Ministry of Economic Affairs,
Agriculture & Innovation

Netherlands' National Report

For the 2nd Convention on Nuclear Safety (CNS) Extraordinary Meeting to be held in August 2012

May 2012

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Ministry of Economic affairs, Agriculture & Innovation
Ministerie van Economische zaken, Landbouw & Innovatie (EL&I)

May 2012

Abstract

This is the National Report of the Kingdom of the Netherlands for the second CNS Extraordinary Meeting to be held in August 2012. The Extraordinary Meeting is a focused review meeting, concentrating on actions, responses and new developments that have been initiated or influenced by the accident at the Fukushima Dai-ichi Nuclear Power Plant in Japan, in 2011.

This National Report reflects the intended focus of aforementioned meeting. It complies with the 'Guidance for National Reports' published by the CNS secretariat in Vienna and is structured along the six topics identified in the 'Guidance for National Reports'. For each topic it presents the analyses conducted, activities performed by the operator and those performed by the regulator. It also provides for a tabled summary of the items reported.

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List of Symbols and Abbreviations

AC	Alternating Current
ACC	Alarm Coördinatie Centrum (Alarm Coordination Centre)
AM	Accident Management
CCB	Conventionele Centrale Borssele (Borssele Coal-fired Power Plant)
CSA	Complementary Safety margin Assessment
CVCS	Chemical and Volume Control System
DBE	Design Basis Earthquake
DBF	Design Basis Flood
DC	Direct Current
DG	Diesel Generator
EDG	Emergency Diesel Generator
EDMG	Extensive Damage Mitigation Guidelines
EL&I	'Ministerie van Economische zaken, Landbouw & Innovatie'; ministry of economic affairs, agriculture & innovation
ENSREG	European Nuclear Safety Regulator Group
EOP	Emergency Operating Procedure
EPRI	Electric Power Research Institute
EPZ N.V.	Elektriciteits-Produktiemaatschappij Zuid-Nederland EPZ
ERO	Emergency Response Organisation
EU	European Union
10EVA13	Current 10 yearly safety evaluation; periodic safety review (PSR)
IenM	'Ministerie van Infrastructuur & Milieu'; ministry of infrastructure & the environment
IAEA	International Atomic Energy Agency
HCLPF	High Confidence Low Probability of Failure
HERCA	Heads of the European Radiological protection Competent Authorities
I & C	Instrumentation and Control
ILT	Human Environment and Transport Inspectorate
IPPAS	International Physical Protection Advisory Service
IRRS	Integrated Regulatory Review Service
KCB	Kerncentrale Borssele; NPP Borssele
KFD	Kernfysische Dienst; Department for Nuclear Safety, Security, Safeguards, and Radiation Protection
KNMI	Koninklijk Nederlands Meteorologisch Instituut
KTA	Kerntechnische Ausschuss

KWU	Kraftwerk Union
LOOP	Loss Of Offsite Power
LUHS	Loss of Ultimate Heat Sink
MCR	Main Control Room
mSv	milliSievert
MWe	Megawatts Electrical
MWth	Megawatts Thermal
NAP	Normaal Amsterdams Peil
NPK	Nationaal Plan Kernongevallenbestrijding
NPP	Nuclear Power Plant
NRC	Nuclear Regulatory Commission (in the USA)
NS 1	Nood Stroom net 1 (Emergency Grid 1)
NS 2	Nood Stroom net 2 (Emergency Grid 2)
PAR	Passive Autocatalytic Recombiner
PGA	Peak Ground Acceleration
PORV	Power-Operated Relief Valve
PRA	Probabilistic Risk Analysis
PSA	Probabilistic safety Analysis
PWR	Pressurised Water Reactor
RCS	Reactor Coolant System
ROT	Regional Operational Team
RPV	Reactor Pressure Vessel
RWS	Rijkswaterstaat
SALTO	Safety Aspects of Long Term Operation
SAMG	Severe Accident Management Guidelines
SBO	Station Blackout
SFP	Spent Fuel Pool
SG	Steam Generator
SMA	Seismic Margin Assessment
SOER	Significant Operating Experience Report
SSCs	Structures, Systems and Components
UPS	Uninterrupted Power Supply
US, USA	United States, United States of America
WANO	World Association of Nuclear Operators

Introduction

This section starts with the background of the 2nd Convention on Nuclear Safety (CNS) Extraordinary Meeting and then sets out the purpose and scope of this document: '*Netherlands' National Report for the 2nd Extraordinary Meeting to be held in August 2012'*. It then continues with the intended audience, the relationship of the exercise with other evaluations, the developments at the regulatory body, and an overview of the national nuclear programme in the Netherlands since the publication of the national report for the 5th CNS meeting. The introduction finishes with a description of the structure of the report.

Background

March 11 2011, Japan was struck by an earthquake of enormous magnitude, followed by a devastating tsunami that affected large parts of its eastern coast. This natural disaster killed thousands of people, and caused enormous damage to Japanese cities and infrastructure.

After the earthquake, the Japanese Nuclear Power Plant Fukushima Dai-ichi shut down automatically. However it failed to adequately maintain all of its safety functions after been hit by the tsunami that was initiated by the earthquake.

March 24th and 25th, the European Council declared that:

'the safety of all EU nuclear plants should be reviewed on the basis of a comprehensive and transparent risk assessment ("stress test");..'

The Western European Nuclear Regulators Association (WENRA) end of March 2011 produced a basis for a technical definition of a "stress test" and how it should be applied to nuclear facilities in Europe. The WENRA proposals were used as a basis for the official specifications[1] issued by the European Nuclear Safety Regulatory Group (ENSREG), issued on May 13th 2011. These were endorsed by EU Commissioner Öttinger on May 24th 2011.

First the licensees as being primarily responsible for the safety of their NPPs produced their reports ('Licensee Reports') on the "stress test" of their facilities, in accordance with the ENSREG specifications. In a second step, the regulatory bodies evaluated these reports, and reported their findings in 'National Reports' and submitted these to the EC. Later in a third step there was a peer review of these reports. This yielded a set of so-called Country Reports and a Summary Report with recommendations for consideration by the participating countries, which was endorsed by ENSREG in April 2012.

In parallel with the European efforts, the international community took two important steps. On the 5th regular review conference of the CNS (4 – 14 April 2011) it was decided to organize from 27 – 31 August 2012 a 2nd CNS Extraordinary Meeting[2] on the lessons learnt after 'Fukushima Dai-ichi'. In May 2012, all CNS signature states will submit a National Report to the CNS secretariat, dedicated to the purposes of this Extraordinary Meeting. At a special IAEA ministers conference in June 2011 the IAEA was asked to propose a post Fukushima Dai-ichi action plan, which was unanimously accepted on the General Conference in September 2011. The present national report describes the national action that has been taken, its planning and its progress.

The licensee of the NPP also participated in two post-Fukushima WANO self assessment exercises. The stress test benefited from these WANO self assessments. In the remainder of this

[1] Declaration of ENSREG, agreed with the European Commission on the 13th of May 2011, with Annex I : 'EU "Stress tests" specifications'

[2] The first Extraordinary Meeting of the CNS on 28 September 2009 was dedicated to the revision of the Guidelines regarding National Reports and rules of procedure and guidelines for training purposes.

report, the results of the WANO assessments are considered to be *included* in the stress test results. The regulatory body has been informed by the licensee about the results.

Purpose and Scope of this National Report

The 2nd CNS Extraordinary Meeting is a focused review meeting, concentrating on actions, responses and new developments that have been initiated or influenced by the accident at the Fukushima Dai-ichi Nuclear Power Plant in Japan, in 2011.

The present National Report reflects the intended focus of aforementioned meeting. It complies with the 'Guidance for National Reports' published by the CNS secretariat in Vienna.

The National Report is structured along the six topics identified in the 'Guidance for National Reports':

- External Events
- Design Issues
- Severe Accident Management and Recovery (On-Site)
- National Organisations
- Emergency Preparedness and Response and Post-Accident Management (Off-Site)
- International Cooperation

For each topic the National Report presents the analyses conducted, activities performed by the operator and those performed by the regulator. It also provides for a tabled summary of the items reported.

Intended Audience

This National Report is mainly targeted at regulatory bodies of other CNS signature states, to enable them to perform a peer review. As agreed the report is written in English. Nevertheless, it will be made available to the general public. The report will also be sent to the Dutch Parliament.

Relationship 'National Report for the 2nd Extraordinary Meeting with other Evaluations

The Netherlands has participated in the ENSREG-led 'stress test'; its findings have been recorded in a National Report on that stress test and published in December 2011. That report presented conclusions about licensee's compliance with its design basis, and the safety margins identified above the design base. In addition it noted the measures proposed and considered by licensee. On top of this the regulatory body proposed additional topics for (more detailed) assessment or improvement measures for consideration.

The present National Report for the 2nd Extraordinary Meeting benefits from the evaluation conducted for the ENSREG-led complementary robustness assessment (the 'stress test'). Especially the first three chapters of the present report benefit from the previous assessment, concluded in December 2011.

Actions from the IAEA action plan are related to all subjects of the present national report and will be discussed accordingly.

Nuclear Programme

The Netherlands has a small nuclear programme, with one NPP in operation, producing about 4% of the country's electrical power consumption. The programme features a number of steps of the nuclear fuel cycle. Some of the Dutch nuclear businesses have a global impact. Urenco supplies about 25% of world-demand for low-enriched uranium, of which its plant in Almelo, the Netherlands, provides about a third. The company ET-NL in Almelo supplies all centrifuges for the enrichment plants of Urenco and AREVA – world-wide. The High Flux Reactor (HFR) in Petten, on average supplies 70% of the European demand for medical radio-isotopes – and no less than 30% of the global demand. The Nuclear Research & consultancy Group (NRG) operates the HFR and several nuclear research facilities on their site in Petten and in addition provides consultancy services to clients on several continents. In addition, scientists of the Dutch universities and NRG participate in many international nuclear research programmes.

In the Dutch 5th national report for the CNS and at the conference of CNS it was mentioned that there were three plans for the new build of reactors. Two plans were aiming at building NPPs with a capacity of 2500MW each, with license applications in 2012/2013 and plants ready to connect to the grid in 2018-2020. However, these two plans have been shelved; they are put on hold for at least 2-3 years. The third initiative aims to replace the current HFR with the so-called PALLAS-reactor. The Province of Noord-Holland and the Government have decided in the beginning of the year to each provide a loan of 40 M€ for the support of a licensing procedure for the PALLAS reactor. Current plans aim to replace the HFR around 2020-2022.

Detailed information on the Borssele NPP and its robustness

Detailed information on the Borssele NPP and assessment of its robustness can be found in:

- The self assessment by utility EPZ, also called 'Complementary Safety margin Assessment' (CSA), following the format prescribed by ENSREG, can be found at: http://www.rijksoverheid.nl/bestanden/documenten-en-publicaties/rapporten/2011/11/02/final-report-complementary-safety-margin-assessment/complementary-safety-margin.pdf
- The regulatory body's evaluation of the CSA performed by utility EPZ: http://www.rijksoverheid.nl/bestanden/documenten-en-publicaties/rapporten/2011/12/20/netherland-s-national-report-on-the-post-fukushima-stress-test/netherland-s-national-report-on-the-post-fukushima-stress-test.pdf

Regulatory Body or Regulator

All nuclear facilities in the Netherlands, including the NPP of Borssele, operate under licence, awarded after a safety assessment has been carried out.

The licence is granted by the regulatory body under the Nuclear Energy Act. The 'regulatory body' is the authority designated by the government as having legal authority for conducting the regulatory process, including issuing licences, and thereby regulating nuclear, radiation, radioactive waste and transport safety, nuclear security and safeguards.

Since the responsibility, the organisation and the location of the regulatory body as described in the August 2010 report to the 5th CNS conference has been changed a few months later, this change has been presented at the April 2011 conference. The changes came about by modifications of the number of ministries and reorganisations.

For more information on the regulatory body, refer to chapter 4 '

National Organisations'.

Structure of the Report

This report follows the guidance[3] provided by the CNS secretariat on the contents and format of National Reports for the 2nd CNS Extraordinary Meeting in August 2012. The numbering of its chapters corresponds to that of the guidance provided by the secretariat.

This report is designed to be a 'stand alone' document to facilitate the international review by regulatory bodies of other nations. On the other hand it refers to publicly available material and contains Appendices if considered necessary.

Chapter 1 on External Events relates to analysis undertaken to re-evaluate the safety of the existing NPP in Borssele, the Netherlands, taking in consideration the hazards of catastrophic external events. Measures proposed are described.

Chapter 2 on Design Issues focuses on actions to prevent severe damage to the reactor and the spent fuel pool, including any last resort means, as well as an evaluation of the time available to prevent severe damage. The focus is on LOOP-SBO events and LUHS issues.

Chapter 3 addresses the Severe Accident Management (SAM) and Recovery on site. It focuses on mitigating actions taken if severe reactor or spent fuel pool damage occurs, in order to prevent large radioactive releases. The chapter reports on the regulatory review of SAM which was conducted in the ENSREG led stress test exercise in 2011.

Chapter 4 National Organisations reviews the organisations involved in maintaining and enhancing nuclear safety, and on the strength of these organisations. This review extends past governmental organisations, incorporating vendors and Technical Support Organisations cooperating with the governmental organisations in maintaining a high level of safety.

Chapter 5 is about Emergency Preparedness and Response and Post Accident Management off site. These are essential to prevent or reduce the potential health effects of a release of radioactive materials.

Chapter 6 International Cooperation considers just that. An objective of the CNS is to achieve and maintain a high level of safety worldwide through the enhancement of national measures and international cooperation. The present report considers the actions taken to strengthen the global nuclear safety regime and reports on actions that have been taken or are being planned to enhance international cooperation.

[3] "Second CNS Extraordinary Meeting (August 2012) Guidance for National Reports, Addendum", IAEA, 17 January 2012

1. External Events

This chapter focuses on the external hazards earthquakes, flooding and extreme weather conditions. The phenomena loss of electrical power and loss of ultimate heat sink may be caused by natural or man-made extreme events. In the present report, these topics are addressed in chapter 2, 'Design Issues'.

1.0 Introduction to assessment of external events in the Netherlands and to the single operating NPP

In the safety cases of nuclear facilities in the Netherlands, traditionally threats from external hazards of natural and man-made origin are being addressed, including earthquakes, flooding and extreme weather conditions. In the PSA of the Borssele NPP they are addressed too. The ongoing Periodic Safety Review (PSR) will address all external events as well.

Detailed information on the Borssele NPP and its robustness can be found in:

- The self assessment by utility EPZ, also called 'Complementary Safety Assessment', following the format prescribed by ENSREG, which can be found at: http://www.rijksoverheid.nl/bestanden/documenten-en-publicaties/rapporten/2011/11/02/final-report-complementary-safety-margin-assessment/complementary-safety-margin.pdf
- The evaluation of the CSA performed by the regulatory body: http://www.rijksoverheid.nl/bestanden/documenten-en-publicaties/rapporten/2011/12/20/netherland-s-national-report-on-the-post-fukushima-stress-test/netherland-s-national-report-on-the-post-fukushima-stress-test.pdf

The Borssele NPP is the single operating NPP in the Netherlands. It is also known as the 'Kerncentrale[4] Borssele', the KCB. The KCB is a single unit NPP owned by the utility 'N.V. EPZ'. The unit is also known as 'unit BS30'. It was designed and built by Kraftwerk Union (KWU) and started commercial operation in 1973. Since that date several major modernization projects have been carried out.

Currently, the KCB has a thermal power of 1365 MW_{th}, a gross capacity of 512 MW_e and a net capacity of 485 MW_e.

The nuclear reactor of KCB is a pressurized water reactor (PWR) with two loops, each with one primary pump and one steam generator. The turbine generator installation consists of one high-pressure and three condensing dual-flow steam turbines, a generator and an exciter on a single shaft. The condensers have titanium tubes and are cooled with salt water from the Westerschelde. As is usual with the KWU/Siemens plant designs, the condensate is collected and de-aerated in a large feed water accumulator.

The containment is a 46-meter spherical steel shell, which is in turn encapsulated by the concrete reactor building. The spherical shell not only contains the reactor and steam generators, but also the spent fuel pool.

The main control room[5] is based on an ergonomically optimisation of plant operation procedures, including emergency procedures. A redundant bunkered control room is available

[4] 'Kerncentrale' is the Dutch word for Nuclear Power Plant.
[5] The main control room was back-fitted during the second 10 yearly safety evaluation (Modification Project, 1997)

for controlled shutdown, core cooling and spent fuel pool cooling after occurrence of external hazards and in beyond-design conditions.

To cope with external hazards, important safety systems like emergency core cooling, spent fuel pool cooling, reactor protection system and the emergency control room are installed in 'bunkered' buildings. These buildings are qualified to withstand earthquake, flooding, gas cloud explosions, aeroplane crash and severe weather conditions.

The KCB is located on the Northern shore of the river Westerschelde, about 1.4 km Northwest of the village Borssele. The area belongs to the municipality of Borsele. The site is located directly behind the dyke of the river Westerschelde. Due to the open connection to the North Sea, near the site this river can be considered to be an estuary. The area around the site is mainly flat.

1.1 Overview of topic analysis

As explained in the Introduction chapter to this report, the Netherlands has participated in the ENSREG led European 'stress test', also called a 'Complementary Safety margin Assessment' (CSA). The licensee has produced a Licensee Report and the regulator a National Rapport in which the findings of the licensee are evaluated by the regulatory body. The National Report was submitted to ENSREG for Peer Review. A Peer review team has visited the Netherlands; its final draft report has been published and can be found in Appendix B.

The analysis in the stress test of the robustness of the NPP with respect to earthquakes, flooding and extreme weather conditions is further commented upon in the sections 1.2 (for the part of the licensee) and 1.3 (for the part of the regulatory body).

1.2 Activities performed by the operator

1.2.a Discussion of activities taken or planned by the NPP operator

1.2.a.1 Demonstration of compliance with design basis

Licensee has demonstrated compliance with the current licensing basis. This position of the regulatory body is based on decades of regulatory oversight. Evidence of compliance is documented in many licensing documents that are subject to regulatory oversight like the Safety Report, the Technical Specifications, strategic maintenance and surveillance plans and (in more detail) to extensive maintenance and in-service inspection programmes.

The Netherlands, especially the region near NPP Borssele, is a region with low seismicity. The DBE of the NPP has a PGA=0.06 g at ground level and 0.075 g at pile foundation level. There is a safety margin to at least 0.15 g. This PGA of the DBE is below the value of 0.1 g of the IAEA guidance for new power plants. A comprehensive seismic hazard assessment is performed within the framework of the ongoing periodic safety assessment and this will consider a PGA value of 0.1 g at free field for the DBE.

Flooding is a more relevant hazard in the Netherlands regarding the assessment of the siting of all industrial activities. Currently the DBF for Borssele NPP is 7.3 m above Normal Amsterdam Water Level (NAP) with dynamic wave height. The highest flood known dates from 1953 with 4.7 m above NAP. A DBF is not formally required. The Water Act includes regulation on flood defences and water management and is important for the implementation of the governmental policy of flood risk. The protection against the DBF is not based on the presence of dykes, although some credit is given to the dampening effect of dykes for the dynamic effects of waves against the buildings.

1.2.a.2 Safety margin assessment

Seismic

In the so-called stress test, licensee has performed the analysis of the margins above the design basis; cliff edges have been identified. PSA shows seismic hazard contributes less than 5.4% to the total core damage frequency.

Elements of the EPRI NP-6041 method were used for the seismic margin assessment, together with results of past earthquake studies and experience gained in comparable NPPs in Germany. Buildings and SSCs designed for seismic loads are able to take 0.3 g. The High Confidence Low Probability of Failure (HCLPF) value for the stability of the reactor building was estimated to a value of 0.15 g.

The seismic load that may lead to loss of containment integrity is 0.3 g. Other effects may be failure of fire fighting systems which are not seismically qualified and failure of the filtered containment venting system.

Flooding

Licensee has assessed plant's vulnerability to increasing levels of flooding. In licensee's analysis, the presence of the sea dyke (9.4 meters above NAP) is disregarded. Only for damping of the strength of waves, the presence of (damaged) dykes is regarded. With these presumptions, exceeding the DBF of 7.3 m + NAP by more than 1.25 meter has the potential to lead to core damage.

Flooding may make the site inaccessible to offsite support and replacement shifts. This is discussed in chapter 3 'Severe Accident Management and Recovery (On-Site)'.

Extreme weather

Safety margins are considered for water and air temperatures, wind, ice formation, rainfall, snowfall, lightning and credible combinations thereof. Maximum allowable loads and foreseeable weather conditions have been compared. Margins have been shown to exist; no cliff edges have been identified.

