so-called pressurised water reactor. In these reactors, water under high pressure is used to extract the heat produced during nuclear fission. This heat is used to produce electricity. The water is also used to slow down the neutrons in order to ensure continuity of the nuclear fission process.

3.1 60-year service life

NV EPZ and its shareholders entered into an agreement with the State of the Netherlands in 2006 (the Borssele Nuclear Power Plant Covenant, Government Gazette of 17 July 2006), stipulating 31 December 2033 as the closure date for the plant. As a result of the Covenant, Borssele NPP can continue to operate for sixty years instead of the originally planned forty years. As of 2014, Borssele NPP will enter the so-called Long Term Operation phase.
Long Term Operation (LTO) is an international term referring to an ‘extended’ period of operation of NPPs, i.e. the continuation of operation beyond the period originally foreseen. The original period may be limited on the basis of e.g. rules and regulations, licences, standards and/or design. LTO needs to be justified by carrying out a safety review looking directly at lifetime-limiting processes and characteristic systems, structures and components (SSCs). Other regular activities, such as the periodic safety reviews, ageing management and configuration/modification management are also a requisite of LTO.

The operating licence for Borssele NPP is not time-limited, but the original design and construction of Borssele NPP were based on a service life of forty years.
This design lifetime was taken as the basis for the design and as such included in the Safety Report that forms part of the Nuclear Energy Act licence.
Therefore, LTO does not require a request for an extension of the operating licence, as the licence has been issued for an indefinite period. Instead, LTO requires an amendment to the text of the Safety Report, namely the extension of the original design lifetime from forty to sixty years. Any such change needs to be meticulously argued. The substantiation, which is the justification for the amendment to the Safety Report, was conducted in accordance with the guidelines provided by the IAEA in Safety Report No. 57: 'Safe Long Term Operation of Nuclear Power Plants' [3].



3.2 Nuclear safety, lifetime and service life

It is important to make a clear distinction between the concepts of lifetime and service life in order to understand what studies have been performed to justify LTO. The original design and construction of Borssele NPP were based on a service life of forty years. This service life has been taken as starting point in a number of relevant analyses and evidence provided within the framework of nuclear safety. This service life was calculated into the design of the NPP and shall further be referred to as the original design lifetime. This original design lifetime was solely used as a starting point for the calculation of the loads on the structures and components for a service life of forty years. In the 1970s, conservative load estimates were typically applied (in quantities and size). Today we have access to a lot more information about the actual loads and a longer service life of sixty years was made possible thanks to more reliable load calculations.

The design lifetime and the technical lifetime are thus two different things. The technical lifetime is the maximum period during which the nuclear plant can technically be used. The technical lifetime of a plant is generally longer than the economic lifetime. Because most components (such as pumps and valves in auxiliary systems) are relatively easy replaceable, the technical lifetime of these components is of less importance in the calculation of the maximum achievable service life.

The technical lifetime is primarily of importance for a number of hard to replace (or extremely costly to replace) components, such as the RPV and other components of the pressurised primary cooling system. The technical lifetime of these components is determinative for the economic lifetime of the plant and thus also the maximum achievable service life.

The components in the design are dimensioned such that they will be able to withstand the anticipated loads during the entire design lifetime. Examples of such loads are exposure to neutron and other radiation and transients (such as reactor shutdown, scram and start-up). The design analyses are based on conservative assumptions and margins to ensure that the functions, or the functioning of the components, are guaranteed for the entire design lifetime of the plant.

A demonstrably good design and correct implementation of this design (manufacture and assembly) do not of themselves provide a guarantee for safe operation over the entire design lifetime of the plant.
The behaviour, operating conditions and the status of the components will also need to be continually monitored. This ensures that the new design lifetime is in keeping with the design principles. Deviations from the design principles can lead to greater loads than were calculated into the design which can result in a shorter service life than the original design lifetime. Likewise, overdesign and lower loads than initially calculated can lead to a longer service life than the original design lifetime.

LTO involves more than just technical factors. A robust organisation is also important. This is assessed every ten years during the 10-yearly safety review (10EVA) in accordance with regulation II B.11 of the Nuclear Energy Act licence.
The next 10-yearly safety review will be completed in 2013 (10EVA13). However, in order to substantiate the justification for LTO, a review of the aspects ‘organisation, management system and safety culture’ and ’human factors’ has already been carried out to verify that Borssele NPP can continue to operate safely in an LTO situation.

3.3 Reader’s guide to the licence application

The structure of the licence application for a 60-year service life for Borssele NPP is described below. The current licensing situation is described in Chapter 4. This is followed by the formal application for an amendment to the current Nuclear Energy Act licence, including the legal motivation, in Chapter 5.

Chapter 6 describes the framework used for the evidence for justifying a 60-year service life, focusing on the technical as well as the organisational aspects. The technical aspects involve the validation and revalidation of the safety analyses for which a service life of forty years is taken as the design lifetime (Chapter 7) and ageing management (Chapter 8). The organisational aspects involve the suitability of the EPZ organisation for continued safe operation during the entire service life of the plant (Chapter 9).

The measures specifically related to LTO which have or will be initiated by EPZ within the framework of the 60-year service life are summarised in Chapter 10.