1.2.a.3 Proposals for potential safety improvements

In the so-called stress test, licensee has identified potential measures and topics for research to increase nuclear safety with respect to natural hazards. The regulator in principle can endorse these, but assessments are needed to evaluate their effectiveness. In addition the regulator has made additions to the proposed measures. The entire set of measures (with contributions of both licensee and regulator) associated with natural hazards is listed Table 1-1. Appendix A shows the tabled measures, procedures and studies as proposed by licensee in its Licensee Report for the European stress test.

Notable proposals are:

- Conducting a Seismic Margin Assessment or Seismic Probabilistic Safety Assessment;
- Ensuring availability of fire annunciation and fixed fire suppression systems in vital areas after a seismic event;
- Ensuring the availability of the containment venting system after seismic events;
- Adjustment of flood resistance of certain buildings;
- Improvement of the dyke ring near the NPP;
- Reassessment of depth of piping with respect to risk of freezing.

1.2.b Schedules and milestones to complete operator's planned activities

The planning of operator's planned activities (and those by the regulator) associated with natural hazards can be found in Table 1-1.

1.2.c Preliminary or final results of operator's activities including proposals for further actions

Two WANO SOER missions (2011-2 and 2011-3) were finished in 2011. They were initiated after the Fukushima Dai-ichi accident.

As part of the ENSREG-led stress test, the compliance of the NPP with its licensing base was demonstrated, the safety margins were assessed and potential safety improvements were proposed.

1.3 Activities performed by the regulator

1.3.a Discussion of activities taken or planned by the regulator

1.3.a.1 Regulatory review of Licensee's complementary safety assessment

The regulator has reviewed the Licensee Report. It defined the specifications of the stress test to be undertaken by licensee EPZ. It coordinated the review and support of several national organisations (RWS, KNMI, and NRG) and international organisations (FANC, GRS) took part or supported the review. The regulator produced a National Report which presented findings of the review like compliance with licensing base and conclusions on the presence of margins. The National Report was submitted to ENSREG in December 2011.

1.3.a.2 Evaluation of licensee's proposals

In principle the regulator can endorse licensee's proposals, but evaluation of their effectiveness is needed. In 2011, regulator published regulatory position statements in its National Report on the stress test. Appendix A shows the full list of licensee's proposals and the matching regulatory position statements of the regulatory body. In addition, Table 1-1 shows the activities related to External Events, performed or due to be performed by licensee and regulator.

Some notable regulatory positions are listed below.

The regulatory body has the opinion that the impact of floods with a long return period are not known in much detail yet and that further assessments are necessary.

The design basis for loads from extreme weather conditions largely originates from industrial and civil engineering codes, climate models and the like. Most extreme weather conditions do not pose extreme challenges to the plant. A study will be carried out to evaluate the effects of a super storm with a return period of one million years.

The intended seismic margin assessment or seismic PSA should also include characterization of the subsurface of the site and the possible impact of foreseeable mining activities in the region.

1.3.a.3 Regulatory oversight of implementation of measures

The regulator is overseeing implementation of measures and research conducted by licensee. Part of the effort is evaluation of proposed measures and establishing agreement on a suitable planning with prioritisation of key issues.

1.3.a.4 ENSREG Peer Review

After submitting the National Report to ENSREG (December 2011), the regulator entered into the international Peer Review phase, which was concluded with a visit by a European review team to the Netherlands (12-15 March 2012). The review team visited the site of the licensee and the offices of the regulatory body, having ample discussions. The review team presented its conclusion on 15th of March 2012. The Peer Review team judged that the National Report complies with the specifications defined by ENSREG and that the report is of a very good quality. The information provided is sufficiently adequate. The following recommendation, additional to those of the regulatory body and related to natural hazards, was given for consideration:

- "Licensee has identified relevant improvements in order to increase plant robustness against flooding. In 2013 the Borssele NPP will perform a new assessment of the DBF in the frame of the PSR. However, considering the very specific approach of the Netherlands for the flooding protection of the site, which relies on the national dyke system, the reviewers recommend to examine thoroughly the consistency of this approach with the new IAEA guidance (SSG-18), i.e.:"
  "*A nuclear power plant should be protected against the design basis flood by one of the following approaches:*
  (a) The 'dry site' concept (...)
  (b) Permanent external barriers such as levees, sea walls and bulkheads (...) Care should also be taken that periodic inspections, monitoring and maintenance of the external barriers are conducted, even if such barriers are not under the responsibility of the plant operating organization. (...) For both approaches, as a redundant measure against flooding of the site, the protection of the plant against extreme hydrological phenomena should be augmented by waterproofing and by the appropriate design of all items necessary to ensure the fundamental safety functions in all plant states. All other structures, systems and components important to safety should be protected against the effects of a design basis flood."
- The Final Report issued by ENSREG of the country peer review of the Netherlands can be found in Appendix B.

1.3.b Schedules and milestones to complete regulatory body's planned activities

The planning of actions can be found in Table 1-1.

1.3.c Conclusions of the regulatory body regarding the outcome of the operator's activities

Based on decades of regulatory oversight compliance of the nuclear power plant with its licence base has been established. The regulatory review of the Licensee Report has not provided evidence for a different position.

Some main remarks from the regulatory review are listed here in summary.

- The licensee has proposed measures to further increase robustness of its plant and topics for further study. Most of these proposals in principle can be endorsed by the regulatory body. Before implementation, their effectiveness needs to be assessed;
- The description of 'cliff edges'[6] in the Licensee Report for most scenarios has been elaborated to a limited detail[7] but has been elaborated on to sufficient detail during the ENSREG Peer Review;
- The regulatory body has the opinion that the impact of floods with a very long return period (e.g. ten thousand, one hundred thousand or one million years) is not known in much detail yet and that further assessments are necessary.

[6] Cliff edge effect is the effect of an abrupt transition from one status to another when exceeding a certain limit or applying a small change to a parameter.

[7] Licensee's CSA report is a publicly available document. Due to security requirements description of some details has been limited.

1.4 Tabled summary of items reported

Legend:

M = Measure, P = Procedure, S = Study. Lic = M, P or S proposed by licensee, **Reg** = M, P or S proposed by regulator. Lic & **Reg** = something proposed by regulator, but with added requirements from the regulator.

The full list of measures etcetera mentioned in the National Report for the ENSREG-led stress test, can be found in Appendix A.

Items to be undertaken by the licensee and proposed by regulator or with added requirements by the regulator, are marked with bold typeface.

Table 1-1 Tabled summary of items reported for Topic 1 – External Events (excluding LOOP/SBO and LUHS). *In the table, the planning of the actions on the part of licensee has been proposed by licensee. The planning is subject to discussions with the regulator and may change.*

Activity	Activities by the Operator*			Activities by the Regulator*		
	(Item 2.a) Activity - Taken? - Ongoing? - Planned?	(Item 2.b) Schedule Or Milestones for Planned Activities	(Item 2.c) Results Available - Yes? - No?	(Item 3.a) Activity - Taken? - Ongoing? - Planned?	(Item 3.b) Schedule Or Milestones for Planned Activities	(Item 3.c) Conclusion Available - Yes? - No?
Topic 1 – External Events						
WANO SOER 2011-2[8] execution	Taken	Finished 2011	Yes			
WANO SOER 2011-3 execution	Taken	Finished 2011	Yes			

[8] SOER: Significant Operating Experience Report issued by WANO and made available to its members. A SOER describes and classifies a number of important events that happened in one or more NPPs and lists the recommendations that WANO has defined after a root cause analysis of the events. All WANO members are required to analyse the SOER's recommendations for their own NPPs. After the Fukushima Dai-ichi incident, three special post-Fukushima SOERs haven been issued and WANO required all members to report the results of the implementation of their recommendations.

Activity	Activities by the Operator*			Activities by the Regulator*		
	(Item 2.a) Activity - Taken? - Ongoing? - Planned?	(Item 2.b) Schedule Or Milestones for Planned Activities	(Item 2.c) Results Available - Yes? - No?	(Item 3.a) Activity - Taken? - Ongoing? - Planned?	(Item 3.b) Schedule Or Milestones for Planned Activities	(Item 3.c) Conclusion Available - Yes? - No?
ENSREG stress test: Demonstration of compliance with licensing basis	Taken	Finished Oct 2011	Yes, okay	Taken	Finished Dec 2011	Yes
ENSREG stress test: Evaluation of WANO SOER results				Taken	Finished 2011	Yes, results SOER accepted
ENSREG stress test: Assessment of safety margins	Taken	Finished Oct 2011	Yes	Taken	Finished Dec 2011	Yes
Propose potential safety improvements – preliminary proposals.	Taken	Finished Oct 2011	Yes	Taken	Finished Dec 2011	Yes
ENSREG Peer Review, receiving peer review	Taken	March 2012 discussion with reviewers	Yes	Taken	Jan – March 2012	Yes

Activity	Activities by the Operator*			Activities by the Regulator*		
	(Item 2.a) Activity - Taken? - Ongoing? - Planned?	(Item 2.b) Schedule Or Milestones for Planned Activities	(Item 2.c) Results Available - Yes? - No?	(Item 3.a) Activity - Taken? - Ongoing? - Planned?	(Item 3.b) Schedule Or Milestones for Planned Activities	(Item 3.c) Conclusion Available - Yes? - No?
ENSREG Peer Review, participating in review teams visiting other countries			Yes	Taken	Feb – March 2012	Yes
Agree on final set of measures[9] and implementation plan. Details below:	Ongoing	End 2012	No, not yet, final set subject to discussion between licensee & regulator	Ongoing	End 2012	No, not yet, final set subject to discussion between licensee & regulator
I-1. (M) Ensuring availability of fire annunciation and fixed fire suppression systems in vital areas after seismic events (Lic)	Planned	Start 2012, end 2016	No			
I-2. (M) Ensuring availability of containment venting system after seismic events (Lic)	Planned	Start 2012, end 2013	No			

[9] Measures for improvement of safety have been proposed by licensee and regulator and in the ENSREG Peer Review. They can be found in the Netherlands' National Report on the post-Fukushima Stress Test and in the ENSREG Peer Review country report.

Activity	Activities by the Operator*			Activities by the Regulator*		
	(Item 2.a) Activity - Taken? - Ongoing? - Planned?	(Item 2.b) Schedule Or Milestones for Planned Activities	(Item 2.c) Results Available - Yes? - No?	(Item 3.a) Activity - Taken? - Ongoing? - Planned?	(Item 3.b) Schedule Or Milestones for Planned Activities	(Item 3.c) Conclusion Available - Yes? - No?
I-3. (M) Adding extra wave protection beneath entrances of several buildings to make the NPP less dependent on the dike (Lic)	To be planned after completion of I-6 & I-9	Start at end I-6 & I-9	No			
I-4 Improvement of dyke ring near NPP, not Fukushima related[10] (Reg)				Planned	2012	No
I-5. (P) Develop procedure for plant walk downs and other actions needed for various levels of foreseeable hazards (Lic)	Ongoing	End July 2012	No			
I-6. (S) Research into measures to further increase safety margins in case of flooding (Lic)	Ongoing	End 2012	No			

[10] The improvement of the dyke will make it satisfy the requirements of the 'Waterwet' i.e. the 'Water act' which specifies the safety standards for the national levee system. The improvement will contribute to the protection of the NPP against flooding.

Activity	Activities by the Operator*			Activities by the Regulator*		
	(Item 2.a) Activity - Taken? - Ongoing? - Planned?	(Item 2.b) Schedule Or Milestones for Planned Activities	(Item 2.c) Results Available - Yes? - No?	(Item 3.a) Activity - Taken? - Ongoing? - Planned?	(Item 3.b) Schedule Or Milestones for Planned Activities	(Item 3.c) Conclusion Available - Yes? - No?
I-7. (S) Implementation of state-of-the art models for seismic assessments, like seismic margin assessment or seismic PSA, including attention to subsurface and mining activities (Lic & **Reg**)	Ongoing	End 2013	No			
I-8. (S) Additional research to reduce uncertainty in the margins for airplane crash (Lic)	Ongoing	End 2013	No			
I-9. (S) Additional Assessment of the impact of floods with long return periods (**Reg**)	Ongoing	End 2012	No			
I-10. (S) Additional review of previously conducted research into threats to containment posed by hydrogen (Lic)	Planned	End 2013	No			
I-11. (S) Additional research into accumulation of snow dunes (by wind) or water on roofs by fire fighting activities. (**Reg**)	Planned	Start 2013, end 2013				

Activity	Activities by the Operator*			Activities by the Regulator*		
	(Item 2.a) Activity - Taken? - Ongoing? - Planned?	(Item 2.b) Schedule Or Milestones for Planned Activities	(Item 2.c) Results Available - Yes? - No?	(Item 3.a) Activity - Taken? - Ongoing? - Planned?	(Item 3.b) Schedule Or Milestones for Planned Activities	(Item 3.c) Conclusion Available - Yes? - No?
I-12. (S) Additional research into minimum depth of underground piping for protection against freezing (**Reg**)	Planned	Start 2013, end 2013				

2. Design Issues

This chapter 'Design Issues' focuses on the hazards loss of electrical power and loss of ultimate heat sink. These may be caused by natural or man-made extreme events. In general these topics are referred to in terms of Loss Of Offsite Power (LOOP), Station Blackout (SBO) and Loss of Ultimate Heat Sink (LUHS).

2.0 Introduction to design issues in the Netherlands and to the single operating NPP

In the safety cases of nuclear facilities in the Netherlands, traditionally threats from external hazards of natural and man-made origin are being addressed. In the accompanying PSA of the NPP they are addressed too. The Periodic Safety Review also addresses these issues.

The KCB is a single unit NPP owned by the utility 'N.V. EPZ'. The unit is also known as 'unit BS30'. It was designed and built by Kraftwerk Union (KWU) and started commercial operation in 1973. Since that date several major modernization projects have been carried out.

Currently, the KCB has a thermal power of 1365 MW_{th}, a gross capacity of 512 MW_e and a net capacity of 485 MW_e.

The NPP has the possibility to fall back from full power to house load operation, with a 80% success rate (experience feedback).

There are two grids (NS1 and NS2) for the emergency AC power system, for different levels of plant accident conditions. Emergency Grid 1 has 3 * 100% capacity (3 emergency diesel generators, EDGs) and the bunkered Emergency Grid 2 has two extra, smaller emergency diesel generators (2 x 100%) in separate rooms. There is also a mobile emergency diesel generator which currently needs offsite support to be moved into position. Also the normal residual heat removal system and the spent fuel cooling system have reserve systems and are supplied from the bunkers.

There are multiple connections to the external grid. Power can also be obtained via coupling to the onsite coal-fired plant or its connection to the external grid. In addition the emergency power generators of the coal fired plant can also service the emergency AC power system of the NPP.

The NPP has an uninterrupted power supply system based on batteries in each grid.

Other essential safety systems have been backed up in the bunkers. The 4-pump high pressure safety injection system & residual heat removal system is backed up by a 2-train bunkered Backup coolant makeup system, and the 3-pump Main and auxiliary feed water system is backed up by a 2-train bunkered Backup feed water system.

For conditions that result in the failure of all trains of the Conventional emergency cooling water system the plant is equipped with a redundant Backup cooling water system. This reserve ultimate heat sink can remove decay heat from the reactor core and the spent fuel storage pool, and ensures long term cooling of the emergency diesels. Its cooling water is groundwater, pumped from eight wells (8 * 17%) on the premises of the plant. The system is operated from the emergency control room.

2.1 Overview of topic analysis

As explained in the Introduction, the Netherlands has participated in the ENSREG led European stress test, also called a 'complementary robustness assessment' (CSA). In this 'test', the licensee has produced a Licensee Report and the regulator a National Rapport in which the findings of the licensee are evaluated by the regulatory body.

ENSREG has postulated various scenarios with various degrees of loss of offsite power (LOOP) and station blackout (SBO) and loss of ultimate heat sink (LUHS). These scenarios had to be considered without giving regard to the probability of the events that might initiate them. The licensee has assessed the impacts of these postulated scenarios on its plant and thus has assessed its safety margins. The analysis of the robustness of the NPP with respect to LOOP and LUHS is further commented upon in the sections 2.2 (for the part of the licensee) and 2.3 (for the part of the regulatory body).

2.2 Activities performed by the operator

2.2.a Discussion of activities taken or planned by the NPP operator

2.2.a.1 Demonstration of compliance with design basis

Main requirements to the area of LOOP/SBO and LUHS are based on corresponding IAEA standards that have been adopted or adapted to the Dutch situation as Dutch Safety Rules, the so called NVRs[11]. In particular the following documents apply: NVR NS-R-1 (design safety), NVR NS-G-1.8 (emergency power systems), NVR NS-G-1.9 (reactor coolant system and associated systems), NVR NS-G-1.10 (containment systems). In some cases addition standards apply, like the KTA-3710 for electrical power supply in NPPs.

Licensee has demonstrated compliance with the current licensing basis. This position of the regulatory body is based on decades of regulatory oversight. The regulatory review of the Licensee Report has not raised compliance issues and has confirmed this position.

The compliance is documented in many licensing documents that are subject to regulatory oversight like the Safety Report, the Technical Specifications, strategic maintenance and surveillance plans and (in more detail) to extensive maintenance and in-service inspection programmes. Safety assessment is based on both deterministic as well as probabilistic assessments (PSA). Periodic Safety Reviews (PSR) are part of the continuous improvement process.

2.2.a.2 Safety margin assessment

Licensee has analysed postulated scenarios of LOOP SBO and LUHS as prescribed by ENSREG in the European stress test.

LOOP is within the design basis of the plant. Numerous options are available to cope with the LOOP scenario for at least 72 hours. The maximum running time of a particular EDG can be extended by using available fuel stocks from several tanks. The minimum amount of diesel available to an EDG is enough to feed it for up to 1300 hours. However this requires transfer of fuel while there are no dedicated hardware provisions and procedures for such actions; staff would have to improvise.

2.2.a.3 Proposals for potential safety improvements

Licensee EPZ has identified possibilities for improvement of the robustness of the plant. Those possibilities that are related to LOOP/SBO and LUHS are listed in Table 2-1 under the action: 'Agree on final set of measures and implementation plan'. The full set of proposed measures and associated regulatory position statements as far as listed in the National Report on the ENSREG stress test, can be found in Appendix A.

The licensee proposed among others:

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[11] 'Nucleaire Veiligheidsregel', NVR, a Dutch nuclear safety rule.

- Increase the robustness by an extra grid connection to the nearby 400kV grid;
- Enhance possibilities to transfer diesel fuel to various locations;
- Reduce connection time of the mobile Emergency Diesel Generator(s);
- Introduce Extensive Damage Mitigation Guidelines for safety such as coal fired plant connections to Emergency Grid 1, direct injection of fire fighting water into the alternative deep-well pumps system;
- Enhance the use of steam to power Emergency Feed Water System in case of total loss of electrical power (in case of loss of Emergency grids 1 and 2);
- Perform training on the procedures (which are still to be developed) and actions during mid-loop operations in case of total loss of electrical power (loss of Emergency grids 1 and 2);
- Implement additional reserve spent fuel cooling system;
- Envisage potential actions to prevent running out of on-site diesel supply for fire extinguishing system and the fire brigade.

2.2.b Schedules and milestones to complete operator's planned activities

The planning of operator's planned activities (and those by the regulator) can be found in Table 2-1.

2.2.c Preliminary or final results of activities including proposals for further actions

Licensee has submitted its Licensee Report in which it presented a demonstration of the compliance of the NPP with its licensing base and the presence of margins on top of this license base.

Licensee has identified possibilities for improvement of the robustness of the plant and has produced a list of numbered measures and topics for further research. A preliminary set can be found in Table 2-1.

2.3 Activities performed by the regulator

2.3.a Discussion of activities taken or planned by the regulator

2.3.a.1 Regulatory review of Licensee's complementary safety assessment

The regulatory review of the Licensee Report was finished in December 2011 and reported in the Netherlands' National Report on the post-Fukushima Dai-ichi stress test. Some findings of the review are presented in this section, as far as they are related to the topics LOOP/SBO and LUHS.

The regulator concluded the NPP satisfies its licensing base. Numerous options are available to cope with a LOOP scenario for a period of at least 72 hours without any external support. It is noted that the redundancy of power supply (two emergency grids NS1 and NS2) is a good practice as well the coal fire plant nearby with its own emergency diesel generators and linked to the NPP. Another strong point is the fully qualified UHS consisting of eight deep water wells.

A 1 MW mobile diesel generator is available on the site, but it is stored in a container and needs to be transported over the site using external resources in case of an emergency (a truck is needed to place the DG near the NS2 diesels). The time estimated for on-site transportation is 2 hours, and the time needed for connection is 4 hours.

The maximum running time of a particular EDG can be extended by using available fuel stocks from several tanks. The minimum amount of available diesel fuel in the stock on-site is reported to be 245 m^3, which is enough to feed one EDG for up to 1300 hours. However, this would require diesel fuel transfer whereas there are no dedicated hardware provisions and procedures available to support the required fuel transfers. This situation will be improved to ensure and improve the autonomy of the EDGs.

Emergency grid NS2 together with its two EDGs is well protected from flooding, earthquakes and explosions. However, the mobile diesel generator could not be available in case of flooding.

In a number of SBO and loss of UHS scenarios, the plant relies strongly on the low pressure fire system (UJ) to supply makeup and/or cooling water. It therefore has been required that the robustness of this system will be improved.

The description of 'cliff edges' in the Licensee Report for most scenarios has been elaborated to a limited detail.

2.3.a.2 Evaluation of licensee's proposals

The regulator is studying proposals of licensee, the preliminary opinion of the Regulatory Body, has been expressed in regulatory position statements in the National Report. The Regulatory Body can largely agree with the proposed measures although evaluation is necessary to judge their effectiveness. In addition some other measures are required like:

- Assessment of the design classification and testing of Structures, Systems and Components handling severe accidents;
- Increase the amount of lubrication oil in stock;
- Analyses of the highest core temperatures during the various operational states;
- Assessment of the cooling possibilities in the case of loss of the main Grid, Emergency Grids 1 and 2 and no secondary bleed and feed available;
- Test severe accident measures to restore power from various possibilities like mobile diesel generators and connections to the coal fired plant;
- Increase the robustness of the fire fighting system.

2.3.a.3 Regulatory oversight of implementation of measures

The regulator is overseeing implementation of measures and research related to LOOP, SBO and LUHS conducted by licensee. Some issues have been prioritized in the planning.

For the planning, refer to the table in section 2.4..

2.3.a.4 ENSREG Peer Review

After submitting the National Report to ENSREG (December 2011), the regulator entered into the international Peer Review phase, which was concluded with a visit by a European review team to the Netherlands (12-15 March). The review team visited the site of the licensee and the offices of the regulatory body, having ample discussions. The review team presented its conclusion 15th of March 2012. The Peer Review team judged that the National Report complies with the specifications defined by ENSREG and that the report is of a very good quality. The information provided is sufficiently adequate.

A strong safety feature is the redundancy of power supply (NS1 and NS2 EDGs), and the coal fire plant nearby with its own emergency diesel generators and linked to the NPP. An other strong point is the fully qualified UHS consisting of eight deep water wells.

It should be noticed as a good practice to use the risk monitor for planning maintenance during operation and outages.

The recommendations of the Peer Review regarding 'design issues' LOOP/SBO and LUHS coincided with those published by the regulatory body in its National Report on the Borssele stress test.

2.3.b Schedules and milestones to complete regulatory body's planned activities

The planning can be found in Table 2-1.

2.3.c Conclusions of the regulatory body regarding the outcome of the operator's activities

Licensee has submitted its Licensee Report as part of his contribution to the ENSREG-led stress test.

Based on decades of regulatory oversight compliance of the nuclear power plant with its licence base has been established. The regulatory review of the Licensee Report has not provided evidence for a different position.

The licensee has proposed measures to further increase robustness of its plant and topics for further study. Most of these proposals in principle can be endorsed by the regulatory body. Before implementation, their effectiveness needs to be assessed.

The planning of measures is subject to discussions between licensee and regulator.

2.4 Tabled summary of items reported

Legend:

M = Measure, P = Procedure, S = Study. Lic = M, P or S proposed by licensee, **Reg** = M, P or S proposed by regulator. Lic & **Reg** = something proposed by regulator, but with added requirements from the regulator.

The full list of measures etcetera mentioned in the national report for the ENSREG-led stress test can be found in Appendix A.

Items to be undertaken by the licensee and proposed by regulator or with added requirements by the regulator, are marked with bold typeface.

Table 2-1 Tabled summary of items reported for Topic 2 – External Events LOOP/SBO and LUHS). *In the table, the planning of the actions on the part of licensee has been proposed by licensee. The planning is subject to discussions with the regulator and may change.*

Activity	Activities by the Operator*			Activities by the Regulator*		
	(Item 2.a) Activity - Taken? - Ongoing? - Planned?	(Item 2.b) Schedule Or Milestones for Planned Activities	(Item 2.c) Results Available - Yes? - No?	(Item 3.a) Activity - Taken? - Ongoing? - Planned?	(Item 3.b) Schedule Or Milestones for Planned Activities	(Item 3.c) Conclusion Available - Yes? - No?
Topic 2 – Design Issues						
ENSREG stress test: Demonstration of compliance with licensing basis	Taken	Finished Oct 2011	Yes, okay	Taken	Finished Dec 2011	Yes
ENSREG stress test: Assessment of safety margins	Taken	Finished Oct 2011	Yes	Taken	Finished Dec 2011	Yes
ENSREG stress test: Propose potential safety improvements – preliminary proposals.	Taken	Finished Oct 2011	Yes	Taken	Finished Dec 2011	Yes

Activity	Activities by the Operator*			Activities by the Regulator*		
	(Item 2.a) Activity - Taken? - Ongoing? - Planned?	(Item 2.b) Schedule Or Milestones for Planned Activities	(Item 2.c) Results Available - Yes? - No?	(Item 3.a) Activity - Taken? - Ongoing? - Planned?	(Item 3.b) Schedule Or Milestones for Planned Activities	(Item 3.c) Conclusion Available - Yes? - No?
Agree on final set of measures and implementation plan. Details below:	Ongoing	May 2012	No, not yet, final set subject to discussion between licensee & regulator	Ongoing	May 2012	No, not yet, final set subject to discussion between licensee & regulator
II-1 (M) Finding possibility to refill spent fuel pool (SFP) without entering containment (in which it is located), with worker dose kept ALARA (Lic & **Reg**)	Ongoing	End June 2012	No			
II-2 (M) Finding additional means for refilling the SFP (Lic)	Ongoing	End 2013	No			
II-3 (M) Reduction of time needed to connect on-site mobile Emergency Diesel Generator (Lic)	Ongoing	July 2012	No			

Activity	Activities by the Operator*			Activities by the Regulator*		
	(Item 2.a) Activity - Taken? - Ongoing? - Planned?	(Item 2.b) Schedule Or Milestones for Planned Activities	(Item 2.c) Results Available - Yes? - No?	(Item 3.a) Activity - Taken? - Ongoing? - Planned?	(Item 3.b) Schedule Or Milestones for Planned Activities	(Item 3.c) Conclusion Available - Yes? - No?
II-4 (M) Establishing ability to transfer diesel fuel from storage tanks of inactive diesels to active diesel generators. Phase 1: emergency grid 1 EDGs Phase 2: remaining diesels. (Lic)	Ongoing	Phase 1: Dec 2013. Phase 2: start June 2013, end July 2014	No			
II-5 (S) Research into reserve SFP cooling system which should be independent of power supply by the present emergency grids of the NPP. (Lic)	Ongoing	End 2013	No			

3. Severe Accident Management and Recovery (on site)

3.0 Introduction to SAM at licensee EPZ

3.0.a Regulatory basis

The Dutch Nuclear Energy Act sets the framework for nuclear safety management. Beneath this, "Decrees" provide for additional regulations, including provisions for licensing and requirements for risk assessments, and specifically those for managing severe accidents.

The regulator can also issue "Nuclear Safety Rules" (NVRs) – the third tier in the regulatory framework. These have allowed the regulator to attach international safety standards to the licence, including the WENRA Reference Levels (RLs) and IAEA Safety Requirements and Guides (47 are attached at present). The safety standards attached include "Severe Accident Management Programmes for NPPs" (NS-G-2.15). IAEA GS-G-2.1, '*Arrangements for Preparedness for a Nuclear or Radiological Emergency'*, is also attached to the site license as an NVR.

Basic requirements for emergency preparedness are provided for in the operating licence; this includes requirements to conduct emergency exercises.

In principle, the approach adopted in the Netherlands enables regulation in accordance with current international practice, and to be flexible in adopting further requirements if this changes. The Dutch legal framework gives the Regulatory Body adequate powers to require any Severe Accident Management (SAM) measures it deems necessary, the main instrument being through the operating licence.

The Decrees include specific requirements for numerical risk. These are general requirements that apply to all industrial activities in the Netherlands. From this, risks need to be less than: 10^{-6} per year for individual risk (mortality) as a consequence of operating an installation; 10^{-5} per year for societal risks, i.e. risks directly attributable to events leading to 10 or more fatalities. Supplementary criteria are also applied, requiring a hundredfold reduction in this limit for each tenfold increase in the predicted number of fatalities.

3.0.b Use of PSA at the licensee

The licensee has conducted complete Level 1, 2 and 3 PSAs, which include external hazard initiators. The full scope Level 3 PSA (which utilises the COSYMA computer program) results in estimated risk levels compliant with the regulatory criteria outlined above. These are "living" PSAs, i.e. they are updated yearly. They also provide input to the surveillance and maintenance strategies, modification planning and execution, and periodic safety assessments.

Early, late, and very late release frequencies over all operational states are calculated in the Netherlands. Large release frequencies are not calculated and so used in the licensing basis. Instead the risk levels mentioned above (including individual and societal risks) are included in the licence process.

The full scope Level 3 PSA has been used to derive EPZ's Severe Accident Management strategy.

3.0.c SAM strategy at licensee

Twin strategies are applied to manage a severe accident. Due to the layout of the reactor pit, the generic in-vessel retention strategy is not feasible in Borssele NPP. The SAMGs conservatively assume that the corium will ultimately penetrate the basemat and the corresponding strategy is to prevent a high-pressure melt-through scenario. Since this is a very conservative assumption, the SAMGs also takes into account that a coolable configuration of the corium will be reached due to the spreading of the corium. The associated strategy is to enhance cooling of the corium by supplying water (through the damaged reactor vessel) to the corium. The licensee is currently reviewing international research to better underpin these strategies.

Severe Accident Management Guidelines (SAMGs) have been in operation at Borssele NPP since 2000 as an outcome from the PSR at the plant in 1993. Their scope was expanded following the 2003 PSR to include shutdown conditions. The SAMGs are based on the generic SAMGs produced by the Westinghouse Owners Group and were considered state of the art in 2003. They are intended to address scenarios deriving from severe external hazards, such as earthquakes and floods, where there is the imminent potential for core melt.

The SAMGs include guidance for using the pressure relief valves and various pressuriser spray options to control the Reactor Pressure Vessel (RPV) pressure. For an ex-vessel event the containment (37,100m^3) has filtered venting, a spray system, air coolers, a filtered recirculation system and Passive Autocatalytic Re-combiners (PARs). The containment is designed for overpressures of 3.8 bar.

3.0.d SAM facilities at the licensee

Borssele has standard arrangements for controlling the plant in the event of a severe accident. The Main Control Room (MCR) has a filtered air supply and, following a SBO event, compressed air and respirators are available. There is also an alternative Emergency Control Room (ECR, which is bunkered and has gas-tight doors, but which does not have a filtered air supply) for managing a controlled shutdown, core cooling and spent fuel pool cooling. Both the MCR and ECR have suitable and robust access to plant measurements needed to control a severe accident.

There are seven operations shift teams at Borssele, each managed by a shift supervisor and each composed of at least eight operators. It is the shift supervisor's responsibility to decide on the extent of the licensee's Emergency Response Organisation (ERO) that needs to be activated. Once the ERO is operational, the site emergency director takes over responsibility for the emergency. Based on data from exercises, the ERO will be set up within 45 minutes (even outside normal working hours) and then requires a further 30 minutes to become operational.

The ERO is a scalable organisation: the number of staff called in (by pagers, phone calls) will depend upon the scale of the emergency being addressed. The ERO will be located in the plant's Alarm Coordination Centre (ACC). This is a purpose-built facility designed for internal events and emergencies. Though bunkered (like the ECR), it is not designed to withstand severe events such as a major earthquake, flood or aircraft crash. If damaged, ERO has to use an other room, but consequently lose some of the dedicated ERO-facilities.

3.0.e Training

Training and emergency exercises are conducted routinely and include change-over of ERO shifts. Scenarios are controlled using the plant's full scope simulator (located in Essen, Germany), though it is noted that this cannot simulate severe accidents. Emergency exercises can be very large scale, e.g. a recent national exercise involved 1000 people. The licensee produces an annual summary report of its exercises which is assessed by the regulator. The KFD participates in six emergency exercises annually. One or two KFD-inspectors are based at the ERO location to observe the exercise and to check if the correct measures are taken to restore safety functions.

3.1 Overview of topic analysis

As explained in the Introduction to the present report, the Netherlands has participated in the ENSREG led European stress test, also called a 'Complementary Safety margin Assessment'

(CSA). In this 'test', the licensee has produced a Licensee Report and the regulator a National Rapport in which the findings of the licensee are evaluated by the regulatory body.

The analysis of the robustness of the NPP organisation and facilities with respect to Severe Accident Management is further commented upon in the sections 3.2 (for the part of the licensee) and 3.3 (for the part of the regulatory body).

3.2 Activities performed by the operator

3.2.a Discussion of activities taken or planned by the NPP operator

3.2.a.1 Evaluation of SAM capability

In the ENSREG-led stress test, licensee has evaluated his SAM capability and has judged it adequate, although noting several options for improving on this capability.

3.2.a.2 Proposals for potential safety improvements

Licensee has identified possibilities for improvement of the robustness of the plant and its SAM organisation, and has produced a list of numbered measures and topics for further research, also refer to Table 3-1. Examples of issues identified, accompanied by proposed measures are detailed below.

When EPZ's Emergency Response Organisation needs to be activated, it will be located in the plant's Alarm Coordination Centre (ACC). This is a purpose-built facility designed for internal events and emergencies. Though bunkered (like the ECR), it is not designed to withstand severe events such as a major earthquake, flood or aircraft crash. The licensee has therefore proposed a new Emergency Response Centre (ERC) to provide a more robust shelter. In the meantime, the ERO will need to relocate, if the ACC becomes uninhabitable, to a standard meeting room. This will however entail losing much of the functionality (e.g. communications provisions) of the ACC. Interim measures are therefore envisaged to enhance the capability of some of the meeting rooms on site (though not to the same standards as the ERC will have), pending full ERC commissioning.

The licensee is currently in the process of developing a set of Extensive Damage Mitigation Guidelines (EDMGs). They address gross infrastructure problems deriving from a major incident, e.g. blocked roads, or doors no longer amenable for access.

3.2.b Schedules and milestones to complete operator's planned activities

The planning can be found in Table 3-1.

3.2.c Preliminary or final results of activities including proposals for further actions

Licensee has submitted its Licensee Report in which it presented a demonstration of the compliance of the NPP with its licensing base and the presence of margins on top of this license base.

Licensee has identified possibilities for improvement of the robustness of the plant and has produced a list of numbered measures and topics for further research. A preliminary set can be found in Table 3-1.

3.3 Activities performed by the regulator

3.3.a Discussion of activities taken or planned by the regulator

3.3.a.1 Regulatory review of Licensee's complementary safety assessment

The regulatory body has reviewed the Licensee Report (the CSA) as part of the ENSREG-led stress test exercise and reported on its review in the Netherlands' National Report on the post-Fukushima Dai-ichi stress test. Regarding SAM, regulator has concluded that the EOPs and SAMGs are wide-ranging and include coverage of shutdown states. The regulator is confident that their coverage is adequate and that the sets of EOPs and SAMGs complement one another.

3.3.a.2 Evaluation of licensee's proposals

The regulator is studying proposals of licencee, the preliminary opinion of the RB has been expressed in regulatory position statements in the National Report. The Regulatory Body can largely agree with the proposed measures although evaluation is necessary to judge their effectiveness.

Some additional comments are:

- There is scope for improved training in the SAMGs, focusing on circumstances of reduced accessibility to the site, reduced numbers of ERO staff, reduced availability of instrumentation, harsh conditions and long duration accidents;
- Specific SAMs need to be developed for the Spent Fuel Pool (SFP);
- There are question marks over whether all the SSCs installed for SAM are capable of delivering their intended safety functions reliably;
- Not all SAM equipment is subjected to routine maintenance and/or inspection.

3.3.a.3 Regulatory oversight of implementation of measures

The regulator is overseeing implementation of measures and research conducted by licensee. Some issues have been prioritised in the planning.

3.3.b Schedules and milestones to complete regulatory body's planned activities

The schedule of actions identified can be found in section 3.4.

3.3.c Conclusions of the regulatory body regarding the outcome of the operator's activities

Licensee has submitted its Licensee Report as part of his contribution to the ENSREG-led stress test.

Based on decades of regulatory oversight compliance of the nuclear power plant with its licence base has been established. The regulatory review of the Licensee Report has not provided evidence for a different position.

The licensee has proposed measures to further increase robustness of its plant and topics for further study. Most of these proposals in principle can be endorsed by the regulatory body. Before implementation, their effectiveness needs to be assessed.

The planning of the measures is subject to discussion between licensee and regulator.

3.4 Tabled summary of items reported

Legend:

M = Measure, P = Procedure, S = Study. Lic = M, P or S proposed by licensee, Reg = M, P or S proposed by regulator. Lic & Reg = something proposed by regulator, but with added requirements from the regulator.

The full list of measures etcetera mentioned in the national report for the ENSREG-led stress test can be found in Appendix A.

Items to be undertaken by the licensee and proposed by regulator or with added requirements by the regulator, are marked with bold typeface.

Table 3-1 Tabled summary of items reported for Topic 3 – Severe Accident Management (SAM). *In the table, the planning of the actions on the part of licensee has been proposed by licensee. The planning is subject to discussions with the regulator and may change.*

Activity	Activities by the Operator*			Activities by the Regulator*		
	(Item 2.a) Activity - Taken? - Ongoing? - Planned?	(Item 2.b) Schedule Or Milestones for Planned Activities	(Item 2.c) Results Available - Yes? - No?	(Item 3.a) Activity - Taken? - Ongoing? - Planned?	(Item 3.b) Schedule Or Milestones for Planned Activities	(Item 3.c) Conclusion Available - Yes? - No?
Topic 3 – Severe Accident Management						
ENSREG stress test: Evaluation of SAM[12] capability	Taken	Finished Oct 2012	Yes	Taken	Finished Dec 2011	Yes
ENSREG stress test: Propose potential safety improvements – preliminary proposals.	Taken	Finished Oct 2011	Yes	Taken	Finished Dec 2011	Yes

[12] SAM strategies of licensee are supported by a full scope PSA-3, the strategies have been subject to IAEA IPSART missions.