The licence application contains various text boxes, which provide an explanation of various definitions or parameters that are used in the licence application, or explain how EPZ manages or plans to manage the relevant theme.

Chapter 4 CURRENT LICENCE

EPZ is the operating organisation with the licence to operate Borssele NPP. The current Nuclear Energy Act licence for Borssele NPP was issued on 18 June 1973 and most recently amended on 24 June 2011 by decree ETM/ ED/11081801.

An overview of all intervening amendments has been included with this application as Appendix A.
The competent authority that oversaw the most recent amendment was the Ministry of Economic Affairs, Agriculture and Innovation (EL&I). This amending licence was issued on 24 June 2011 and provides for an expansion of the number of types of nuclear fuel to be deployed in the reactor (fuel diversification).
Alongside the holding and use of enriched natural uranium (ENU) and enriched reprocessed uranium (ERU), the licence has been extended to cover the use of mixed oxide (MOX) fuel elements and the use of compensated enriched reprocessed uranium (c-ERU) fuel elements.

Chapter 5 DESCRIPTION OF THE LICENCE AMENDMENT

EPZ has applied for the addition of VR-KCB93 REV.7 to regulation I.1 of the current Nuclear Energy Act licence in consequence of the fact that:

- sections of the Borssele Nuclear Power Plant Safety Report (VR-KCB93; [1]) are part of the Nuclear Energy Act licence, and
- amendments to these sections of the Safety Report are required in connection with the new design lifetime of sixty years (service life extended to no later than 31 December 2033) in accordance with the provisions of Section 15a (1) of the Nuclear Energy Act.

No changes will be made to the actual physical state of Borssele NPP.

Note

Aandeelhouders en de Staat ondertekenen het 'Borssele Convenant'

The Borssele NPP Nuclear Energy Act licence is valid for an indefinite period and therefore provides for an unlimited service life of the nuclear power plant. The Nuclear Energy Act (Section 15a (1)) limits the service life of Borssele NPP to sixty years.

Regulation I.1 attached to the Nuclear Energy Act licence lays down that “following completion of the changes the nuclear power plant must be equipped and operated in accordance with the provisions of paragraph 1.4 and Chapters 3-21 of Safety Report VR-KCB93, as amended and supplemented by the revisions with the references VRKCB93 REV.1, VR-KCB93 REV.2, VRKCB93 REV.3, VR-KCB93 REV.4, VR-KCB93 REV.5 and VR-KCB93 REV.6”.

The Safety Report assumes a service life of forty years (the original design lifetime) for the design analyses. The Borssele Nuclear Power Plant Covenant (Government Gazette of 17 July 2006) and Section 15a (1) of the Nuclear Energy Act permit operation up to and including 31

December 2033, corresponding to an operating life of sixty years. The effect of the new design lifetime on the design analyses is described in Safety Report VR-KCB93 REV.7.

Safety Report VR-KCB93 REV.7 also describes the topic of ageing management.

An overview of the amendments to the Borssele Nuclear Power Plant Safety Report (VR-KCB93) following from the new design lifetime of sixty years has been included as Appendix C. These amendments were incorporated as changes in the Safety Report (VR-KCB93 REV.7).

An overview of all information to be supplied in support of an application for an amending licence pursuant to the Nuclear Facilities, Fissionable Materials and Ores Decree (Bkse) is included in Appendix B.

EIA review requirement
The Environmental Impact Assessment Decree of 1994 describes the activities, plans and decisions for which an Environmental Impact Assessment is required or to which Sections 7.16 up to and including 7.19 of the Environmental Management Act must be applied. The latter category concerns the activities that are subject to an EIA review requirement.
Category 22.3 of List D of the activities that require an EIA review refers to “modification or expansion of a facility in which nuclear energy can be released”. On the basis of this, the competent authority assessed whether an EIA is required for the current licence application. The conclusion of this assessment is that an EIA is not required [3].

Chapter 6 Evidence framework for the licence application

When Borssele NPP was designed and built in the early 1970s the anticipated service life was forty years. The 40-year service life was applied at the time to be able to specify and demonstrate technical aspects of the nuclear power plant. For example, during construction evidence had to be provided that safe operation over the anticipated lifetime was feasible. This established a design lifetime of forty years.

6.1 Introduction

The original design lifetime served as a guideline rather than a fixed endpoint for the operation of the NPP. If a new design lifetime of more than forty years is assumed, it must be demonstrated that the plant can be safely operated during the new design lifetime. The technical service life of the plant is unlimited in effect. After all, components affected by wear and ageing can be repaired or replaced, so that the plant remains safe despite its age. Putting the need for a technically safe nuclear power plant first, it is therefore primarily economic factors that determine the maximum achievable service life. In contrast to most other components, the condition of the RPV determines the lifetime of the plant, because it will not be economically feasible to replace it. Within the framework of the current licence amendment, evidence will be provided that Borssele nuclear power plant can be operated safely for a period of sixty years.

6.2 Assessment framework

The assessment framework for the current licence application is set down in the Nuclear Energy Act (Kew) and the underlying legislation and regulations (including the Nuclear Safety Rules (NVR)). The general assessment framework for the current licence application as set down in the Nuclear Facilities, Fissionable Materials and Ores Decree is included in Appendix B.