Activity	Activities by the Operator*			Activities by the Regulator*		
	(Item 2.a) Activity - Taken? - Ongoing? - Planned?	(Item 2.b) Schedule Or Milestones for Planned Activities	(Item 2.c) Results Available - Yes? - No?	(Item 3.a) Activity - Taken? - Ongoing? - Planned?	(Item 3.b) Schedule Or Milestones for Planned Activities	(Item 3.c) Conclusion Available - Yes? - No?
Agree on final set of measures and implementation plan. Details below:	Ongoing	End 2012	No, not yet, final set subject to discussion between licensee & regulator	Ongoing	End 2012	No, not yet, final set subject to discussion between licensee & regulator
III-1 (M) On-site Emergency Response Centre facilities that could give shelter to emergency response organisation (ERO) after all foreseeable hazards (Lic) Phase 1: optimization current facilities Phase 2: realisation additional facilities	Ongoing	Phase 1: end June 2013; Phase 2: start July 2014, end Oct 2014	No			

Activity	Activities by the Operator*			Activities by the Regulator*		
	(Item 2.a) Activity - Taken? - Ongoing? - Planned?	(Item 2.b) Schedule Or Milestones for Planned Activities	(Item 2.c) Results Available - Yes? - No?	(Item 3.a) Activity - Taken? - Ongoing? - Planned?	(Item 3.b) Schedule Or Milestones for Planned Activities	(Item 3.c) Conclusion Available - Yes? - No?
III-2 (M) Storage facilities for ERO accessible after all foreseeable hazards – re-evaluate dose rates in those areas for representative scenarios (Lic & **Reg**) Phase 1: optimization current facilities; Phase 2: realisation additional facilities.	Ongoing	Phase 1: end June 2013; Phase 2: start July 2014, end 2014.	No			
III-3 (M) Establish independent voice and data communication that will be able to operate under adverse conditions, both on and offsite (Lic)	Ongoing	End 2012	No			

Activity	Activities by the Operator*			Activities by the Regulator*		
	(Item 2.a) Activity - Taken? - Ongoing? - Planned?	(Item 2.b) Schedule Or Milestones for Planned Activities	(Item 2.c) Results Available - Yes? - No?	(Item 3.a) Activity - Taken? - Ongoing? - Planned?	(Item 3.b) Schedule Or Milestones for Planned Activities	(Item 3.c) Conclusion Available - Yes? - No?
III-4 (P) Further develop set of Extensive Damage Mitigation Guidelines (EDMGs), implement associated training program.(Lic) Phase 1: procurement 1st batch of mobile equipment Phase 2: EDMGs and procurement additional equipment	Ongoing	Phase 1: end July 2012. Phase 2: start Jan 2013, end 2013	No			
III-5 (P) Procedures for functionally testing of SSCs important for handling severe accidents (**Reg**)	Planned	Start 2013, end 2013	No			
III-6 (P) Develop criteria for deciding when to switch off oil pump of turbine to save battery power (**Reg**)	Planned	Start August 2012, end 2012	No			

Activity	Activities by the Operator*			Activities by the Regulator*		
	(Item 2.a) Activity - Taken? - Ongoing? - Planned?	(Item 2.b) Schedule Or Milestones for Planned Activities	(Item 2.c) Results Available - Yes? - No?	(Item 3.a) Activity - Taken? - Ongoing? - Planned?	(Item 3.b) Schedule Or Milestones for Planned Activities	(Item 3.c) Conclusion Available - Yes? - No?
III-7 (S) Research into more extensive use of steam for powering emergency feed water pump and an emergency AC generator (Lic)	Planned	Start 2014 – end 2016	No			
III-8 (S) Assessment of the need to upgrade equipment and/or instrumentation dedicated to SAM purposes (**Reg**)	Ongoing	End 2013	No			
III-9 (S) Re-assessment of alternative power sources (alternatives to emergency grids) (**Reg**)	Ongoing	End 2013	No			
III-10 (S) Reassessment of usefulness of cooling water from fire fighting pond (**Reg**)	Planned	Start Aug 2012, end Dec 2012	No			
III-11 (P) Study to develop procedures and measures for specific SAM like long term measures & specific SFP guidelines (**Reg**)	Ongoing	End 2013	No			

Activity	Activities by the Operator*			Activities by the Regulator*		
	(Item 2.a) Activity - Taken? - Ongoing? - Planned?	(Item 2.b) Schedule Or Milestones for Planned Activities	(Item 2.c) Results Available - Yes? - No?	(Item 3.a) Activity - Taken? - Ongoing? - Planned?	(Item 3.b) Schedule Or Milestones for Planned Activities	(Item 3.c) Conclusion Available - Yes? - No?
III-12 (P) Training activities for long term SAM measures (**Reg**)	Planned	Start after 10EVA13	No			
III-13 (M) Increase autarky time (Lic)	Planned	Start 2014 - end 2016	No			
III-14 (S) Study of handling of large amounts of contaminated water (**Reg**)	Planned	Start 2015 – end 2016	No			
III-15 (S) Reassessment of ERO staffing regarding its adequacy 24/7 under all conditions (**Reg**)	To be planned, subject to discussion Reg & Lic	-	No			
III-16 (S) Assessment of adequacy of amount of lubricating oil (**Reg**)	Planned	Start July 2012, end Dec 2012	No			
III-17 (S) Study of option to use remotely controlled valves for handling mid-loop (SBO) situation (**Reg**)	Planned	Start July 2012, end Dec 2012	No			

Activity	Activities by the Operator*			Activities by the Regulator*		
	(Item 2.a) Activity - Taken? - Ongoing? - Planned?	(Item 2.b) Schedule Or Milestones for Planned Activities	(Item 2.c) Results Available - Yes? - No?	(Item 3.a) Activity - Taken? - Ongoing? - Planned?	(Item 3.b) Schedule Or Milestones for Planned Activities	(Item 3.c) Conclusion Available - Yes? - No?
III-18 (M) unambiguous tagging of keys in bunkered building(s) and SAM manuals at locations where they are to be used (**Reg**)	Planned	Start June 2012, end June 2012	No			

4. National Organisations

The licensee is primarily responsible for nuclear safety. However, the government, the regulator, technical support organizations, vendors, service providers and other stakeholders are also important to improve and to maintain a high standard of safety.

The first 'zero'-numbered section of this chapter describes the status quo of the national organisations in the Netherlands. The other sections closely follow the structure of the tables '*of items reported*' that have been requested by the CNS secretariat and that identify the actions planned, ongoing or taken in support of maintaining and enhancing nuclear safety.

4.0 Introduction to National Organisations

As described in the introduction chapter of this report, the organisation of the regulatory body has changed since the publication of the Netherlands' 2010-report to the CNS. This is not related to the Fukushima Dai-ichi events.

4.0.a Regulatory body

All nuclear facilities in the Netherlands, including the NPP of Borssele, operate under licence, awarded after a safety assessment has been carried out. The licence is granted by the regulatory body under the Nuclear Energy Act.

The 'regulatory body' is the authority designated by the government as having legal authority for conducting the regulatory process, including issuing licences, and thereby regulating nuclear, radiation, radioactive waste and transport safety, nuclear security and safeguards.

In the Netherlands, since October 2010, the minister of Economic Affairs, Agriculture & Innovation (EL&I[13]) is the principal responsible authority for conducting the regulatory process under the Nuclear Energy Act and for the main functions of the regulatory body.

The structure of the current regulatory body is presented in the figure below.

[13] Dutch: EL&I, 'Economische Zaken, Landbouw & Innovatie'

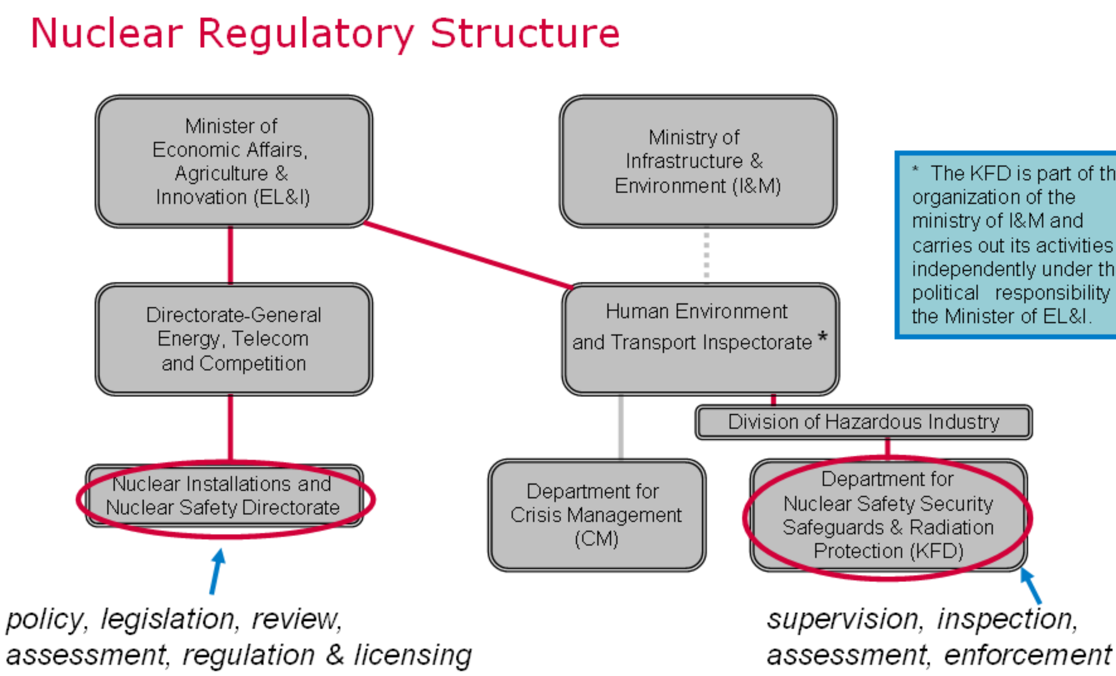

Figure 1 New regulatory structure in the Netherlands, with the ministry of EL&I as the principal responsible authority for conducting the regulatory process under the Nuclear Energy Act.

Within the ministry of EL&I, the 'Directoraat voor Nucleaire installaties en veiligheid' (NIV), i.e. directorate for nuclear installations and nuclear safety, is involved in the preparation of legislation, formulating policies (excluding energy policy) and licensing.

The nuclear inspectorate, the 'Kernfysische dienst' (KFD) is within the general responsibility of the Minister of EL&I the responsible organisation for the independent supervision (safety assessment, inspection and enforcement) of the safety, security and non-proliferation of activities and facilities (including nuclear facilities). The KFD is embedded in an organisational division of the 'Inspectorate for the Environment and Transport' (ILT), which is the inspection branch of the ministry of Infrastructure and the Environment (IenM).

4.0.a.1 Emergency preparedness organizations

This issue is addressed in chapter 5.

4.0.b Governmental supporting organisations: RIVM

The National Institute for Public Health and the Environment (RIVM) is a specialised Dutch government agency. The RIVM coordinates the back-office of the National Nuclear Assessment Team for radiological analyses and information (BOR).This issue is also addressed in chapter 5.

RIVM is the premier expertise and orchestration centre in its field and its remit is to modernise, gather, generate and integrate knowledge and make it usable in the public domain. By performing these tasks RIVM contributes to promoting the health of the population and the environment by providing protection against health risks and environmental damage.

The RIVM supports the Ministries with scientific studies about the emergency preparedness of severe accidents and the ERO. RIVM works together with other (governmental) expert organisations as the Royal National Meteorological Institute (KNMI) with models for the prediction of the effects of discharges of radioactive material in the air.
RIVM also operates the national radiological monitoring network.

4.0.c Notified bodies

The assessment and inspection of the integrity of pressure retaining components is subcontracted to a Notified Body, Lloyds Register Nederland BV. The assessments and inspections of the Notified Body are performed under supervision of the KFD.

Companies having the required knowledge and expertise can qualify as a Notified Body. Lloyds Register Nederland BV is one of such organisations. This organisation is the privatised former Pressure Vessel Inspectorate (Stoomwezen BV) and is certified as a Notified Body in accordance with the European Pressure Equipment Directive.

4.0.d Education and training organisations

The RID/R3 organisation at the Technical University in Delft and the Nuclear Research & consultancy Group (NRG) in Petten and Arnhem provide education and training in nuclear technology and radiation protection to clients from nuclear and non-nuclear businesses and various governmental organisations. NRG also provides training for the NPP staff.

For the education and training in radiation protection a national system exists with four levels of education. The government recognizes training institutes for a specific training of radiation protection. For getting a degree in radiation protection, an exam has to be passed.

A change in the system of education for radiation protection is under construction. Registration of radiation protection experts of the levels 2 and 3 is foreseen in 2013. There are formal requirements to obtain registration certificates are laid down for the initial education, for continuing education and for work experience.

4.0.e Technical (Support) Organisations

GRS, Germany

The Dutch regulatory body cooperates with the Technical Support Organization from Germany, GRS. This is the major Technical Support Organisation in Germany. GRS aids the German regulatory body in the regulatory oversight process. Occasionally GRS provides education and training for governmental and commercial organisations.

NRG, Netherlands

The Nuclear Research & consultancy Group (NRG) in Petten and Arnhem provides consultancy services to government and industry and operational support to utilities.

4.0.f Utility N.V. EPZ

N.V. EPZ is the only single nuclear utility in the Netherland. It operates one NPP in Borssele, the KCB. The KCB shares its site with a conventional power plant which is mainly a coal fired plant and seven wind turbines.

4.0.g Vendor

The architect engineer and original vendor of the Borssele NPP is Siemens-KWU. The nuclear part of Siemens-KWU is now named Areva NP GmbH. For the non-nuclear part of the plant, the vendor is Siemens AG.

Both companies are contracted by EPZ for specialised services in their respective areas.

With respect to nuclear incidents, the Areva NP Emergency response support service is particularly noteworthy. Areva NP maintains an emergency support organisation for its customers. KCB is one of the customers that has a contract in place for support during and after incidents, with the emphasis on beyond design-base incidents including core melt scenarios. In both Areva NP crisis centers (Erlangen and Offenbach) real-time KCB process information can be displayed and all necessary documentation is kept current and available on a dedicated computer. Specialised equipment for (post-) accident support can be made available through Areva. Emergency exercises with the Areva NP crisis centre are held each year.

4.1 Overview of topic analysis

The Fukushima Dai-ichi accident did not result into an immediate dedicated analysis of the regulatory organisation. Already before the accident and required by 2009 EU Nuclear Safety Directive, the Netherlands has committed itself to undergo an IRRS-mission in 2014. The IRRS-mission will be executed according to the Memorandum of Understanding (MoU) between ENSREG and the IAEA.

This MoU also requires the involvement of the Dutch regulatory body into IRRS missions in other countries, which is a direct benefit for the preparation of the mission in 2014 in the Netherlands.In 2005, 2008 and 2011 one employee took part in the French and German (follow-up) missions. In February 2012 one person was a member in the Swedish mission.

A task force from both organisations of the Dutch Regulator (EL&I and at ILT) has been established as well as a Steering Committee which will monitor the process. The self-assessment of the Regulatory Body is planned in the first half of 2013.
KFD will also request IAEA support in 2012 or 2013 for the actions related to the IAEA-Action Plan, on order to perform a comprehensive competence analysis using the tool developed by IAEA. KFD is represented in the IAEA Steering Committee on Human Resources for Regulatory Bodies.

4.2 Activities performed by the operator

4.2.a Discussion of activities taken or planned by the NPP operator

Before the Fukushima Dai-ichi accident, the operator of EPZ implemented a modern set of IAEA Safety Guides. The design rules are evaluated in the current PSR and implemented if needed.

The operator performed WANO-inspections (SOER 2011-2 and 2011-3) immediate after the Fukushima Dai-ichi accident. Results and improvements have been published (also available on the website www.kerncentrale.nl) and were discussed with the regulatory body.

The operator has a programme for continuously improvement of the safety culture, which started in 2006 and is not delayed effected by the Fukushima Dai-ichi event.

EPZ has executed the Complementary Safety margin Assessment (CSA) as defined by ENSREG and proposed measures to further increase the existing margins to cope with extreme events (see chapters 1 – 3). The regulatory body encouraged the implementation of effective improvements and in some cases asked further actions.

The principle of Continuous Improvement is based on internal and external operating experience-feedback. This process is expanded by formally required two-yearly and ten-yearly Periodic Safety Reviews (PSRs). In the two-yearly PSRs the current basis for the license is evaluated, in the ten-yearly PSRs the license itself is also subject to evaluation, This evaluation takes into account (inter)national developments, like evolutions in siting conditions, safety assessment methodologies, safety standards, design, operation and QA. Ten-yearly PSRs have resulted in several design modifications. The operator has started the 4th Periodic Safety Review, to be finalised in 2013; some of the proposed measures, in particular research activities, resulting from the 'stress test', were included in this PSR, while some others have been added or made more explicit in this PSR.

The operator will apply for a license change in 2012 for the life extension beyond the original 40 years lifetime of the installation ending December 2013. In the framework of this license application a full scope SALTO mission has taken place in 2009 and another SALTO mission has taken place in 2012. Also the operator is required to prove to the regulator that the organisation is suitable equipped for the next 20 years. A structural increase of the number of staff at the NPP will be realised. This aspect has been evaluated by an MOA review concurrently with the 2012 SALTO mission.

The licensee regularly receives IAEA missions, like the OSART (every 10 years), SALTO and IPPAS and WANO missions, like Peer Reviews and Technical Support Missions. These are not related to post-Fukushima Dai-ichi 'stress test' exercises, but contribute to nuclear safety as well. Post Fukushima Dai-ichi WANO has decided to increase the frequency of peer review missions to once in four years and to extend and modify the content of the missions (include design and emergency preparedness). EPZ already implemented this development. The next WANO peer review has been scheduled in September 2012 with a follow-up in 2014. It will be one of the first including the post-Fukushima Dai-ichi extensions. The licensee has also agreed to host an WANO Emergency Preparedness Workshop in November 2012.

In reaction to the IAEA Action Plan KFD intends to invite an OSART mission in last quarter of 2013.

4.2.b Schedules and milestones to complete operator's planned activities

For actions, planning and preliminary results, as part of the ENSREG post-Fukushima Dai-ichi stress test, refer to chapters 1, 2 and 3 of the present report.

4.2.c Preliminary or final results of activities including proposals for further actions

For actions, planning and preliminary results, as part of the post-Fukushima Dai-ichi stress test, refer to chapters 1, 2 and 3 of the present report.

4.3 Activities performed by the regulator

4.3.a Discussion of activities taken or planned by the regulator

Dutch Nuclear Safety Rules

Because of the intention for a licence application for a new build nuclear power plant a new regulations framework is in preparation. The basis of this framework are the IAEA-requirements, the WENRA recommendations and -reference levels and the first lessons learned from Fukushima. Examples of these lessons are the need for a second Ultimate Heat Sink and the better protection of the spend fuel pools and an update of the requirements in relation to external hazards. Although the realisation of the plans for the new reactor are postponed by the initiators by two to three years, the development of the new regulations framework will be continued and finalised by the end of 2013. Other lessons to be learned from Fukushima will as much as possible also be implemented in this new framework.

In 2011 an update and extension of Dutch Safety Rules (which are based on IAEA-requirements and guides) was introduced exclusively dedicated to the existing NPP.

Expanding staff

The organisation of the regulator is strengthened by expanding its staff. This is not related to post-Fukushima Dai-ichi insights, but to the plans for nuclear new build in the Netherlands and the prolonged operation of the single operating NPP.

Assessment of the Complementary Safety Assessment (CSA) of Borssele NPP

The regulatory body (EL&I/NIV and ILT/KFD) assessed this report published as part of the ENSREG 'stress test' and published a National Report with the findings of the assessment, in the format prescribed by ENSREG. Refer to chapters 1-3 of the present report for the details.

Participation in the peer review process of the ENSREG-led stress test

The regulatory body (ELenI/NIV and ILT/KFD) took part in this process in two ways: (1) receiving visiting review team and answering questions etc, and (2) taking part in missions to other countries as part of the review team. Refer to chapters 1-3 of the present report for the details.

Participation in 2nd Extraordinary Meeting for the CNS

The regulatory body (ELenI/NIV and ILT/KFD) takes part in this meeting and makes the proper preparations, among others, preparation of the present report.

Regulatory body's projects on lessons learnt after Fukushima Dai-ichi

Several Fukushima-related meetings[14] were attended in 2011. The regulatory body has various post-Fukushima activities.

From the 1st of January 2012, the Inspectorate or ILT/KFD branch started with a special work package called 'Lessons Learned post-Fukushima Dai-ichi'. The ILT/KFD has given high priority to this work package; about 15 – 20% of capacity of KFD is reserved for it during 2012. Its goal is to stimulate and to continue to improve nuclear safety in The Netherlands by making sure that Dutch licensees take lessons from the accident in Fukushima-Dai-ichi.

Related activities are:

- Translation of IAEA action plan into actions for EL&I/NIV and for the ILT/KFD action plan[15];
- Translating the internationally identified Lessons Learned post-Fukushima into measures for the Dutch Nuclear Installations and the governmental bodies;
- ILT/KFD membership of Special Task Group Lessons Learned Fukushima of the OECD/NEA.

4.3.b Schedules and milestones to complete regulatory body's planned activities

Refer to section 4.4.

4.3.c Conclusions of the regulatory body regarding the outcome of the operator's activities

Not applicable in this chapter.

[14] ILT/KFD attended OECD/NEA Forum on the Fukushima accident – Insights and Approaches in June 2011, IAEA ministerial conference on nuclear safety in June 2011, General Conference of the IAEA in September 2011, and Eurosafe meeting in November 2011.

[15] Examples of activities: self-assessment for IRRS-mission; OSART-mission; participation in IRRS-missions.

4.4 Tabled summary of items reported

Table 4-1 National organisations

Activity	Activities by the Operator*			Activities by the Regulator*		
	(Item 2.a) Activity - Taken? - Ongoing? - Planned?	(Item 2.b) Schedule Or Milestones for Planned Activities	(Item 2.c) Results Available - Yes? - No?	(Item 3.a) Activity - Taken? - Ongoing? - Planned?	(Item 3.b) Schedule Or Milestones for Planned Activities	(Item 3.c) Conclusion Available - Yes? - No?
Topic 4, strengthening (National) Organisations						
Regulator using lessons learnt after Fukushima Dai-ichi in development of policies and, regulations and in its regulatory oversight.				Ongoing	No end date	Yes. Participated in ENSREG stress test and peer review efforts, rest of act.'s ongoing.
IRRS mission in 2014 and preparations in 2012 and 2013, initiated before Fukushima Dai-ichi accident. This mission will include an EPR[16] and post-Fukushima module.				Planned	2012: preparations, 2013: self assessment & IRRS preparatory mission, 2014: IRRS mission	No

[16] EPR: Emergency Preparedness & Response

5. Emergency Preparedness and Response and Post Accident Management (off site)

Off site emergency preparedness and response (EPR) and post accident management (PAM) mainly is a national responsibility. Nevertheless utility's responsibility is also important especially regarding technical information on plant conditions and the potential risk for emissions.

5.0 Introduction to organisation of EPR and PAM in the Netherlands

5.0.a Regulatory frame work - National Plan for Nuclear Emergency Management and Response Plan, NPK

Chapter VI of the Dutch Nuclear Energy Act describes the responsibilities and tasks of the authorities that are responsible for nuclear emergency management (preparation and response)

Under Article 40 of the Act, the national government is responsible for the preparatory work and for actually dealing with any emergency that may occur in case of nuclear accidents. The operational structure of nuclear emergency preparation and response is described in the National Plan for Nuclear Emergency Management and Response: NPK[17] and the NPK Response Plan.

5.0.b Organisation - National Nuclear Assessment Team, EPAn

The key organization in this structure is the National Nuclear Assessment Team, ('EPAn')[18]. This team advises the policy teams on local and national level when there is a real threat of an off-site emergency in a nuclear installation or a radioactive release (in the Netherlands or in a neighbouring country). This team consists of a front-office, where the emergency situation is analysed and advice on measures is drafted, and back-offices for radiological, and medical information. The back-office for radiological information provides projected dose data on the basis of dispersion calculations and monitoring data concerning the environment, drinking water and foodstuff. It is located within the National Institute for Public Health and the Environment (RIVM[19]). RIVM operates the national radiological monitoring network (NMR[20]) and in addition monitoring vans. It also collects data from other institutes. Alongside the radiological experts, the inspectorate of the nuclear regulatory body (KFD) has an important role in assessing the status of the relevant nuclear installation, the accident prognoses and the potential source term. In addition, KFD inspectors go to the region of the accident site to support the off-site regional crisis management centre (the 'ROT').

5.0.c Training and exercises and their organisation

Based on the NPK, the Dutch training and exercise programme for nuclear emergency management and response is based on a four-years training- and exercise-cycle that is implemented in the annual programmes. Training is organized for different topics e.g. the use of Emergency Information and Decision Support Systems, and some exercises. A full scale exercise is planned approximately every five years. In these national exercises the interaction

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[17] Dutch: 'National Plan Kernongevallenbestrijding', NPK
[18] Dutch: 'Eenheid Planning en Advies nucleair', EPAn
[19] Dutch: 'Rijksinstituut voor volksgezondheid en milieu', RIVM
[20] Dutch: 'Nationaal Meetnet Radioactiviteit', NMR

between generic national emergency management structures and nuclear emergency management and response are integrated.

Officials of different departments and organisations of the National Nuclear Assessment Team (EPAn) participate in exercises and trainings. They all have their own expertises and roles during such an exercise and during an actual accident-response. Examples of such roles are performing radiological/technical analyses, advising on health aspect, etc.

Nuclear and radiological training and exercises are organised by the Ministry of Infrastructure and the Environment (IenM/ILT/CM), under the responsibility of the Ministry of Economic Affairs, Agriculture and Innovation (El&I). The Ministry of Safety and Justice is responsible for the general (non-nuclear) national response-organisation and for exercises to train this organisation. Ministries work together in the organisation of integrated large scale exercises.

5.1 Overview of topic analysis

In the next two sections, the activities undertaken by operator and especially regulator on EPR and PAM are discussed. Not all of these were initiated by post-Fukushima Dai-ichi insights.

5.2 Activities performed by the operator

5.2.a Discussion of activities taken or planned by the NPP operator

The EPZ emergency response organisation has not changed as a result of the Fukushima Dai-ichi accident. It includes a liaison officer at the regional crisis management centre (ROT).

One of the measures that EPZ has defined as a result of the ENSREG-led stress test is the strengthening of data and voice communication means between the on-site emergency organisation and off-site organisations relevant for crisis management and support, refer to chapter 3 for a listing of such measures.

Another measure worth noting is the strengthening of external support for long-term support and for support under harsh conditions. The Dutch Army has a National Support Detachment that is very well suited to provide important equipment (like EDGs and mobile pumps), to provide personnel trained to damage repair under (radiological) harsh conditions, and to transport people and equipment under adverse conditions. In March, 2012, an exercise with the Army to arrange/deliver/connect a mobile EDG and to collect/deliver personnel (ERO and shift) to the required buildings while the site was flooded has been held. Although arranged on short notice and without pre-planned strategies for these tasks, the tasks were well executed. Yearly exercises have been agreed upon. Screenplays for different support scenarios will be developed as part of the EDMGs.

5.2.b Schedules and milestones to complete operator's planned activities

Information on operator's planned activities regarding improvement of communication means that are relevant for off-site emergency and response can be found in chapter 3.

5.2.c Preliminary or final results of activities including proposals for further actions

External support exercise with the Netherlands Armed Forces has been held March 3, 2012.

Yearly support exercises with the Netherlands Armed Forces have been agreed upon.

5.3 Activities performed by the regulator

5.3.a Discussion of activities taken or planned by the regulator

Activity: Exercise Indian Summer

Although not related to the Fukushima Dai-ichi accident, the large scale (1,000 staff) exercise Indian Summer is worth mentioning. This exercise involved staff of governmental bodies as well staff of the utility. Even two ministers were involved. Such exercises are periodically organised. Smaller exercises are organised more frequently. During their visit to the Netherlands the ENSREG Peer Review Team members noted such large scale exercises as a very good practice.

This exercise is evaluated by an external organisation and results will be sent to Parliament.

Activity: Operation of National Nuclear Assessment Team EPAn March-June 2011

During the response phase of the nuclear accident in Fukushima Dai-ichi, the National Nuclear Assessment Team EPAn was operational from March 12th to June 16th 2011. There was no radioactive threat or release in The Netherlands, thus EPAn mainly provided advice to the Ministry of Foreign Affairs and the Dutch Embassy in Tokyo.

EPAn advised customs and authorities of harbours and the national airport about inspections of ships with origin Japan and incoming planes. Measuring protocols were developed and standards were set for the inspection of goods (non-food) from airplanes and containers from ships. A protocol for the decontamination of container is being developed. The Netherlands Food and Consumer Product Safety Authority inspected food in accordance with European guidance.

Activity: Review of performance of EPAn after 'Fukushima Dai-ichi'

After the Fukushima Dai-ichi accident, no review has been performed of the full response and emergency framework. Nevertheless, there were two small reviews of parts of the response organisation and the performance *during* the Fukushima Dai-ichi accident of the involved departments:

Main conclusion of these small reviews was that the National Nuclear Assessment Team (EPAn) performed well during the Fukushima Dai-ichi accident.

It was also concluded that this accident caused a lot of work for the EPAn and claimed much of the resources of the EPAn organisation.

Activity: Analysis of required EPAn capacity

Any (nuclear) accident nearby or in the Netherlands will require much more resources of EPAn and other organisations. Therefore an analysis is planned of the capacity needed during an accident nearby or in the Netherlands in order to see if the present capacity is sufficient to manage such an accident.

Activity: Transparency and providing public information in the Netherlands

This section addresses public information about Fukushima Dai-ichi-related facts given in the context of the Dutch Government Information (Public Access) Act.

Under the Dutch Government Information (Public Access) Act, any person can request information related to an administrative matter as contained in documents held by public authorities or companies carrying out work for a public authority. As a basic principle, information held by public authorities is public, excluding information covered by the exceptions enumerated in the Act. In the second half of 2011 a lot of documents about the Dutch handling of the Fukushima Dai-ichi incident were published on the governmental internet website on requests of Greenpeace and the national television broadcasting organization NOS. The documents were amongst others related to the subject of the monitoring of shipments of radioactive materials following Fukushima Dai-ichi, the organization for managing a nuclear crisis in the Netherlands, and communication about Fukushima Dai-ichi in relation to the Dutch national policy on nuclear installations.

Activity: EPR module in IRRS mission in 2014

The planning of the IRRS mission has no direct link to the Fukushima Dai-ichi accident. The international review of EPR is in discussion. At least during the IRRS mission in 2014 one of the modules is related to EPR. At a later date an EPREV mission may be undertaken, but there is no fixed date yet.

Activity: Bilateral 'tuning' of EPR with Belgium, Germany and participation in HERCA WG Emergencies

To improve harmonization of the emergency preparedness and response (EPR) in the neighboring countries projects with Belgium and with Germany were started. The first step inventory of the principles and policies regarding nuclear emergency preparedness approaches in the countries has been started. The second step will be a comparison of these principles and define proposals for further harmonization and common policies.

One of the topics on the agenda of the Heads of the European Radiological Competent Authorities (HERCA) is emergency preparedness. A representative of the Dutch government participates in the working group which prepares proposals for harmonization at this subject.

Activity: Development of strategy for clearance of materials, e.g. for containers from accident region

After the Fukushima accident a study has started with the goal to develop a strategy for the clearance of contaminated material. In the first phase of the project, the focus is to achieve a standard for potentially contaminated products after a nuclear accident at a far distance from the Netherlands. In the second phase a strategy will be developed for an accident in the Netherlands or nearby the Netherlands.

5.3.b Schedules and milestones to complete regulatory body's planned activities

Refer to section 5.4 for a tabled survey of schedules and milestones.

5.3.c Conclusions of the regulatory body regarding the outcome of the operator's activities

Not applicable; activities relevant for this chapter for the most part are tasks for the regulator.

5.4 Tabled summary of items reported

Table 5-1 Emergency Preparedness and Response and Post Accident Management off-site

Activity	Activities by the Operator*			Activities by the Regulator*		
	(Item 2.a) Activity - Taken? - Ongoing? - Planned?	(Item 2.b) Schedule Or Milestones for Planned Activities	(Item 2.c) Results Available - Yes? - No?	(Item 3.a) Activity - Taken? - Ongoing? - Planned?	(Item 3.b) Schedule Or Milestones for Planned Activities	(Item 3.c) Conclusion Available - Yes? - No?
Topic 5 – EPR[21] & PAM[22] (offsite).						
Indian Summer large scale exercise, 1,000 staff participating[23], reoccurring event				Taken	October 2011, evaluation in 2012	Yes

[21] Emergency Preparedness and Response (EPR)
[22] Post Accident Management (PAM)
[23] It was noted by the ENSREG Peer Review, that such large scale exercises are a good practice

Activity	Activities by the Operator*			Activities by the Regulator*		
	(Item 2.a) Activity - Taken? - Ongoing? - Planned?	(Item 2.b) Schedule Or Milestones for Planned Activities	(Item 2.c) Results Available - Yes? - No?	(Item 3.a) Activity - Taken? - Ongoing? - Planned?	(Item 3.b) Schedule Or Milestones for Planned Activities	(Item 3.c) Conclusion Available - Yes? - No?
Lessons learnt 'Indian Summer' • Reviewing structure national assessment team EPAn; • Reviewing relation/structure EPAn with structure National Crisis Management System				• Ongoing • Ongoing	• 2012 • 2012	• No • No
WakeUp, 2-week long large scale exercise near various power stations of mechanised (army) brigade in cooperation with civil units. Reoccurring event. At NPP simulated flooding, with army to arrange & transport fuel, food & staff to predetermined buildings on-site, in accordance with plant's ERO[24] requirements.	Taken	March 2012	Yes			

[24] ERO: NPP's Emergency Response Organisation

Activity	Activities by the Operator*			Activities by the Regulator*		
	(Item 2.a) Activity - Taken? - Ongoing? - Planned?	(Item 2.b) Schedule Or Milestones for Planned Activities	(Item 2.c) Results Available - Yes? - No?	(Item 3.a) Activity - Taken? - Ongoing? - Planned?	(Item 3.b) Schedule Or Milestones for Planned Activities	(Item 3.c) Conclusion Available - Yes? - No?
Activation & operation of EPAn[25] nuclear assessment team after Fukushima Dai-ichi				Taken	Finished March 2011	Yes
Development of protocols for measurement, decontamination and clearance, applicable e.g. to clearance of containers, planes and other materials				Taken	Finished 2011	Yes
Review of operation of EPAn during & after Fukushima Dai-ichi				Taken	August 2011	Yes
Providing information to the public	Ongoing	No end date	-	Ongoing	No end date	-
IRRS mission in 2014 and preparations in 2012 and 2013, initiated before Fukushima Dai-ichi accident. This mission will include an EPR and 'Fukushima' module.				Planned	2012: preparation, 2013: self assessment & IRRS preparatory mission, 2014: IRRS mission	No

[25] National Nuclear Assessment Team - EPAn

Activity	Activities by the Operator*			Activities by the Regulator*		
	(Item 2.a) Activity - Taken? - Ongoing? - Planned?	(Item 2.b) Schedule Or Milestones for Planned Activities	(Item 2.c) Results Available - Yes? - No?	(Item 3.a) Activity - Taken? - Ongoing? - Planned?	(Item 3.b) Schedule Or Milestones for Planned Activities	(Item 3.c) Conclusion Available - Yes? - No?
Bilateral 'tuning' of EPR with Belgium, Germany and participation in HERGA WG Emergencies				Planned	2013	No
Development of strategy for clearance of materials, e.g. for containers from accident region.				Ongoing	End 2013	No

6. International Cooperation

Contracting Parties are expected to report on actions that have been taken, or are planned, to enhance international cooperation, including:

- Changes in status with respect to the safety conventions;
- Mechanisms for communicating with neighbouring countries and the international community;
- Cooperation with international organizations;
- Cooperation in the frame of international working groups;
- Hosting international peer reviews;
- Sharing international operating experience; and
- Utilization of IAEA safety standards.

6.0 Introduction to contributions of the Netherlands to international cooperation

The regulatory body in the Netherlands has always participated in the most important international organisations like OECD/NEA, IAEA and Euratom. Also the Netherlands is a 'Contracting Party' to various (nuclear safety-related) conventions.

International cooperation

Regular exchange meetings are taking place with Germany and Belgium, also in relation with post-Fukushima Dai-ichi lessons learned. Other ways of communications are established through the incident reporting and communication channels that are well established (e.g. IAEA/NEA IRS[26], IRSRR[27], INES, NEA/CNRA/WGPC[28]).

International organisations, apart from the above mentioned, with which there is cooperation are for instance WENRA, ENSREG, EUROSAFE Forum, HERCA[29] and NERIS[30].

The regulatory body in the Netherlands participates in working groups of IAEA (Safety Standard Committees), WENRA (reactor harmonisation working group), and ENSREG (nuclear safety, decommissioning/waste). There is also cooperation in various OECD/NEA committees like the NEA/CSNI[31] and NEA/CNRA[32] and their working groups. Examples of CNSI-groups are WGFS, WGAMA, WGRISK, WGHOF, and WGIAGE. CNRA-groups are WGIP and WGOE.

Peer reviews

International peer reviews have always been part of the strategy for improvement. Regularly OSART (once in 10 years) and INSARR missions are invited. Also there is a lot of experience with other missions like IPSART, AMAT/SALTO, IPPAS, and Waste Safety Appraisal. In 2014 there will be an IRRS mission. Members of the regulatory body have participated in several missions to France, Germany and Sweden.

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[26] IRS: IAEA and OECD/NEA Incident Reporting System, using operational experience to improve safety
[27] IRSRR: Incident Reporting System for Research Reactors at the IAEA
[28] NEA/CNRA/WGPC: Working Group on Public Communication of Nuclear Regulatory Organisations
[29] HERCA: Heads of the European Radiological protection Competent Authorities
[30] NERIS: European platform on preparedness for nuclear and radiological emergency response and recovery
[31] CSNI: Committee on the Safety of Nuclear Installations
[32] CNRA: Committee on Nuclear Regulatory Activities

Regulation

Not related to Fukushima Dai-ichi, an update and extension of Dutch Safety Rules (which are based on IAEA-requirements and guides) has been introduced for the existing NPP. In the project for new build of NPPs a new regulation framework is developed based on IAEA requirements.

Implementation of COUNCIL DIRECTIVE 2009/71/EURATOM of 25 June 2009 on nuclear safety has no direct relation with the Fukushima Dai-ichi accident.

The Netherlands has brought this directive into force on July 22, 2011: Regulation of the Minister of Economic Affairs, Agriculture and Innovation and the Minister of Social Affairs and Labour of 18 July 2011, No WJZ/11014550, concerning the implementation of Directive No 2009/71/Euratom of the Council of the European Union 25 June 2009 establishing a Community framework for nuclear safety of nuclear installations (PB EU L 172/18). The Netherlands forth withed to inform the European Commission thereof. This regulation prescribes the systematic evaluation and investigation of the nuclear safety of nuclear installations during the lifetime of the nuclear installation. Also, the regulation prescribes inter alia that:

- Licensees should give sufficient priority to nuclear safety systems;
- Licensees must provide adequate human and financial resources to meet the obligations on the nuclear safety of a nuclear installation;
- All parties, including the licensee, are required to provide a mechanism for educating and training their staff responsible for the safety of nuclear plants to meet the expertise and competence in the field of nuclear safety to be maintained and developed.

6.1 Overview of topic analysis

In the following paragraphs the evaluations of the international activities are described as performed by utility EPZ and the regulatory body, the latter constituted by ELenI/NIV and ILT/KFD.

6.2 Activities performed by the operator

6.2.a Discussion of activities taken or planned by the NPP operator

The operator has performed self assessments proposed by WANO and performed the European ENSREG defined stress test (all in 2011). Furthermore in March 2012 it received a Peer Review team of ENSREG. It has a long lasting practice of hosting IAEA missions. In chapters 1 – 3 of the present report, the activities coordinated by ENSREG have been addressed.

A WANO Peer Review is scheduled to begin end of September 2012. This review had been arranged prior to the Fukushima Dai-ichi accident, but as a result from this accident WANO has expanded its review scope to include Emergency Preparedness.

The operator actively collects relevant information from workshops, conferences, regular participations in experience-feedback working groups (WANO, VGB), etc.

Several VGB[33] working groups (notable the Technical Committee Nuclear Power Plants, the Working Group Crisis Staff Coordinators, the ad-hoc Working Group Mobile EDGs) in the nuclear field are active in 'post-Fukushima' experience exchange and in the development of mitigation strategies. The WG Mobile EDGs, for example, is developing strategies for the use of small (mobile) EDGs.

[33] VGB is a technical association for power and heat generation. It is a non-profit organisation and voluntary association of companies of power plant operators and manufacturers.

6.2.b Schedules and milestones to complete operator's planned activities

The ENSREG led review activities have been addressed in chapters 1 – 3 of the present report.

6.2.c Preliminary or final results of activities including proposals for further actions

Results of the ENSREG led review activities have been addressed in chapters 1 – 3 of the present report.

6.3 Activities performed by the regulator

6.3.a Discussion of activities taken or planned by the regulator

Implementation IAEA Action plan

- The IAEA action plan is considered as a leading document for a number of regulatory body activities. Examples are the invitation of an OSART mission, earlier than originally planned and a competence analysis.

Participation in ENSREG-led Peer Review of the European stress test

The regulatory body participated in the ENSREG led Peer Review of the stress tests performed in the European Union. Regulator staff visited various countries. The Netherlands hosted a European Peer Review team that assessed the stress test of the Borssele NPP and its assessment by the regulatory body.

In addition, there is an increased activity in WENRA-led activities.

Communication with Belgian counterparts during assessment of stress tests of NPPs

During the assessment by the regulatory body, there was communication with the Belgian counterparts (FANC). A project meeting in the Netherlands was visited by FANC and Dutch representatives attended a meeting in Belgium.

Bilateral 'tuning" of EPR with Belgium, Germany and participation in HERGA WG Emergencies

In the regular bilateral the subject harmonization of emergency preparedness is addressed. With Belgium and with Germany a project has been started which aims at further harmonization. EL&I/NIV, IenM/ILT/CM, IenM/ILT/KFD and RIVM are involved in the project.

One of the topics on the agenda of the Heads of the European Radiological Competent Authorities (HERCA) is emergency preparedness. A representative of the Dutch government participates in the working group which prepares proposals for harmonisation at this subject.

Participation in international post-Fukushima Dai-ichi activities

Within the regulatory body it has been decided to follow the international post-Fukushima Dai-ichi activities as far as reasonably achievable. This means that one will mainly try to follow related international activities like conferences and workshop organized by IAEA, NEA and EU. But also the activities and results of individual countries will be closely followed. The reporting on the CNRA-website, the EU-stress test outcomes and the national reports to the CNS are important sources of information. After Fukushima Dai-ichi it was decided to participate in some extra gremials considered important for improvement.