Dutch nuclear legislation does not set down specific rules, guidelines or norms for Long Term Operation. IAEA

Example

During the construction phase, it was demonstrated for a main component such as the RPV that it would still retain sufficient ductility after forty years of neutron radiation (ductility as opposed to brittleness in this case). This does not mean that the RPV will no longer be able to withstand the forces that act upon it after forty years of operation. Rather, this only entails that this has been demonstrated for the limited period of forty years. The evidence provided was an answer to the question that was asked at the time, namely whether the RPV would be suited to forty years of safe operation – the originally anticipated service life of the nuclear power plant. To extend the design lifetime of the plant to sixty years, it will need to be demonstrated (among other things) that the RPV will still retain sufficient toughness to withstand the forces that act on it after sixty years of operation.

In consultation with the competent authority, Safety Report No.57 “Safe Long Term Operation of Nuclear Power Plants” [3] served as a guideline for the evidence for the new design lifetime of sixty years. Safety Report No. 57 provides a broad framework of technical aspects that need to be assessed in order to justify extension of the design lifetime of the nuclear power plant. Two important activities referred to in Safety Report No. 57 are:

1. Revalidation of time-limited ageing analyses;
2. Assessment of the ageing management of systems, structures and components important to safety.

The former activity is the formal reason for the applicable licence application (amendment of the Safety Report for those analyses in which the original design lifetime is applied).
The second activity provides insight into the current status of the systems, structures and components of the installation that are important to safety, as well as the manner in which it has been demonstrated that the ageing of these systems, structures and components can be managed during the NPP's new design lifetime. A paragraph on ageing management will be added to the Safety Report.

For the organisational and administrative aspects of LTO, an evaluation was performed of the organisation, management system, safety culture and the human factor on the basis of Safety Factors 10 and 12 of the periodic safety review guideline of the IAEA (Safety Guide No. DS426). This Safety Guide is the basis of the 10-yearly evaluation (10EVA13), the evaluation phase of which is to be completed by 31 December 2013.
The action plan and the assessment framework for 10EVA13 are set down in the so-called "10EVA13 basic document" [6].

SALTO

The IAEA provides various services to national administrations in the field of LTO. One of these is the performance of a SALTO mission (Safe Long Term Operation), at the request of the national government, to a nuclear power plant that wishes to make the transition to LTO. During this mission, independent international experts review the relevant methods and activities within the framework of LTO.

A SALTO mission reviews a very wide range of aspects. The most important of these are:

- Organisation and functions
- Configuration and change management
- Current safety analysis report and other documents relevant to the licence
- Identification of the structures, systems and components relevant to LTO
- Existing programmes and activities relevant to LTO
- Assessment of the ageing management programme
- Revalidation of the safety analyses that involve time-limited assumptions

In 2010, a limited-scope SALTO mission visited Borssele nuclear power plant and in 2012 a full-scope SALTO mission was conducted during which all the above aspects were reviewed.

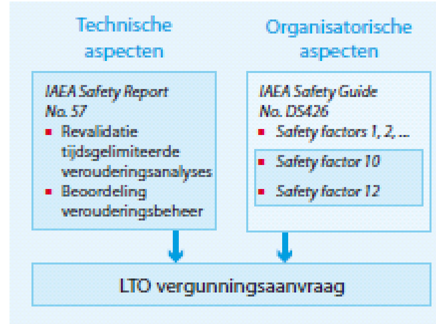
The measures pursuant to the findings of the SALTO missions have been incorporated in the assessment of the technical aspects (see §6.4.1) or the measures as described in Chapter 10.

6.3 1 January 2014

As of 1 January 2014, Borssele NPP will have been operating for forty years. Prior to this date, the analyses and calculations on the basis of the 40-year design lifetime were reviewed/revalidated in order to demonstrate that the plant could continue to operate safely for a service life of sixty years.

6.4 Evidence

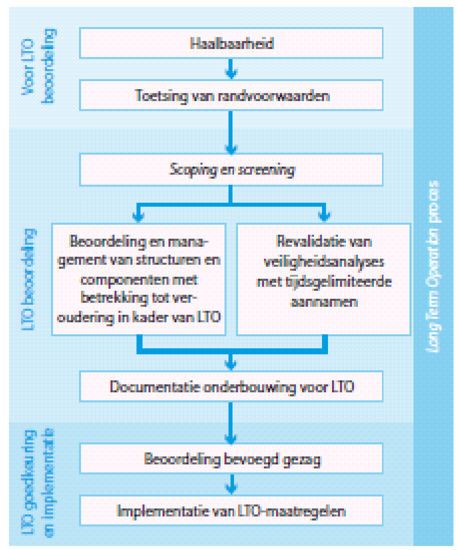
The evidence that the nuclear power plant can continue to operate safely for sixty years is provided in an evaluation of the technical aspects in accordance with Safety Report No. 57 and the evaluation of Safety Factors 10 and 12 in accordance with Safety Guide No. DS426 for the organisational aspects. Figure 1 provides a schematic overview of the coherence between these evaluations.