Participation in IAEA- and OECD-led efforts

The regulatory body participates in the activity of the extraordinary CNS meeting, report preparation, analysis of the reports and the meeting itself. In 2011 a member of the ILT/KFD branch became member of and participated in the IAEA Steering Committee on Human Resources for Regulatory Bodies.

It is planned to invite IAEA to provide training to the ILT/KFD branch in the area of competence building (IAEA-action plan item).

Since 2012 the ILT/KFD branch is member of the CNRA Special Task Group on Fukushima Dai-ichi Lessons Learned. ILT/KFD will take part in further forthcoming activities as necessary and reasonably possible.

Missions planned: IPSART and OSART

In 2013 ILT/KFD will host an IPSART follow-up mission and an OSART mission (IAEA-action plan item). As far as possible, post-Fukushima Dai-ichi related adaptations will be implemented.

KFD-Ambition document

ILT/KFD has concluded an ambition document for long term international participation. The increased Fukushima Dai-ichi activities combined with the effective capacity in 2012 limits the international activities that are not directly Fukushima Dai-ichi related. It is expected that from 2013 on the international presence will grow to the level that has been decided in the ambition document.

6.3.b Schedules and milestones to complete regulatory body's planned activities

Refer to section 6.4 for a tabled summary of schedules and milestones.

6.3.c Conclusions of the regulatory body regarding the outcome of the operator's activities

Not applicable to this chapter.

6.4 Tabled summary of items reported

Table 6-1 International cooperation[34]

Activity	Activities by the Operator*			Activities by the Regulator*		
	(Item 2.a) Activity - Taken? - Ongoing? - Planned?	(Item 2.b) Schedule Or Milestones for Planned Activities	(Item 2.c) Results Available - Yes? - No?	(Item 3.a) Activity - Taken? - Ongoing? - Planned?	(Item 3.b) Schedule Or Milestones for Planned Activities	(Item 3.c) Conclusion Available - Yes? - No?
Topic 6 – International Cooperation						
Participation in ENSREG Peer Review 2011/2012; being reviewed and participating in review missions to other countries				Taken	Jan – March 2012	Yes
Communication with Belgian counterparts during EU stress test in 2011				Taken	Finished 2011	Yes
Bilateral 'tuning' of EPR with Belgium, Germany and participation in HERGA WG Emergencies				Planned	2013	No

[34] Several of the actions mentioned in this and other tables of the report are related to the IAEA action plan.

Activity	Activities by the Operator*			Activities by the Regulator*		
	(Item 2.a) Activity - Taken? - Ongoing? - Planned?	(Item 2.b) Schedule Or Milestones for Planned Activities	(Item 2.c) Results Available - Yes? - No?	(Item 3.a) Activity - Taken? - Ongoing? - Planned?	(Item 3.b) Schedule Or Milestones for Planned Activities	(Item 3.c) Conclusion Available - Yes? - No?
Topic 6 – International Cooperation						
Missions 2013, IPSART and OSART, including post Fukushima Dai-ichi updates				Planned	2013	No
IRRS mission in 2014 and preparations in 2012 and 2013, initiated before Fukushima Dai-ichi accident. This mission will include an EPR and 'Fukushima' module				Planned	2012: preparations[35], 2013: self assessment & IRRS pre mission, 2014: IRRS mission.	

[35] Related to this, the Dutch regulator has contact with its German and Swedish counterparts that were subjected to IRRS missions before.

Appendix A Post-Fukushima measures, procedures and studies

In the ENSREG-led stress test performed in all European Member States[36] licensees of NPPs were obliged to produce so-called Licensee Reports of their NPPs. These reports were in a prescribed format and addressed scenarios postulated by ENSREG.

In the Netherlands, the licensee EPZ in its Licensee Report has proposed various measures, alterations and extensions of its procedures and topics for further study. In principle the regulatory body endorses most improvements proposed. However, before implementation, their effectiveness needs to be assessed.

The licensee in its proposals for further studies suggests to implement some of them in the PSR (10EVA13) that is being undertaken. The regulatory body will consider if all or some of these studies should be undertaken as part of the current PSR, and/or if a separate track is needed to perform these studies.

Below licensee's full set of tabled and numbered proposals is reproduced in the subsections A.1 (Measures), A.2 (Procedures) and A.3 (Studies). Each table is followed by regulatory position statements related to a selection of some important issues. Where applicable in the position statements, reference is made to licensee's numbered proposals (format: Mx, Px, and Sx).

A.1 Measures

No.	Measure proposed by licensee EPZ
M1	Emergency Response Centre facilities that could give shelter to the emergency response organisation after all foreseeable hazards would increase the options of the emergency response organisation.
M2	Storage facilities for portable equipment, tools and materials needed by the emergency response organisation that are accessible after all foreseeable hazards would increase the possibilities of the emergency response organisation.
M3	A possibility for refilling the spent fuel pool without entering the containment would increase the margin to fuel damage in certain adverse containment conditions.
M4	Additional possibilities for refilling the spent fuel pool would increase the number of success paths and therefore increase the margin to fuel damage in case of prolonged loss of spent fuel pool cooling.
M5	Reduction of the time necessary to connect the mobile diesel generator to Emergency Grid 2 to 2 hours would increase the margin in case of loss of all AC power supplies including the SBO generators.
M6	Establishing the ability to transfer diesel fuel from storage tanks of inactive diesels to active diesel generators would increase the margin in case of loss of off-site power.
M7	Establishing independent voice and data communication under adverse conditions, both on-site and off-site, would strengthen the emergency response organisation.
M8	Ensuring the availability of fire annunciation and fixed fire suppression systems in vital areas after seismic events would improve fire fighting capabilities and accident management measures that require transport of water for cooling/suppression.
M9	By increasing the autarky-time beyond 10 h the robustness of the plant in a general sense

[36] The stress test was also performed in non-member states Ukraine and Switzerland.

No.	Measure proposed by licensee EPZ
	would be increased.
M10	Ensuring the availability of the containment venting system TL003 after seismic events would increase the margin in case of seismic events.
M11	Wave protection beneath the entrances to the bunkered back-up injection- and feedwater systems and to the bunkered emergency control room would mitigate the sensitivity to large waves combined with extreme high water and would make the plant fully independent from the dike.

Regulatory position statements on measures

The improvement of the accessibility under extreme conditions of rooms, warehouses and others which house (reserve) equipment needed for severe accident management (M2) is important. It should also take into account a re-evaluation of dose rates in these areas for representative scenario's.

Improvement of the possibilities to sustain cooling of the spent fuel pool (SFP) under all foreseeable conditions and replenish its water (M3). Any implementation should keep dose to workers ALARA. Some possibilities have been mentioned in the Licensee Report but they need further study before implementation.

The fire fighting systems in buildings 01/02 (dome) and 35 (backup control room) are not designed for operability after occurrence of the design base earthquake (DBE). To enhance their reliability after a DBE they should be qualified. However, any enhancement should be based on the results of the proposed advanced seismic analysis. This position is linked to licensee's proposal S3 but also (for implementation) to its measure M8.

Technical and organisational improvement of availability under earthquake conditions of systems for containment filtered venting and fire fighting (M8, M10). However, any enhancement should be based on the results of the proposed advanced seismic analysis.

Increasing the autarky time beyond 10 hours (M9). The autarky time is the time that the plant is kept in a controlled, stable state without the need for human interaction[37]. This measure requires further study to define its proper implementation.

A.2 Procedures

No.	Procedure (or its development) proposed by EPZ
P1	Develop a set of Extensive Damage Mitigation Guides (EDMG) and implement a training program. Below are examples of the issues to be addressed:

[37] The autarky time allows bridging the time between an external event that disables the crew, and the arrival of a replacement crew. Autarky time is an entirely different quantity than the autonomy time. The autonomy time of the KCB is much longer than its autarky time. The autonomy time is the time that the plant can be kept in a controlled, stable state without the need for off-site supply of equipment or consumables. It allows bridging the time between an external event with extensive infrastructural damage, and the arrival of replacement equipment, emergency equipment or consumables (diesel, water).

No.	Procedure (or its development) proposed by EPZ
	Description of the alternative ways to replenish the fuel storage pool
	Injection of fire water directly into the fuel storage pool by a flexible hose
	Cooling the fuel storage pool by TG080/VE supplemented by UJ
	Connection of TN to the suction side of the fuel storage pool cooling pumps
	Procedure for spent fuel pool cooling (over spilling, make up)
	Flexible hose connections to the TG system and the spent fuel pool
	Procedures to staff the Emergency Control Room
	Procedure for direct injection of VE by UJ
	Use of autonomous mobile pumps
	Possible leak repair methods for larger pool leakage
	Procedure to transport own personnel to the site
	Procedure for the employment of personnel for long term staffing
	Connecting CCB/NS1
	Uncoupling of lower rails in time in case of flooding
	Alternative supplies for UJ
P2	By training of the procedure ensure that during mid-loop operation, the actions for water supply that are needed in case of loss of all AC power supply, are performed in a timely manner.
P3	Develop check-lists for plant walk-downs and the necessary actions after various levels of the foreseeable hazards

Regulatory position statements on (development of) procedures

Regarding severe accident management (SAM) measures, some aspects need further addressing like long-term measures. Furthermore the effectiveness of some procedures may need to be established by conducting tests. It is understood that internal rules exist for the chain of command under crisis conditions. However training of long-term SAM measures should improve the reliability of existing procedures under these conditions.

The licensee is in the process of developing a set of Extensive Damage Mitigation Guidelines, the EDMGs (P1). This is a model developed by industry, specifically in the USA. The regulatory body endorses the idea of developing the EDMGs, but can not review it yet since its development by utility EPZ has not been completed yet.

It is recommended that the systems, structures and components (SSCs) important to handle severe accidents will be tested functionally (as far as they are applied past their suitable qualification) and their handling be trained according to procedures that need to be established.

A set of clear criteria needs to be established as a basis for deciding when to switch the turbine oil pump off to increase the battery time. Disabling this pump will damage the turbine.

A.3 Studies

No.	Study proposed by EPZ
S1	A reserve spent fuel pool cooling system that is independent of power supply from the emergency grids could expand accident management possibilities. In 10EVA13 this will

No.	Study proposed by EPZ
	be investigated.
S2	In 10EVA13 measures will be investigated to further increase the safety margins in case of flooding.
S3	Uncertainty of the seismic margins can be reduced by a Seismic Margin Assessment (SMA) or a Seismic-Probabilistic Safety Assessment (Seismic-PSA). In 10EVA13 either a seismic-PSA will be developed and/or an SMA will be conducted and the measures will be investigated to further increase the safety margins in case of earthquake
S4	In 10EVA13 the possibilities to strengthen the off-site power-supply will be investigated. This could implicitly increase the margins in case of loss-of-offsite power as it would decrease the dependency on the SBO generators.
S5	More extensive use of steam for powering an emergency feed water pump and for example an emergency AC generator could increase the robustness in case of loss of all AC power supplies including the SBO generators.
S6	Uncertainty in the margins with respect to airplane crash could be reduced by performing a more extensive study of the impact on the safety functions of different airplane crashes.
S7	In previous periodic safety reviews an extensive set of formal analyses has been performed to address the threats of hydrogen to the containment. In 10EVA13 these studies will be reviewed and where necessary renewed and extended.

Regulatory position statements on topics for further study

Flooding (S2): the regulatory body has the opinion that the impact of floods with a very long return period (e.g. ten thousand, one hundred thousand or one million years) is not known in much detail yet and further assessment is recommended. Several governmental bodies are involved in the assessment of the adequacy of the protection of the Netherlands against flood risks. Models have been developed and continuously are being improved to aid this assessment. It is recommended that a reassessment tailored to the needs of the Borssele site be undertaken considering: (1) given a specified return period the maximum challenge a flood will pose to the NPP and its dykes, (2) the various failure mechanisms of the dykes, (3) the impact of the maximum challenge by floods on the safety of the NPP, and (4) the various options to protect the plant against this challenge like improving dykes and/or adding other engineered structures.

Earthquakes (S3): the Licensee Report states that the licensee plans to perform a seismic PSA or a Seismic Margin Assessment, a SMA. The regulatory body endorses this proposal. It is known that the Netherlands Royal Meteorological Institute (KNMI) will contribute data and knowledge to this project. In the seismic study attention should be given to among others characterization of the subsurface of the site and possible seismic impact of foreseeable future mining activities in the neighbourhood.

Extreme weather: heavy rain does not pose extreme challenges to the plant. A special case is the accumulation of water resulting from fire-fighting activities if drain pipes are blocked. The possible consequences of this need to be studied. Further recommended topics for additional study are: the minimum depth of underground piping required for proper protection against freezing, possibility to operate diesel generators at extremely low temperatures and the potential effect of accumulation of wind-transported snow on roofs.

Severe accident management (SAM): the Licensee Report presents a SAM-strategy which uses existing resources and equipment based on its availability, including those designed for the control of design base accidents or non-nuclear class components. This is a common and acceptable approach for accident management past the design basis and for the purpose of the stress test this is acceptable too. However further assessments are recommended to establish the validity of the assumptions made regarding the associated SSCs. It is recommended to evaluate whether an upgrade of the equipment and/or instrumentation especially tailored to SAM needs is necessary and/or feasible. The proper qualification and classification of the SSCs needed for SAM should be part of the study Related topic for study are:

The various alternative power sources should be re-evaluated. As an alternative to emergency grid 2 (NS2) licensee mentions the emergency diesel generator (EDG) of the coal-fired plant, however this is not a nuclear class component and not tested for the purpose. The mobile EDG (EY080) currently needs off-site support, which can not relied upon in all crisis situations. Also procurement arrangements for externally supplied EDGs are mentioned, which still have to be concluded. Some crisis conditions may make it impossible to transport an EDG to the site. Alternate and independent means to recharge batteries should also be part of the study.

Connection equipment and connection points for power sources, fuel resources etc. are available. Their ease of use and availability for all foreseeable circumstances should be analysed.

In the Licensee Report, the fire fighting pond of the nearby coal-fired unit (CCB) is mentioned as an alternative resource (1,600 m^3) for cooling water. Investigation into the actual usefulness and availability of this resource is recommended.

Appendix B ENSREG Country Peer Review of the Netherlands

Final Report 2012

Post-
Fukushima
accident

Netherlands

Peer review country report

Stress tests performed on European nuclear power plants

ENSREG
European Nuclear Safety Regulators Group
Stress Test Peer Review Board

1 GENERAL QUALITY OF NATIONAL REPORT AND NATIONAL ASSESSMENTS

The accident at the Fukushima nuclear power plant in Japan on 11th March 2011 triggered the need for a coordinated action at EU level to identify potential further improvements of Nuclear Power Plant safety. On 25th March 2011, the European Council concluded that the safety of all EU nuclear plants should be reviewed, on the basis of comprehensive and transparent risk and safety assessments - the stress tests. The stress tests consist in three main steps: a self-assessment by licensees, followed by an independent review by the national regulatory bodies, and by a third phase of international peer reviews. The international peer review phase consists of 3 steps: an initial desktop review, three topical reviews in parallel (covering external initiating events, loss of electrical supply and loss of ultimate heat sink, and accident management), and seventeen individual country peer reviews.

Country review reports are one of the specific deliverables of the EU stress tests peer review process. They provide information based on the present situation with respect to the topics covered by the stress tests. They contain specific recommendations to the participating Member States for their consideration or good practices that may have been identified, and to some extend information specific to each country and installation. Draft country review reports were initiated during the topical reviews based on discussions with the country involved in the three topics and on the generic discussions within each of the three topical reviews. Issues identified for each country during the topical reviews, due to only limited time available for each country, have required follow-up discussions in more detail, both between the topical reviews and the country reviews, and during the country reviews.

The current National Report was finalized at the end of the Country Review, after final discussion with the reviewed country and visit of nuclear power plant (NPP). It is a part of the Final Report combining the results of the Topical Reviews and Country Reviews.

1.1 Compliance of the national reports with the topics defined in the ENSREG stress tests specifications

The Netherlands' National Report on the Post-Fukushima stress test for the Borssele Nuclear Power Plant (National Report) was submitted to the European Commission by the Dutch Ministry of Economic Affairs, Agriculture & Innovation (EL&I) in December 2011. The National Report in general is compliant with the specifications defined by ENSREG. All topics defined in the ENSREG stress tests specifications are addressed. The report encompasses the single operating nuclear power plant in the Netherlands – Borssele NPP. The plant consists of a single unit, designed by Kraftwerk Union (KWU), Germany, and operated by the licensee Elektriciteits-Produktiemaatschappij Zuid-Nederland EPZ (EPZ).

1.2 Adequacy of the information supplied, consistency with the guidance provided by ENSREG

The national report basically addresses all relevant issues related to earthquakes and flooding, but the information available on the assessment of extreme weather conditions is very limited. Adequate information has been provided during the country session, satisfying the requirements in the ENSREG specifications.

Regarding the loss of electrical power and loss of ultimate heat sink, some information is missing (system drawings/schematics, analyses of incident scenarios when the steam generators are not available, national regulation requirements), but has also been provided during the peer review process.

The information supplied in regard to the management of severe accidents, supported by additional information provided during the peer review process, complies very well with the guidance provided in the ENSREG stress tests specification. The report is of a very good quality, suggesting an in-depth and challenging review has been conducted by the regulator. The report provides information in sufficient detail in most areas to allow commensurately detailed questions to be asked in the peer review process.

1.3 Adequacy of the assessment of compliance of the plants with their current licensing/safety case basis for the events within the scope of the stress tests

In general the information provided in the National Report is sufficiently adequate and it is also consistent with the ENSREG guidance.
The current version of the Dutch safety rules came into force end of May 2011, when the last version of the license was issued to Borssele NPP. The safety requirements in the Netherlands are based on the International Atomic Energy Agency (IAEA) requirements with adaptions, including the Western European Nuclear Regulators' Association (WENRA) Reference Levels. During the preparation of the implementation of the new safety rules, the state of compliance was checked by the regulator. It was confirmed that a large majority was already complied with. It was decided to allow more time for implementation of the design requirements through the process of Periodic Safety Review (PSR). The other requirements are to be complied with immediately. It is part of the PSR approach that if deviations with large safety impact are detected, the correction will be made as soon as reasonably possible, and if necessary the reactor will be shut down. During the evaluation phase of PSR which will be finished by the end of 2013, both the licensee and regulator verify compliance with existing and modern regulations. Deviations will have to be solved within four years after 2013, unless due justification is provided and agreed with the Regulator.
The report provides satisfactory evidence that the plant is in compliance with its current licensing basis for all external events: earthquakes, flooding and extreme weather conditions. Inspections and PSR are tools applied for assessment. The report identifies explicit work to demonstrate ongoing compliance with external events safety cases.
Also with respect to the Loss of Off-site Power (LOOP), Station Black Out (SBO), primary Ultimate Heat Sink (UHS) loss, and primary UHS loss together with SBO, the information provided is generally satisfactory, although comprehensive and unambiguous information on the current licensing and safety basis for the Borssele NPP is missing but more information was provided during the country visit.
The Dutch regulator has conducted a thorough review, looking in depth at severe accident management within the remit of the stress tests. It is confirmed that requirements for severe accident management are addressed explicitly within the Dutch regulatory framework. Based on this review, the Dutch regulator is confident that the licensee is in compliance with its current licensing basis, though it is noted that there are no detailed reviews of compliance in individual sections of the national report to back-up this assertion. Nevertheless, no deviations have been highlighted through the stress tests process, though a number of improvements to reduce or mitigate risks have been identified. No evidence was presented during the ENSREG peer review process to suggest any non-compliance with the Dutch licensing basis in regard to severe accident management.

1.4 Adequacy of the assessments of the robustness of the plants: situations taken into account to evaluate margins

The safety margins beyond design basis are described and discussed in the report. The margins for seismic events and flooding are basically assessed, with limited identification of cliff edge effects and weak points. Margins for extreme weather are not quantified in the report. The assessment has been performed, basically, on the engineering judgement basis or by simplified methods. A more comprehensive assessment of all external hazards is being done in the ongoing PSR. The assessment provided in the Partner National Report encompasses many various situations linked to loss of power and ultimate heat sink events. Nevertheless, adequacy of the assessments of the robustness of the Borssele NPP is not clear as far as information on transient/incident scenario analysis for all initial plant operational conditions is not presented. The results of scenarios presented in the report may be understood provided for "steam generators available" plant state, although scenarios linked to "open primary circuit" and "core in spent fuel pool" plant states shall be analysed as well. The National report gives no time constraints linked to cliff edge effects such as time to core (fuel) damage, nevertheless they were presented during peer review. The Dutch report addresses all the constituents

that, based on international guidance, would be expected for the management of severe accidents. This includes organisational arrangements of accident management and emergency planning, hardware measures to be used in case of a severe accident, (e.g. depressurization, hydrogen management, corium stabilization etc) as well as procedures (Emergency Operating Procedures (EOP) and Severe Accident Management (Guidelines)(SAMG)). These arrangements are already well-established at Borssele, though a number of improvements are also in progress / being considered.
The results of the assessments of margins for earthquake, flooding and extreme meteorological conditions, as well as those for loss of electric power and loss of ultimate heat sink, have been taken into account in the severe accident management section of the Dutch report.