Figuur 1 Schematische weergave opbouw LTO vergunnings aanvraag.

6.4.1 Technical aspects

The assessment of the technical aspects was performed in accordance with the document entitled IAEA Safety Report No. 57 “Safe Long Term Operation of Nuclear Power Plants” [3]. EPZ has elaborated and described the method set down in this Safety Report in the so-called KCB LTO Evidence Conceptual Document [4].
The structure of and coherence between the various activities is described in Figure 2.



Figuur 2 Overzicht structuur en samenhang van de activiteiten van het LTO-beoordelingsproces voor wat betreft de technische aspecten [4].

The assessment process in accordance with Safety Report No. 57 roughly consists of three consecutive phases:

- The “Prior to LTO assessment” phase involves the feasibility study and verification of the preconditions:
  - Prior to the actual analyses, a feasibility study and verification of the preconditions were performed in order to assess whether a 60-year service life was technically and economically feasible.
  - As part of the verification of the preconditions, the efficacy of the existing plant programmes was examined. These plant programmes are designed to ensure the functionality of passive and active components based on recurring trials, inspections, maintenance, etc. By 1 January 2014 it must have been verified that all active components are included in the plant programmes. For the passive components, an assessment of the ageing management programme was conducted in accordance with Safety Report No. 57 (see the “LTO assessment” phase).
- The “LTO assessment” phase involves the following activities:
  - Scoping is used to identify those structures, systems and components that are important or relevant to safety and that will or must be analysed more closely within the framework of LTO (60-year service life).
  - Screening is used to provide further details of the various structures, systems and components.
  - An assessment of the ageing management programme was conducted for all passive components within the scope, where a distinction was made between mechanical, electrical and structural components.
  - A revalidation of the time-limited ageing analyses was conducted for RPV embrittlement, fatigue and leak-before-break.

- An assessment of the qualification of the accident-resistant electrical equipment was conducted. Due to the explicitly time-limited aspect, and in accordance with international developments, this subject was categorised under “revalidation of safety analyses with time-limited assumptions” and treated accordingly.
- Collection and archiving of all documentation relevant to LTO evidence.

The current licence application is based on this documentation.

- The “LTO approval and implementation” phase involves the assessment by the competent authority of the plan to implement the measures:
  - The assessment of Borssele NPP is based on the decision on the current licence application.

Verification of the preconditions

As described in Chapter 3, LTO involves more than the performance of a safety review of the service life limiting processes and characteristic structures, systems and components. Existing plant programmes and other programmes and documentation are also part of LTO and have therefore been assessed as well. The following programmes and documentation are considered preconditions for LTO in this regard:

1. Programmes involving maintenance, qualification, in-service inspections, surveillance and monitoring, and water chemistry monitoring.
2. Quality management system and configuration management.
3. Original safety analyses involving time-limited assumptions.
4. The current safety analysis report or other documents relevant to the licence.

6.4.2 Organisational aspects

The assessment of the organisational aspects was carried out as part of 10EVA13. This 10-yearly safety review was organised on the basis of the document entitled “IAEA Draft Safety Guide No. DS426 ‘Periodic Safety Review of Nuclear Power Plants’” [5].

In accordance with the previously mentioned “Basic document” [6], 10EVA13 was conducted on the basis of an analysis of 15 Safety Factors, of which Safety Factors 10 and 12 applied specifically to this licence application. The evaluation of Safety Factors 10 and 12, which are relevant to this licence application, was performed as follows:

1. Status and developments at Borssele NPP

The current status and the developments during the evaluation period and in the near future were examined for each part of the evaluation. The status was described on the basis of procedures and other organisational documents, supplemented with the results of interviews with the persons or departments responsible for the relevant part. Various annual reports were also consulted in order to provide an overview of the recent focus on specific aspects and the developments involved.

2. Evaluation of the review framework documents

The review framework sets down the relevant regulations and other directives (review framework documents). The relevant sections for the evaluation are given per document. The status with regard to the requirements in place for Borssele NPP is described alongside any deviations identified, followed by a conclusion on the status of these deviations.
The results of the review of the Nuclear Safety Rules are set down in so-called standards frameworks to ensure that these are being adhered to and that this can be verified in future.

3. Operational evaluation

The evaluations of the results of the 2-yearly evaluations and of the WANO Peer Reviews form the operational evaluation. These evaluations review the efficacy of the organisation, management system, safety culture and human factors. The annual reports of various departments and working groups were also consulted.

6.4.3 LTO licence application

The results of the assessment of the technical and organisational aspects as described in §6.4.1 and §6.4.2 resulted in the current licence application as described in Chapter 5.

Chapter 7
Revalidation of time-limited analyses

Not translated.

Chapter 8
Ageing management

Not translated.

Chapter 9
Robustness of the EPZ organisation

Not translated.

Chapter 10 MEASURES REQUIRED IN RELATION TO A 60-YEAR SERVICE LIFE

The analyses/evaluations as described in chapters 6, 7, 8 and 9 of the current licence application led to the following measures that have been taken or are to be taken specifically in relation to LTO.
The analyses/evaluations described in chapters 6, 7, 8, and 9 can also be regarded as specific LTO measures, but these are not repeated as they have since been completed.

Only new measures are described of which the activities have yet to be initiated or have yet to be completed, or that require a continuous effort until the end of Borssele NPP's service life. These measures are described below:

Active components

- Verifying that all active components are included in the plant programmes.
  This, along with the fact that these programmes have already been demonstrated to be effective, provides a guarantee that the active components are operating correctly.

RPV embrittlement

- Installation of two additional sets of test specimens (SOP3 and SOP4) in the reactor to verify the ductile-brittle transition temperature safety margin for a 60-year design lifetime. These test specimens have already been installed (in 2007). Verification is to take place during the 2014-2018 period once the test specimens have been removed from the reactor (following sufficient neutron irradiation) and the brittle fracture behaviour has been ascertained empirically.

Fatigue

- New state-of-the-art analyses of five components/locations to demonstrate that the cumulative usage factor CUF_{2034} is less than 1.
- New state-of-the-art analyses of eight components/locations to demonstrate that the reference levels for environmental fatigue are not being exceeded.
- Installation of the FAMOS fatigue monitoring system to provide more accurate information on the actual fatigue loads. The results are to be used to monitor the criteria for, and hence the validity of, the fatigue analyses and to optimise the regular conduct of operations (minimise loads). The FAMOS system was installed in 2010 and will remain in service until the end of Borssele NPP operations.
- Updating the original load catalogue for a 40-year design lifetime.
  The new load catalogue for a 60-year design life will become available in 2015. Sufficient measurement results will be collected over five cycles using the FAMOS fatigue monitoring system to provide a representative picture of the load fluctuations.

Leak-before-break

- Verification of the criteria regarding stratification based on the results obtained (and to be obtained) using the FAMOS fatigue monitoring system. This verification can take place as soon as a sufficient quantity of representative data is available (around 2014).

Qualification of accident-resistant electrical equipment

- Implementation of a new method to ensure the availability/functionality of accident-resistant equipment during and after an accident. The method is based on ascertaining the qualified residual life.
- Formal calculation of the qualified residual life of all accident-resistant electrical components. As this residual life depends on the ageing factors, this calculation will be repeated periodically (after each fuel cycle).
- Requalification or replacement of accident-resistant components with a qualified residual lifetime of less than five years.

Ageing management

- Adding to the existing ageing management programmes in line with the AMR improvement measures for mechanical, electrical and I&C, and civil structures and components.
- Further research into possible specific ageing phenomena of particular structures and components in line with the AMR improvement measures for mechanical, electrical and I&C, and civil structures and components.
- Streamlining the organisation of ageing management and laying down the responsibilities clearly.

The measures will be initiated before 1 January 2014. The results and potential consequences on the basis of the measures can be made available at a later stage.

Chapter 11
List of tables and figures

Not translated.

Chapter 12 References

Referenties

[1] Veiligheidsrapport Kernenergie-eenheid centrale Borssele, VR-KCB93, rev. 6
[2] m.e.r.-beoordelingsplicht Long Term Operation KCB, Ministerie van Economische Zaken, Landbouw en Innovatie, ETM/ED/11132793, 13 september 2011
[3] Safe Long Term Operation of Nuclear Power Plants, IAEA, Safety Report Series No. 57, October 2008
[4] Conceptual Document LTO Bewijsvoering KCB, NRG, NRG-22701/10.103460, 9 september 2011
[5] Periodic Safety Review of Nuclear Power Plants, IAEA, Draft Safety Guide No. DS426, 27 november 2009
[6] Basisdocument 10EVA13 (Toetsingskader en PvA van de 3e tienjaarlijkse evaluatie), EPZ, KT/MCr/HtL/R10617, 6 december 2011
Ter info: het ministerie van EL&I heeft ingestemd met dit Basisdocument (brief no. ETM / 1203528 7 d.d. 21 juni 2012)
[7] KCB RPV safety assessment assuming 60 years of operation, AREVA, NTCM-G/2009/en/0549, 12 juli 2010
[8] LTO Demonstration of Fatigue TLAAs, NRG, NRG-22488/11.106369 Revision 1, 30 mei 2012
[9] Review Time Dependency Break Preclusion for Borssele NPP to 2034, NRG, NRG-912192/09.97298, 26 november 2009
[10] Ageing Management Review – Methodology Report, AREVA, PESS-G/2010/en/0041, 11 augustus 2011
[11] 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, 27 juli 2011
[12] Screening of relevant Structures and Components in the frame of the KCB Long-Term Operation Process, AREVA, NTCM-G/2009/en/0144, 6 oktober 2011
[13] Summary report Ageing Management Review, NRG, NRG-22503/11.109273, juni 2012
[14] ASME Boiler and Pressure Vessel Code, Section XI: Rules for Inservice Inspection of Nuclear Power Plant Components
[15] OSART guidelines, IAEA, juli 2005
[16] Methodology, approach and results of the “Long Term Operation Bewijsvoering subproject: Qualification of Design Base
Accident resistant electrical Equipment”, EPZ, KTE/AdJ/SAL/R106299 revisie A, 7 september 2012

APPENDIX A
List of licences issued

Not translated.