1.5 Regulatory treatment applied to the actions and conclusions presented in national report (review by experts groups, notification to utilities, additional requirements or follow-up actions by Regulators, openness,…)

The comments of the regulatory authority concerning the licensee's analysis and conclusions are presented. It is reported that the regulator is ready to endorse measures proposed by the licensee after assessment of its effectiveness. Nevertheless, the regulatory authority stressed some problems as inadequately addressed and made a few additional recommendations. Regulatory treatment of the provided information and proposed actions seems to be adequate.
The Dutch national report was prepared by its regulatory body, with support from the German TSO (Technical Support Organisation) GRS. The regulatory body appears to have taken a proactive approach to the stress tests work, looking not only at the submitted report, but also at other safety documentation produced in the past by the licensee, and drawing from its history of regulatory interaction. The report also documents other interactions, including meetings with the licensee and a site visit.
The key lessons learned from the stress tests and ENSREG peer review exercise relating to severe accident management are the need for better qualification / substantiation of Structures, Systems and Components (SSCs) required in severe accidents; improvements in the effectiveness of existing procedures and guidance, specifically for long term scenarios and the need for timely implementation of the identified improvements.
A broad implementation plan has been proposed by the licensee. During the peer review the regulator has provided information that the licensee was asked to refine this by adding a firmer time schedule to the plan. By 1st of March 2012 a list of improvements to be addressed in 2012; by 1st of June the list of the remaining improvements. It will be decided if and which measures are handled within the plant's current PSR to be delivered in 2013 .

2 PLANT(S) ASSESSMENT RELATIVE TO EARTHQUAKES, FLOODING AND OTHER EXTREME WEATHER CONDITIONS

2.1 Description of present situation of plants in country with respect to earthquake

2.1.1 DBE

2.1.1.1 Regulatory basis for safety assessment and regulatory oversight (national requirements, international standards, licensing basis already used by another country,…)

The Netherland's legislation does not specify a definition of Design Basis Earthquake (DBE) in terms of a ground motion level or occurrence probability. The operator demonstrates the resilience of the plant against a certain DBE. This documentation together with the results of SHA needs to be accepted by the regulator. It is stated that IAEA documents are "part of the license".

2.1.1.2 Derivation of DBE

The original design of the plant, which started operation in 1973, does not consider seismic loads. Seismic Hazard Assessment (SHA) has been performed in 1993 and updated in 1995. According to the licensee, the DBE corresponds to Peak Ground Acceleration (PGA)=0.6m/s² (PGA=0.06g) at the ground level and PGA=0.75m/s² (PGA=0.076g) at foundation base. The licensee's judgement of the DBE refers to German KTA standards (KTA 2201.1, KTA 2201.2).

2.1.1.3 Main requirements applied to this specific area

The DBE was established using a deterministic approach by adding one degree of intensity to the maximum intensity observed due to the strongest observed earthquake in the region (Zulzeke-Nukerke, 1938; M=5.6; I_{loc}=5.5MMI (Modified Mercalli Intensity). The DBE is therefore defined by I=6.5MMI. Additional PSHA revealed that this ground shaking level is related to a medium return period of 30.000 years.

Liquefaction is recognized as a potential hazard. The licensee explains that the probability for liquefaction is much lower than the DBE as higher PGA and longer earthquake durations are needed to cause such phenomena. It is further claimed that liquefaction will cause "no instability of the plant anyway".

2.1.1.4 Technical background for requirement, safety assessment and regulatory oversight (Deterministic approach, PSA, Operational Experience Feedback)

DBE value is not explicitly required by regulator. DBE was established by licensee, later than the original design, using a deterministic approach and updated during the PSR. The PSR starting now (2012) will include state-of-the-art seismic analysis and seismic data will be assessed according to IAEA NS-G-2.13, as reported in the presentation session of the country.All SSCs required to support the safety functions are identified, classified and designed to withstand the DBE.

2.1.1.5 Periodic safety reviews (regularly and/or recently reviewed)

PSRs are regularly conducted in ten years intervals. Information on the past PSRs is contained in the National Report. Such reviews were carried out in 1984, 1993 and in 2003. The next PSR will be submitted in 2013.

PSRs have lead to the implementation of seismic qualification of the plant, which was not originally designed to withstand seismic loads, and to installation of additional safety features (for instance in 1986: additional protection by "Bunker Concept" to improve the safe shutdown of the plant under external events as earthquake, flooding and malevolent actions beyond the original design basis; in 1997: emergency control room, second ultimate heat sink, additional larger and spatially separeted diesel generators; in 2006: autonomy time increased to 72h after accident, higher protection limits against floods).

SHA has been reviewed as part of the Safety Assessment Report (SRA) in the early 1990s and during International Probabilistic Safety Assessment Review Team (IPSART) missions.

2.1.1.6 Conclusions on adequacy of design basis

In the National Report no clear statement is given on the judgement of the adequacy of the design basis for Borssele NPP. Reviewers note that a DBE of PGA=0.06g (PGA=0.076g at foundation level), which has been established for the plant, is below the IAEA's suggested minimum of PGA=0.1g. As clarified during the country visit, a comprehensive SHA is being performed within the framework of the ongoing PSR and will include also liquefaction. This SHA will take account of the state of the art and consider a PGA value of 0.1g at free field for the DBE, as per IAEA guidance.

The Borssele NPP is in a region with low seismicity. In view of this fact, of the result of the margin assessment (0.15g) and of the coming comprehensive seismic analysis ,the regulator considers the present analysis as adequate.

According to the licensee and the regulator the DBE used for Borssele NPP applies German standards and is considered to be justified due to low seismic activity in the area. However, the regulator considers that the information and methods used in derivation of DBE should be updated in accordance with present state of the art.

The plant has no seismic instrumentation. The regulator points further out that possible effects by human–induced earthquakes e.g. gas drilling activity in the Northern part of the Netherlands and shale drilling in Noord-Brabant should be considered too.

2.1.1.7 Compliance of plant(s) with current requirements for design basis

The regulatory position is that the plant complies with its current licensing basis. The position is based on decades of regulatory oversight.

2.1.2 Assessment of robustness of plants beyond the design basis

2.1.2.1 Approach used for safety margins assessment

No seismic PSA and seismic margin assessment (SMA) has been done in the past. The PSA shows that seismic hazard contributes less than 5.4% to the total core damage frequency (for full power state). No detailed fragility analysis was done.
According to the Licensee's report, elements of the EPRI NP-6041 method were used for the margins assessment, together with data from earthquake studies and experience at the German NPP of Neckarwestheim I and the Swiss NPP of Gosgen.
For buildings and SSCs designed for seismic loads a screening value of 0.3 g (EPRI NP-6041 screening value, median NUREG/CR-0098 spectrum) was used and the HCLPF capacity was determined for functions (e.g. subcriticality, decay heat removal) on the basis of the 0.3 g screening value. For the reactor building the HCLPF capacity was estimated to a value of 0.15 g.
A full scale seismic margins assessment is scheduled in the ongoing PSR.

2.1.2.2 Main results on safety margins and cliff edge effects

The result of the EPRI study was that for most safety relevant SSC's the 0.3g PGA value could be verified. A minimum value for all safety relevant SSC's was 0.15 g. The HCLPF capacity for many safety-relevant systems and buildings is higher. A list of the SSCs considered in the analysis is provided in the licensee report.
The seismic load leading to loss of containment integrity is stated as 0.3g. No detailed fragility analysis is available. The report concludes that "earthquakes up to an intensity of VII-VIII (VII½) (i.e. exceeding the DBE by one degree of intensity) will not lead to core damage or confinement failure under high confidence".
The following potential "cliff-edge" effects were identified in the review: failure of confinement integrity in case of earthquakes with ground motion exceeding about 0.30g; unavailability of staff limiting accident management after about 10 hours; inoperability of some conventional fire fighting systems which are not seismically qualified; failure of the containment filter venting which is also not seismically qualified.

2.1.2.3 Strong safety features and areas for safety improvement identified in the process

Accident management and mitigation might be endangered after a beyond DBE due to a potential inaccessibility of staff to the site, unavailability of the main control room, and non seismic-classified fire-fighting and containment filtered venting systems. Overall, emergency preparedness and accident mitigation should be enhanced.

2.1.2.4 Possible measures to increase robustness

The related modifications / investigations that according to the licensee could be envisaged are:
- establishment of an additional Emergency Response Centre
- storage facilities for portable equipment, tools and materials needed by the alarm response organization that are accessible after all foreseeable hazards would enlarge the possibilities of the alarm response organization;
- ensuring the availability of fire annunciation and fixed fire suppression systems in vital areas after seismic events would improve fire fighting capabilities and accident management measures that require transport of water for cooling/suppression;
- by increasing the autarky-time beyond 10 h the robustness of the plant in a general sense would be increased;

– ensuring the availability of the containment venting system TL003 after seismic events would increase the margin in case of seismic events;
– uncertainty of the seismic margins can be reduced by a SMA or a Seismic-PSA. In 10EVA13 either a seismic-PSA will be developed and/or an SMA will be conducted and the measures will be investigated to further increase the safety margins in case of earthquake;
– in 10EVA13 the possibilities to strengthen the off-site power supply will be investigated. This could implicitly increase the margins in case of LOOP as it would decrease the dependency on the (primary) emergency generators and the SBO generators;
– develop a set of Extensive Damage Management Guides (EDMG) and implement training program;
– develop check-lists for plant walk-downs and needed actions after various levels of the foreseeable hazards;
– Modification in process to install a seismic monitoring instrumentation in the plant, as reported in country session.

2.1.2.5 Measures (including further studies) already decided or implemented by operators and/or required for follow-up by regulators

The regulator endorses the measures considered by the licensee. Additionally a SMA or a Seismic-PSA is envisaged.

2.1.3 Peer review conclusions and recommendations specific to this area

During the Topical meeting questions were asked to the Dutch regulator in order to clarify and compare the approach used for design basis and margins for earthquakes at the Borssele NPP and the Belgium NPP at Doel. Reason for this is the relative short distance between both sites (about 40 km). Additional information has been given and discussed during the country visit and no significant differences appear to be in the seismic assessments already performed.
Reviewers suggest to consider updating the hazard assessment for Borssele NPP. It is understood that a comprehensive and state of the art seismic analysis will be performed as part of the PSR of the Borssele NPP starting this year. During the country visit it was also explained that this analysis will consider a PGA value of 0.1g at free field for the DBE, as per IAEA guidance.
Moreover, the reviewers recommend to follow-up the mentioned analysis for verifying its global scope and adequate performance, in particular concerning the revision of the DBE level.
The combination of young unconsolidated sediments; grain size effects; and high water tables are expected to make the site susceptible for liquefaction. It is therefore recommended that the national regulator should consider assessing the liquefaction problem in connection with the ongoing seismic analyses.

2.2 Description of present situation of plants in country with respect to flood

2.2.1 DBF

2.2.1.1 Regulatory basis for safety assessment and regulatory oversight (national requirements, international standards, licensing basis already used by another country,…)

The regulator states that there are no specific requirements for the NPP regarding Design Basis Flooding (DBF).
During the country visit the regulator stated the following with respect to the general flooding policy of the country:

- The Netherlands is protected by a system of levees, dams and dunes. They all have to fulfill strict and legal safety standards that specify the hydraulic conditions that they have to be able to withstand. They legal standards vary from conditions that occur each year with a chance of 1/10,000 for the coastal regions in Holland to 1/250 per year along the Meuse in the province of Limburg.

- The design and maintenance of most of the dykes is the responsibility of the regional water boards (waterschappen) and the Dutch National Water Authority (RWS). Once every 6 year a general safety assessment has to be performed and a report of the state of the national levee system is sent to the parliament.
- For the levee at the site of the plant a safety standard of 4000 year return period has been specified. At this moment the levee does not comply with this standards and a reinforcement of the levees at the plant is starting within the coming months. The reinforcements will include margins in order to guarantee the legal safety standard also in the future. Therefore, the actual protection provided by the levee after the reinforcement should be higher (against events with a return period of 10,000 years).

2.2.1.2 Derivation of DBF

The original design basis for Borssele NPP was 5 meters above NAP (Normal Amsterdam Water Level) - Maximum value known: 4,7m +NAP, February 1953. Currently, the DBF is 7,3m above NAP including dynamic wave height. The new DBF is based on reassessments and modifications implemented. Within this concept all systems essential for operating the plant and all installed (safety) systems for safe shutdown stay available up to at least the level of 5 meters +NAP

2.2.1.3 Main requirements applied to this specific area

In the Netherlands, flooding is a relevant external hazard to be assessed regarding the site of any (industrial) activity. Nevertheless a value for DBF is not explicitly required by Dutch regulator.
The Water Act ('Waterwet') replaces former acts on water management, like the Flood DefensesAct and Public Works Act, both of which were important for the implementation of the governmental policy on flood risk.

2.2.1.4 Technical background for requirement, safety assessment and regulatory oversight (Deterministic approach, PSA, Operational Experience Feedback)

Basically, a deterministic approach had been used for the evaluation of the design basis flood.
The DBF considers the high tide water level with a return period of one million years. For the static effect of the flooding, the dykes of the national dykes network are not considered. The dykes are only considered for dynamic effects such as effects of the waves against the buildings. This combination leads to a level of 7.3 meters + NAP.
However, in the current situation, the site is also protected against flooding by the network of dykes in Zeeland. This network will be improved to comply with the legal requirements of 4000 year return period. The reinforcements will include margins in order to guarantee the legal safety standard also in the future. Therefore, the protection provided by the levee after the reinforcement should be higher (against events with a return period of 10,000 years).

2.2.1.5 Periodic safety reviews (regularly and/or recently reviewed)

Information on the PSRs is contained in the National Report and is summarized in section 2.1.1.5. The next PSR report will be submitted in 2013 and will contain a new comprehensive risk analysis.

2.2.1.6 Conclusions on adequacy of design basis

With regard to SSCs and external flooding the current design basis is adequate with the present situation. The regulatory body has the opinion that the impact of floods with long return periods (ten thousand years or more) is not known in much detail yet and that further assessments is necessary.

2.2.1.7 Compliance of plant(s) with current requirements for design basis

PRSs, including the assessment for DBF, are conducted every ten years to assure that current requirements are fulfilled, modifications made if necessary. A surveillance programme is put in place to ensure DBF levels.

No deviations from the current licensing basis are identified.

2.2.2 Assessment of robustness of plants beyond the design basis

2.2.2.1 Approach used for safety margins assessment

Regarding safety margin, the plant vulnerability (buildings, systems) is assessed at different flood levels. The details of the method are not described in the national report.

2.2.2.2 Main results on safety margins and cliff edge effects

In the low high-water concept (5 m + NAP) of licensee, the weakest link is the cooling water inlet building which is designed against a static water level of 5 m + NAP, but which is water tight to 7.4 m + NAP. However, a possible margin could exist, even when taking wave and run-up effects into account.
Water level reaching the 6.7 m + NAP floor of building 04, 05 and 10 will endanger the electrical power supply from Emergency Grid 1. However, most of the 6 kV / 0.4 kV transformers, including the transformer feeding bus bar CU of Emergency Grid 1 are located in building 05 at the 6.7 m + NAP floor. The air intakes of the cooling of these transformers (via natural convection) are openings in the wall of building 05 at 5 m+ NAP. This means that these transformers are subject to the dynamic water level as is present outside the buildings. This does not apply to the transformer feeding bus bar CV which is fed by bus bar BV; all these components are located in building 10 and are thus not subject to a dynamic water level. As a consequence, this part of Emergency Grid 1 is available up to a static level of 6.7 m+ NAP.
At this level the availability of the main control room is not guaranteed. But its functionality is to be expected because of the availability of (part of) Emergency Grid 1, rectifiers, batteries and the dispatcher (till at least 8.0 m +NAP).
If the water level reaches the 7.3 m + NAP the flooding is covered by the Bunker Concept. The availability of the main control room is not guaranteed. However, its functionality is to be expected because of the availability of (part of) Emergency Grid 1, rectifiers, batteries and the dispatcher. (Emergency) communication to outside parties must be assumed to be lost as no specific protection of the external communication lines against wide-spread flooding is foreseen.
Exceeding the DBF of 7.3 m + NAP by 1.25 meter will potentially lead to core damage.
Accessibility of personnel and means of communication in extreme external conditions has been assessed.
Loss of several electrical rails and main control room will be endangered by the flooding above 6,7m.

2.2.2.3 Strong safety features and areas for safety improvement identified in the process

Presumed a failure of dyke and flooding in extreme weather conditions, LOOP must be anticipated, accessibility to site and communication endangered or lost.
Regarding structural measures, wave protection beneath the entrances to the bunkered backup injection- and feed water systems and to the bunkered emergency control room would mitigate the sensitivity to large waves combined with extreme high water and would make the plant less dependent from the dyke.
Failure mechanisms of dykes (three dykes surrounding the site) will be included in the risk analysis of the ongoing PSR.

2.2.2.4 Possible measures to increase robustness

To improve plant robustness during actual flooding situations, the following measures are proposed by the licensee:
– establishment of the set of EDMG and implementation of a training program. Examples of the issues to be addressed are:
– procedures to staff the Emergency Control Room (ECR)
– use of autonomous mobile pumps
– procedure to transport own personnel to the site

– procedure for the employment of personnel for long term staffing
– an Emergency Response Centre facility that could give shelter to the alarm response organisation after flooding (and all foreseeable hazards) would increase the options of the alarm response organisation;
– storage facilities for portable equipment, tools and materials needed by the alarm response organisation that are accessible after flooding (and all foreseeable hazards) would increase the options of the alarm response organisation;
– establishing independent voice and data communication under adverse conditions, both onsite and off-site, would strengthen the emergency response organisation;
– improvement of plant autonomy during and after an external flooding, for example by establishing the ability to transfer diesel fuel from storage tanks of inactive diesels towards active diesel generators would increase the margin in case of LOOP.
– Wave protection beneath entrances bunker
– Adjustment flood resistance buildings containing emergency supply

2.2.2.5 Measures (including further studies) already decided or implemented by operators and/or required for follow-up by regulators

The protective dykes around the site are regularly inspected, and the sea dyke A of 9,4 m + NAP will be improved in 2012.
Development of an Operating procedure for flooding has been initiated.
Regulator endorses measures proposed by the licensee in section 2.2.2.4.
Regulator considers the impact of floods with long return period must be further assessed. Additional study on extreme flooding with long term period including dyke failure mechanisms is envisaged.

2.2.3 Peer review conclusions and recommendations specific to this area

The main protection against flooding is ensured by Water Act.
Provisions against flooding are in place, e.g. an operating procedure in case of threatening flooding at sea water level + 3,05 m + NAP.
The design basis originated from the highest measured sea water level (4.7 m +NAP). This is updated by extrapolation of high tide total exceedance frequency charts with the addition of several factors (e.g wave height). This has led to a DBF of 7.3 m +NAP. DBF in particular will be regularly checked in PSRs every ten years. Provisions will be conducted if necessary. A surveillance program for ensuring the design levels has been established.
Licensee has identified relevant improvements in order to increase plant robustness against flooding. In 2013 the Borssele NPP will perform a new assessment of the DBF in the frame of the PSR.
However, considering the very specific approach of the Netherlands for the flooding protection of the site, which relies on the national dyke system, the reviewers recommend to examine thoroughly the consistency of this approach with the new IAEA guidance (SSG-18), i.e.:
"A nuclear power plant should be protected against the design basis flood by one of the following approaches:
(a) The 'dry site' concept (…)
(b) Permanent external barriers such as levees, sea walls and bulkheads (…) Care should also be taken that periodic inspections, monitoring and maintenance of the external barriers are conducted, even if such barriers are not under the responsibility of the plant operating organization. (…)
For both approaches, as a redundant measure against flooding of the site, the protection of the plant against extreme hydrological phenomena should be augmented by waterproofing and by the appropriate design of all items necessary to ensure the fundamental safety functions in all plant states. All other structures, systems and components important to safety should be protected against the effects of a design basis flood."