APPENDIX B
License applications pursuant to the Nuclear Facilities, Fissionable Materials & Ores Decrees

Not translated.

APPENDIX C

AMENDMENTS TO THE SAFETY REPORT

The amendments to the Safety Report have been classified based on the subjects in the current licence application. The changes to the Borssele Nuclear Power Plant Safety Report VR-KCB93 rev. 6 are highlighted in red.

RPV embrittlement

5.1.3 Technical strength design principles

Loads
The strength calculations for the primary system components involved the following loads:
- Loads caused by integrated components
- Loads caused by self-weight
- Mechanical external loads
- Stationary and non-stationary loads on the components caused by internal pressure
- Stationary and non-stationary temperature stresses
- Loads caused by hypothetical leaks
- Loads caused by earthquakes

The design of the RPV also takes account of the change in the material properties caused by neutron radiation ~~during a 40-year service life~~. This was performed using a fracture-mechanical ~~fracture~~ analysis. This analysis was initially performed for a 40-year service life. This analysis was later repeated for a 60-year service life based on the state-of-the-art.

Calculation method
The strength calculations for the components, which were conducted in accordance with the steam and pressure plants industry principles (*Stoomwezen Grondslagen*) and **ASME** Section III, as well as **KTA** or **RCCM**, involve:
- The dimensioning of the components
- Elasticity calculation and stress analysis
- Fatigue analysis

Operational safety of the RPV
The safety of the RPV is guaranteed by the following measures:
- Accurate analysis of the operational loads and conservative maximum stress limits
- Limits on the main coolant pressure
- Application of materials with desirable toughness properties
- Qualified manufacturing methods
- Quality assurance during manufacture and multiple testing
- Non-destructive testing during manufacture
- Pressure test at 1.3 times the design pressure
- Determination of the brittleness of the material caused by radiation prior to operation, during operation and by means of suspended test specimens
- Periodic non-destructive testing of the RPV

- Periodic pressure tests

If the service life is increased and hence also the related neutron radiation, then the material properties will change. For example, the susceptibility to brittle fracture will increase under the influence of neutron radiation. In order to be able to predict the long-term brittle fracture behaviour of the materials used in the RPV under the influence of neutron radiation, an extensive radiation programme was set up during the construction phase. The information obtained was used to make a prognosis of the material behaviour prior to actual operation of the plant. The effects of neutron radiation on the material were extrapolated to forty years of service life on the basis of this programme. In 1985, the influence on material behaviour was determined experimentally by means of suspended test specimens. The results revealed that the predetermined extrapolation values were conservative, i.e. that the material behaviour was more favourable than originally estimated.

The brittle fracture behaviour with regard to the RPV was reassessed in 2009.
This took into account the effects of changing the core loading strategy, the possible use of MOX fuel elements and improved understanding of brittle fracture behaviour and methods of calculating it. The new assessment revealed that there are generous safety margins as regards the RPV's brittle fracture behaviour for a 60-year service life as well.

To prevent unacceptable operating conditions during commissioning and shutdown, a brittle fracture prevention system was included in the reactor safety system (YZ) in the form of low temperature pressure control. This prevents the combination of pressure and temperature from reaching unacceptable values.
Before an unacceptable pressure can reached at a given coolant intake temperature, countermeasures are automatically taken to relieve the pressure. For example, the pressuriser heating is switched off. Pressure relief is also arranged by means of the pressuriser's first pressure safety device if necessary.
In addition to the above-mentioned measures for the analysis of normal plant operation, hypothetical faults were also considered in order to assess subcooling transients in case of loss-of-coolant accidents. Thermohydraulic analyses were used to determine the expected pressure and temperature behaviour at the RPV wall during the transient and the resulting stress intensity factors were calculated. The results demonstrated that no early-stage cracking will occur.

Fatigue

3.3 Resistance to internal loads

(see Table 3.3/1 below)

3.3.1 Specification of the load conditions assumed in the design

Internal loads on the components and systems of the plant are caused by the process conditions during various load conditions. The design of the components and systems of the nuclear part of the plant is based on a number of assumed load conditions. The load conditions or changes in load condition are classified as follows, in accordance with international methodologies:

1 Operating conditions
1.1 Normal conditions
1.2 Upset conditions
1.3 Test load conditions

2 Accidents
2.1 Faulted conditions
2.2 Emergency conditions

These load conditions are subdivided further in Table 3.3/1.

Operating conditions

Normal conditions

Normal conditions are operating conditions or changes in operating conditions under which the plant is operated within specific operating limits and conditions. This particularly concerns reactor start-up, power operation and reactor shutdown, including the transients that occur during these changes in operating conditions.

Upset conditions

Upset conditions are deviations in normal operation caused by functional or switching failures in the components themselves or in adjacent components. From a safety perspective, after the functional or switching failures have been resolved, the plant can continue to operate.

Test load conditions

Test load conditions involve the pressure tests of components and systems taken into service for the first time as well as periodic pressure and leak-tightness tests.

Accidents

Accidents involve deviations from normal conditions or upset conditions, after which from a safety perspective the plant cannot continue to operate.

Faulted conditions

Faulted conditions involve accidents with a low probability of occurring.

Emergency conditions

Emergency conditions involve accidents with a very low probability of occurring, or postulated load conditions.

Table 3.3/1 provides the number of occurrences of each of the load conditions as applied in the mechanical analyses for the original 40-year service life when designing the plant.
During the revalidation of the fatigue analyses for a design lifetime of 60 years, the original design numbers were revised based on extrapolation from the actual load fluctuations up to 2007 (see Table 3.3/1). All the numbers projected for the 60-year lifetime were conservative.

The load categories were also provided (see paragraph 3.2.2).

3.3.2 Load categories

The load conditions and resultant loads assumed for the design of the mechanical components and systems were divided into load categories on the basis of the severity of the load condition (see Table 3.1/1). The strength calculations for the components on the basis of these assumed loads, in accordance with the *Stoomwezen Grondslagen* and ASME Code Section III, comprise:

- the dimensioning of the components
- elasticity calculations and stress analyses
- fatigue analyses

The calculated stresses were assessed against the maximum allowable stresses in the ASME Code, which are dependent on the classification of the relevant component in load categories as well as the safety class (see paragraph 3.2.1). The load categories were classified from A to D, where the maximum allowable stresses for category A were lower than those for category D.

3.3.3 Historical loads

The potential consequences of loads on the components of the primary systems are expressed in the so-called fatigue factor. Fatigue analyses have demonstrated that the fatigue factors resulting from the loads assumed in the design of the plant and the assumed number of occurrences of load conditions during the total service life conform to the criteria in the ASME Code and the draft KTA limit values for *environmental fatigue*.

There were relatively few occurrences of load conditions in the plant up until 2007~~1993~~ in comparison with the assumed numbers. The corresponding fatigue factors that were calculated therefore have a considerable safety margin with respect to the design value. If this trend with regard to the number of occurrences of load conditions remains stable for the remaining service life of the plant, then this considerable safety margin will also be maintained for the total service life.

Table 3.3/1 Load conditions assumed in the design, design numbers (40-year service life, projected values for a 60-year service life on the basis of the actual load fluctuations that occurred up until 2007) and the corresponding load categories.

Veronderstelde belastingstoestanden	Ontwerpaantal (40 jaar bedrijfsduur)	Geprojecteerd aantal 1) (60 jaar bedrijfsduur)	Belastings-categorie
1 Bedrijfstoestanden			
1.1 *Normaal bedrijf*			
▪ Opstarten vanuit nullast, koud	155	142	A
▪ Afregelen tot nullast, koud	155	141	A
▪ Sprongvormige belastingsveranderingen	100 000	170	A
▪ Hellingvormige belastingsveranderingen	12 000	61	A
▪ Montage van het reactorvatdeksel	60	71	A
▪ Aan- en uitschakelen van een 2e pomp van het volumeregelsysteem (TA)	10 000	2 388	A
1.2 *Storingen*			
▪ Reactorsnelafschakeling (RESA)	400	42	B
▪ Turbinesnelafschakeling (TUSA), of lastafschakeling op nullast of lastafschakeling op eigenbedrijf	400	91	B
▪ Onbedoeld sluiten van een hoofdstoomafsluiter	20	2	B
▪ Uitval hoofdkoelmiddelpomp	80	49	B
▪ Verandering van de voedingswater-intredetemperatuur bij de stoomgeneratoren		3 4)	
▪ Systeemspecifieke storingen in het volumeregelsysteem met een uitwerking op de componenten van het reactorkoel- en drukhoudsysteem		1 4)	
▪ Onbedoeld openen van de turbine-omloopklep	5	2	B
▪ Hulpsproeien met het TA-systeem	10	18 3)	B
1.3 *Beproevingen*			
▪ Drukbeproeving reactorkoelsysteem	10	3 4)	P*
▪ Dichtheidsbeproeving reactorkoelsysteem	80	- 5)	P*
▪ Drukproeven secundair systeem	10	1 4)	P*
▪ Beproevingen drukhouder veiligheidsklep	45	93	B
2 Ongevallen			
2.1 *Noodgevallen*			
▪ Noodstroomsituatie	80	13	B
* met aansluitend opstart			
* met afregelen tot 120°C en koud water suppletie			
▪ TUSA zonder turbine-omloopleiding	80	5	B
* met aansluitend opstart			
* met afregelen tot nullast, koud			
▪ Stoomgeneratorpijpbreuk		13	
* zonder noodstroomsituatie	18		B
* met noodstroomsituatie	2		C
▪ Aanspreken veiligheidsklep drukhouder	5	1	B
▪ Niet sluiten veiligheidsklep drukhouder			
* bij beproeving	6	6	B
* na aanspreken	2	2	C
▪ Niet sluiten veiligheidsklep hoofdstoomsysteem	2	9	B/C**
▪ Onbedoelde toevoer van koud water in een stoomgenerator	4	1	B
▪ Kleine lekkage hoofdkoelmiddelkringloop	5	1	C
▪ Kleine lekkage secundaire leidingen	5	3	C
2.2 *Schadegevallen*			
▪ Lekkage van hoofdkoelmiddel			
* middelgrote lekkage	1	1	C
* grote lekkage	1	1	D
▪ Lekkage van een secundaire leiding			
* middelgrote lekkage	1	1	C
* grote lekkage	1	1	C
▪ Externe invloeden	1	1	D
▪ Bijzondere schadegevallen			
* ATWS (veronderstelde transiënt zonder reactorafschakeling)	1	5	C
* primaire *feed/bleed*	1	1	D
* secundaire *feed/bleed*	1	1	D

1) Projected load fluctuations up until 2034 based on the actual number of load fluctuations registered up until 2007 (conservative value).
2) No design number defined. Experience-based data are collected using FAMOS so that these can be used for the fatigue analyses.
3) Based on the available FAMOS measurement results.
4) No longer performed at Borssele NPP.
5) Not performed at Borssele NPP.

* P: Special load category for testing.
** Primary side B, secondary side C.

Leak-before-break

3.4 Resistance to internal influences

3.4.2 Leak-before-break principle

The design principle applied to new nuclear power plants is that if five principles are applied during the design, construction and operation of components on the basis of probability calculations, major fractures in these components as a result of a circumferential crack can be statistically ruled out. It is assumed that leakage will occur before the components will fail (the leak-before-break principle), so that precautions can be taken to prevent a major fracture provided that a leak is detected in time.

The five principles are:

- Required component quality by means of:
  - high-grade material properties, in particular toughness - conservative assumptions regarding the allowable stresses - avoiding stress peaks by means of an optimum structural design - guaranteed application of optimised manufacture and testing technologies - awareness and assessment of defects - taking account of the operating medium.
  If these principles are met, the relevant component meets the basic safety requirements.
- Implementation of evidence-gathering, tests and checks relevant to safety by at least two independent parties. These activities must be implemented under a quality assurance regime.
- Assumption of the most unfavourable situation. This entails that all evidence, tests and checks must assume the most conservative preconditions, such as the largest possible load, the lowest material quality specification, etc.
- Continuous monitoring and registration of all process parameters relevant to safety, such as the actual loads, the current state of any materials (including any defects), etc.
- The use of recognised and validated calculation codes, base-line data, testing concepts and testing resources.

The latter four of the above principles are the so-called multiple redundancies.
This entails that, alongside basic safety, it must be demonstrated through multiple redundancies that this basic safety will be maintained during the entire service life of the plant. Alongside basic safety and independent redundancy, leak-before-break has also been verified, so that fractures can be ruled out, as components will always be subject to a detectable leak first.
~~If the five principles are met, it is assumed that major fractures are ruled out and that components will be subject to a detectable leak first.~~

The leak-before-break principle applies to existing nuclear power plants (such as Borssele NPP) if:

- The quality of the relevant components with regard to basic safety is comparable with the current state-of-the-art where the actual requirements are concerned, or any deviating properties have been assessed as acceptable in terms of safety.
- The leak-before-break behaviour has been demonstrated.
- The redundancy measures rule out a major fracture during the total service life.

The leak-before-break principle rules out fractures in the following high-energy lines:

- Main coolant lines (YA)

- Constant volume system surge lines (YP)
- Primary steam lines (RA) within the secondary shield ~~(in the ring space (02) by means of a double walled pipe)~~
- Main feedwater lines (RL) within the secondary shield ~~(in the ring space by means of a double walled pipe)~~
- Emergency feedwater lines (RL) and lines of the secondary reserve make-up system (RS) between the first check valve, the steam generator and the main feedwater lines.

Initially, the leak-before-break behaviour of these lines was analysed for a service life of forty years. It was later demonstrated that, based on the leak-before-break principle, fractures can also be ruled out for a 60-year service life.

Although fractures in these high-energy lines are ruled out, circumferential fractures resulting in two complete fracture surfaces are still a potential risk due to:
- Emergency cooling of the core
- Pressure build-up in the containment
- The accident resistance of electrical and measurement and control equipment

The following concept was applied for high-energy lines for which the leak-before-break principle could not be demonstrated:
- A potential fracture is assumed for every discontinuity of the material and/or the geometry in the line system;
- All interactions between a fracture and a safety-relevant component have been analysed and the risk of the interaction has been calculated;
- If the risk exceeds a certain value, protective measures are taken.

Ageing management

3.7 Ageing management

Ageing is the process whereby the physical properties of a structure or component change under the influence of specific environmental and/or operating conditions as a function of time. Ageing can lead to degradation of the functionality – or in extreme cases to failure – of a structure, system or component. To prevent this from happening, activities have been defined and measures have been taken to guarantee that structures, systems and components that are important or relevant to safety can continue to perform their intended function throughout the total service life of the plant. These activities and measures combined constitute ageing management.
Ageing management starts during the design stage, for example by ensuring that suitable materials are used and by taking current and future environmental and/or operating conditions and inspections into account. Ageing management also plays an important role during manufacture/construction and commissioning, among other things by means of registration of inspections and test results and by documenting any deviations. During normal operating conditions, ageing must be monitored and measures must be taken if required. To this end, periodic tests, inspections, curative and preventative maintenance and monitoring activities are performed .

In 2011, the ageing management programmes for all structures, systems and components important or relevant to safety were tested for comprehensiveness (coverage of relevant parts and ageing mechanisms) and suitability.