2.3 Description of present situation of plants in country with respect to extreme weather

2.3.1 DB Extreme Weather

2.3.1.1 Regulatory basis for safety assessment and regulatory oversight (national requirements, international standards, licensing basis already used by another country,…)

Regulatory requirements are not described in the national report. Design basis mainly originated from civil engineering codes and climate models.

2.3.1.2 Derivation of extreme weather loads

The phenomena considered are:
- maximum and minimum water temperature
- extremely high and low air temperature (no design basis specified)
- extremely high winds (incl. tornados, storms)
- wind missiles and hail
- formation of ice
- heavy rain and snow
- lightning (based on KTA standards)
- credible combinations of the phenomena

The report discusses very briefly the impact of external phenomena on SSCs. Data collection for extreme weather conditions in order to verify the design basis varies around 30 to 60 years, as reported in country session.

Water temperature values have reference to observations. However, the period of observation is not given.

2.3.1.3 Main requirements applied to this specific area

Extreme values allowable for different parameters are not specified as design basis. In the case of lightning the requirements are as established in KTA standards.

2.3.1.4 Technical background for requirement, safety assessment and regulatory oversight (Deterministic approach, PSA, Operational Experience Feedback)

Safety assessment is performed mainly by applying criteria for civil engineering codes and engineering judgment.

The design load of buildings is higher than the design wind load. The maximum expected wind speed is sufficiently covered by the design explosion pressure wave.

Wind missiles and hail is covered by the resistance against a small airplane crash since the design-basis airplane crash.

Credible combinations of extreme weather conditions have been considered and no significant deficiencies have been identified.

Effects from accidents from nearby industrial facilities have been studied.

2.3.1.5 Periodic safety reviews (regularly and/or recently reviewed)

General information on the PSRs is summarized in section 2.1.1.5. A more thorough analysis of the expected frequency of weather conditions considered is ongoing in the current PSR. Concerning the effects of a super storm having a return period of one million years on the site, a study will be carried out in 2012.

2.3.1.6 Conclusions on adequacy of design basis

It can be concluded that there are no flaws in the protection, although there is some room for improvement. These possible improvements are discussed in the evaluation of the safety margins.

2.3.1.7 Compliance of plant(s) with current requirements for design basis

PSRs are performed every ten years to assure that requirements are fulfilled. In general, the degree of resistance against external influences that is required is defined so that the probability of an accident with serious consequences caused by external weather influences is small compared to the risk of serious accidents by causes within the plant.

2.3.2 Assessment of robustness of plants beyond the design basis

2.3.2.1 Approach used for safety margins assessment

Safety margins are considered for water and air temperatures, wind, ice formation, rainfall, snowfall and lightning. Maximum allowable loads and foreseeable weather conditions have been compared.

2.3.2.2 Main results on safety margins and cliff edge effects

Margins exist, but they have not always been quantified in detail. No cliff-edges are identified.

2.3.2.3 Strong safety features and areas for safety improvement identified in the process

- Study of minimum depth of underground piping required for proper protection against freezing
- Possibility to operate diesel generators at extremely low temperatures.
- Potential effect of wind transported snow on roofs.

2.3.2.4 Possible measures to increase robustness

Measures identified by licensees: checklists for walk-downs during/after extreme weather conditions.

2.3.2.5 Measures (including further studies) already decided or implemented by operators and/or required for follow-up by regulators

The regulatory body endorses licensee's proposal, however evaluation of its effectiveness is needed before implementation.

Heavy rain does not pose extreme challenges to the plant. A special case is the accumulation of water resulting from fire-fighting activities if drain pipes are blocked. It is considered that the possible consequences of this needs to be studied.

Further recommended topics that should be considered for additional studies are: the minimum depth of underground piping required for proper protection against freezing, possibility to operate diesel generators at extremely low temperatures and the potential effect of accumulation of wind transported snow on roofs.

2.3.3 Peer review conclusions and recommendations specific to this area

The relevant phenomena of extreme weather conditions are considered, but information available on the assessment is limited. However, more information was provided during the country visit.

The regulatory position is appreciated to do additional studies on freezing underground piping, operating of diesels under extreme low temperatures, potential effects of wind transported snow on roofs and effects of accumulation of firewater. The reviewers have also noticed the study to be carried out about super storms with a very long return period.

3 PLANT(S) ASSESSMENT RELATIVE TO LOSS OF ELECTRICAL POWER AND LOSS OF ULTIMATE HEAT SINK

3.1 Description of present situation of plants in country

3.1.1 Regulatory basis for safety assessment and regulatory oversight (national requirements, international standards, licensing basis already used by another country, ,…)

The regulatory basis is not described in the National Report. During the peer review it was explained that the Dutch Safety Rules (including those for LOOP, UHS and SBO) to a large extent are based on the IAEA-system, with adaptions including the implementation of the WENRA reference levels. The country has a small scale nuclear program with one NPP. It has therefore implemented the Dutch Safety Rules mainly by attaching them directly to the license as a requirement. Well known standards such as KTA are used by utility, after endorsement by the regulator.

3.1.2 Main requirement applied to this specific area

Description of specific requirements relevant to LOOP, SBO or loss of UHS is not provided in the National Report of the country. During the country visit, more details were given by the Dutch Regulator.
Main requirements applied to this area are based on corresponding IAEA safety standards (adapted to the Dutch situation), including WENRA Reference Levels. In particular, the following documents apply: NVR NS-R-1 (design safety), NVR NS-G-1.8 (emergency power systems), NVR NS-G-1.9 (reactor coolant system and associated systems), NVR NS-G-1.10 (containment systems). In some cases, additional standards are imposed, such as KTA3701 for electrical power supply in NPPs.

3.1.3 Technical background for requirement, safety assessment and regulatory oversight (Deterministic approach, PSA, Operational Experience Feedback)

Safety assessment of NPPs of the country involves deterministic as well as probabilistic (probabilistic safety analysis – PSA) studies. PSA is used in the country to evaluate whether a nuclear installation meets the established risk criteria (which is not nuclear specific), to identify improvements areas and to optimize operations at the plant. This is a living process and PSA is updated yearly. Plant modifications and updated failure data are included in this continuous process.
The country explained during the peer review that the “stress tests” assessments were done by the utility, and mainly in an analytical (deterministic) way with support from other organisations. The regulatory authority together with its technical support organisations assessed the information presented by the utility and provided its conclusions.

3.1.4 Periodic safety reviews (regularly and/or recently reviewed)

Information on the PSRs is contained in the National Report (section 7.1) and is summarized in section 2.1.1.5.
During the peer review, the country explained that PSRs played a significant role in the enhancement of the safety capabilities of Borssele NPP. During previous PSRs deviations from international regulation and practice were indentified and based on that very serious improvements were implemented, especially linked to external hazards impacts, to LOOP, SBO and loss of UHS. By this the safety concept of the plant was improved and adapted to the latest German design (Konvoi) resulting in a safety level far better than the original design. Two of the most significant improvements were performed in line with PSR results: introduction of the “bunker concept” and back fitting of an alternate UHS.
It is reported, that the coming periodic safety study will cover the investigation of possibilities to strengthen off-site power supply.

3.1.5 Compliance of plants with current requirements

The National Report indicates that, based on decades of regulatory oversight, compliance of the plant with its license has been established. The regulatory review of the utility report on the "stress test" has not raised compliance issues and has confirmed this position.

3.2 Assessment of robustness of plants

3.2.1 Approach used for safety margins assessment

The country analysed various possibilities to obtain power supply for the site, as well as possibilities to ensure cooling of reactor core and the spent nuclear fuel for scenarios specified by ENSREG. Possible power sources and heat sinks were taken into account, including non-conventional means like mobile equipment. All possibilities were evaluated and time constraints on the implementation of corresponding measures to supply power and (or) cooling were determined. Finally, the autonomy or capacity of the lines of defence were assessed.

3.2.2 Main results on safety margins and cliff edge effects

3.2.2.1 Power supply features

The country reports about various possibilities to supply power for on-site needs. There are several means for on-site power supply:

- Connection to the 150 kV power grid;
- 10 kV connection to the domestic grid;
- 6 kV connection to the neighbouring coal fired power station;
- Diverse two-level emergency power supply grids with three and two diesel generators respectively (called NS1 and NS2);
- NPP operation in "house-load" regime (with a 81% success rate from experience feedback);
- Uninterrupted power supply system (batteries);
- Possibility to supply power from coal fired plant emergency diesel generators(EDG);
- On-site mobile EDG.

3.2.2.2 Heat sink features

The primary UHS for Borssele NPP is water of River Westerschelde. It supplies the main cooling water system and the conventional and emergency cooling water system. The country reports availability of alternative UHSs:

- eight deep-water wells supplying the backup cooling water system for reactor cooling (at least 13h after shutdown form full power) and/or fuel pool;
- the atmosphere, in case of steam dumping via the main steam relief valves;

In addition, low pressure fire water system and fire trucks, demineralised water distribution system, and public water supply system are different sources of water that can be used after establishing special connections or plant alignment.

3.2.2.3 Loss of off-site power (LOOP)

LOOP is within the design basis of the plant. The National Report presents an analysis of various possible situations, indicates preventive features, estimates availability of features and proposes measures for extension and recovery of Alternating Current (AC) power supply. The reported time for start up of EDGs NS1 (belonging to emergency power supply) in case of LOOP is 2 seconds, and full power is reached in 10 seconds. Two of the NS1 EDGs have their own fuel stock for at least 72 hour of operation. The third NS1 diesel generator, separate from the others and serving as back-up, has enough fuel to last for 25 hours. NS 2 will be activated if NS 1 is not available. NS 2 has two separated EDG's each of which is capable to support systems for safe shutdown (see also National Report, section 5.1.1.1).

The coal fired power plant (considered as a non-safety grade on-site AC provider) can immediately supply power if it is in operation. Power from diesel generators of the coal fired power plant can be supplied in 30 minutes. Runtime of the coal fired plant diesel generator is 9 hours. A 1 MW mobile diesel generator is available on the site, but it is stored in a container and needs to be transported over the site using external resources in case of an emergency (a truck is needed to place the DG near the NS2 diesels). The time estimated for on-site transportation is 2 hours, and the time needed for connection is 4 hours. The possibility of delivering an off-site additional diesel generator in 8 hours was also reported. According to the ENSREG specifications, the site remains isolated from delivery of light material for 24 hours, and no credit can be given to mobile generators (on-site or external) for the management of the situation.

The maximum running time of a particular EDG can be extended by using available fuel stocks from several tanks. The minimum amount of available diesel fuel in the stock on-site is reported to be 245 m^3, which is enough to feed one EDG for up to 1300 hours. However, this would require diesel fuel transfer whereas there are no dedicated hardware provisions and procedures available to support the required fuel transfers. According to the National report this situation will be improved to ensure and improve the autonomy of the EDGs.

The batteries for uninterrupted AC power supply (for motor driven pumps and valves) are reported to be available for up to 2.8 hours. There is the possibility to prolong the availability of the batteries up to 5.7 hours, but in that case the turbine will be damaged due to inoperability of the oil pump (possible enhancement of the battery capacity is being considered).

An assessment of the impact of external hazards is also performed. It is stated that emergency grid NS2 together with its two EDGs is well protected from flooding, earthquakes and explosions. However, the mobile diesel generator could not be available in case of flooding (measures for improvement are currently under consideration).

Numerous options are available to cope with a LOOP scenario for a period of at least 72 hours without any external support.

3.2.2.3 Station blackout (SBO)

– **SBO-1 with loss of the normal back-up AC power sources**

In this case, the first-level emergency grid (NS1) is lost. Power supply can then be provided by the redundant and diverse second-level (NS2) emergency grid, which has its own 2 EDGs. Fuel is ensured for 72 hours. This time can be prolonged up to 1300 hours using on site fuel stocks. However, hardware provisions and operational procedures for the usage of additional diesel stocks are not available and will be developed according to the improvements reported. Other options can be power supply from neighbouring coal fired power station, existing mobile generator, and from batteries. AC power can be supplied for up to 5.7 hours. However, no credit can be given for on-site mobile diesel generator given the ENSREG assumptions (see previous paragraph).

The NS2 EDGs provide an adequate response to the SBO-1 scenario for a 72 hour period without any external support. Hardware provisions and procedures will as one of the improvement measures of the stresstest be developed to support operators for on-site fuel transfer operations.

– **SBO-2 with loss of permanently installed normal and diverse back-up AC power sources**

The country describes this situation as the loss of all AC power sources – the emergency grid, connection to coal fired power plant and diesel generators. The only power sources in such situation are the batteries. The discharge time of the 220 V batteries for uninterrupted AC power is more than 2 hours, but can be extended to up to 5.7 hours, following certain procedures (battery load reduction). The possibilities to obtain additional AC power sources are under consideration. Batteries can be recharged when AC power (normal or emergency grid 1) is restored. Recharging takes 8 hours.

Critical time constrains (cliff-edge effect) such as times to core damage are not presented because the situation is bounded by loss of UHS together with SBO.

3.2.2.4. Loss of Ultimate Heat Sink (UHS)

The country gives an analysis of various situations linked to the loss of UHS, and their consequences on reactor cooling as well as cooling of the spent nuclear fuel pool. It is mentioned that the loss of primary UHS is within the design basis of Borssele NPP, and no additional means are needed. Nevertheless, cooling of the spent nuclear fuel pool may need alternative means, which are described in the report. Core cooling is ensured by supplying the steam generators with water from various stocks (main and auxiliary feed water system, demineralised water system, back up feed water system) for about 75 hours. Steam is released via the steam valves. When "decay heat removal" conditions are met, a cooling line can be established using the conventional and emergency cooling system water fed by the low pressure fire system. Another option available after 13 hours is the backup cooling system (protected against external hazards) supplied by the 8 deep-water wells. This latter option provides an unlimited water resource. As for the spent fuel pools, several options are available to provide cooling for the long term (backup cooling system, low pressure fire system).
Several options are available to provide cooling to the core and the spent fuel pools for more than 72 hours without any external support.
In case of the loss of both primary and alternative UHS, cooling may be provided using water stocks in the reservoirs available at the plant. The cool down operational phase is dealt with using the same option as for the loss of primary ultimate heat sink scenario. The cooling line using the conventional and emergency cooling system water fed by the low pressure fire system (UJ) is established to remove heat from the core once the residual heat removal state is met. The UJ system has its own tank providing cooling for about 7 hours. Replenishment is then initiated via the public water supply system or a fire truck (taking suction from various ponds or river).
For the spent fuel pools, the same option is implemented (UJ system) to ensure cooling of the fuel.
The country concludes that characteristic time periods in case of loss of primary and alternative UHS depend on the following available options:

- the reactor cool down phase can be extended for more than 14 days by applying all available on-site water stocks;
- the decay heat removal phase only relies on the fire extinguishing system or fire truck supply, which will last 10 hours and 13 hours respectively (relying on on-site stocks) when decay heat removal starts three hours after reactor shut down, and 11 hours and 16 hours respectively when decay heat removal starts 13 hours after reactor shut down;
- the spent fuel pool cooling can be extended for more than 14 days when evaporation is accepted.

With replenishment from the public water system or the river Westerschelde, cooling can be sustained for an unlimited time, assuming that sufficient power sources are available.
The loss of the primary and alternate UHSs is a beyond design basis scenario. It can be controlled in the long term by supplying the UJ system with water from the public system or fire truck. The robustness and reliability of fire protection system (UJ) should be proven and improved where necessary, as it was requested by regulatory authority.
As a general conclusion, the plant can manage this situation for at least 72 hours without any external support.

3.2.2.5. Loss of UHS & SBO

Two scenarios are analysed in this part:

- the loss of the primary heat sink and SBO-1 (loss of ordinary emergency diesel generators NS1);
- the loss of the primary heat sink and total SBO (NS1 and NS2 unavailable).

In the first scenario, no cooling problem will occur due to the availability of the NS2 emergency grid (EDGs) and alternative UHS means (deep water wells).
In the second scenario, all options using electrical systems are unavailable. The steam turbine driven pump can be operated and secondary feed and bleed can be operated for about 3 hours until the water reserve of the main and auxiliary feedwater system are exhausted. After this short period, the low pressure fire system (UJ) can supply water for about 8 hours using its own fuel stocks. Replenishment of the UJ tank is needed after about 10 hours (public water supply or fire truck).
The "decay heat removal" operational states have not been reported in the National report. It is stated that if no option is available for cooling the core in the most critical case, damage to the fuel would occur in a matter of hours (6 hours is the figure provided during the peer review). Further information

is found in the Licensee Report on page Chapter 5-17. It describes as a bounding critical case the operational state “primary loops not completely filled” (mid-loop). In case of loss of all AC power (including SBO EDGs) and without operator actions, boiling in the open primary circuit will occur after 15 minutes. Core uncovery could be delayed until about 43 hours if required local operator actions to open manual valves – including inside the containment – are performed in a short time. The establishment of an operating procedure and associated training is announced in the Licensee Report. During the peer review it was established that the concept and the elaboration of the corresponding procedure is still under study and that hardware solutions could also be considered.
If the reactor is assumed to have been stopped during operation and primary and secondary feed and bleed systems are available, time till core uncovery is about 12 hours.
The situation of cooling of spent nuclear fuel pool is analysed as well. It is concluded that in case of the loss of all AC power the cooling can be performed only by evaporation. The water inventory in the pool allows a grace period of at least 80 hours before damage to the fuel occurs.
It should be concluded that:

- there is a high reliance on the UJ system for providing cooling in some scenario’s, and improving its robustness will be aimed at according to the National Report;
- the fuel supply for its diesel driven pump is a cliff edge effect, and this should be procedurised; one of the improvement measures in the National Report copes with this issue (see 3.2.5)
- the capabilities to cope with SBO situations during mid-loop operation should be developed and formalised.

improvement should be envisaged to make the existing site mobile diesel generator available, providing an option to retrieve AC power and to control the situation (in the National Report measure M5 is intended to reduce connection time, see 3.2.5.; to improve the availability during a flooding situation is an action from the World Association of Nuclear Operators(WANO)inspection).

3.2.3 Strong safety features and areas for safety improvement identified in the process

As strong safety features can be mentioned: the redundancy of power supply (NS1 and NS2 EDGs), and the coal fired power station nearby with its own diesel generators and linked to the NPP. Another strong point is the fully qualified alternate UHS consisting of 8 deep water wells. It should be noted as good practice to use risk monitor for planning maintenance during operation and outages.
In a number of SBO and loss of UHS scenarios, the plant relies strongly on the low pressure fire system (UJ) to supply makeup and/or cooling water. It has been required that the robustness of this system will be improved (see 3.2.5). An identified weakness is that the on-site mobile diesel generator needs external support to be transported to the connection point. Given the ENSREG assumptions, the mobile generator would not be available in the first 24h or even 72h. According to the National Report an improvement of this situation will be sought in order to reduce connection time to 2 hours (see also 3.2.5).

3.2.4 Possible measures to increase robustness

The utility proposed a number of various additional measures to improve the robustness of the Borssele NPP related to scenarios loss of power and loss of UHS. These measures have been endorsed by the regulatory authority. The measures considered to enhance the robustness of the plant are specified in section 3.2.5 below.

3.2.5 Measures (including further studies) already decided or implemented by operators and/or required for follow-up by regulators

The following proposals for improvement of the Borssele NPP capabilities during LOOP, SBO and loss of UHS events are reported and presented during the peer review:

- Increase the robustness by an extra grid connection to the nearby 400kV grid;
- Enhance possibilities to transfer diesel fuel to various locations;

- Reduce connection time of the mobile Emergency Diesel Generator(s);
- Introduce Extensive Damage Mitigation Guidelines for safety such as coal fired plant connections to Emergency Grid 1, direct injection of fire fighting water into the alternative deep-well pumps system;
- Enhance the use of steam to power Emergency Feed Water System in case of total loss of electrical power (in case of loss of Emergency grids 1 and 2);
- Perform training on the procedures (which are still to be developed) and actions during mid-loop operations in case of total loss of electrical power (loss of Emergency grids 1 and 2);
- Implement additional reserve spent fuel cooling system;
- Envisage potential actions to prevent running out of on-site diesel supply for fire extinguishing system and the fire brigade.

The regulatory authority endorses the actions proposed by the utility. In addition some other measures were required:

- Assessment of the design classification and testing of Structures, Systems and Components handling severe accidents;
- Increase the amount of lubrication oil in stock;
- Analyses of the highest core temperatures during the cooling statutes;
- Assessment of the cooling possibilities in the case of loss of the main Grid, Emergency Grids 1 and 2 and no secondary bleed and feed available;
- Test severe accident measures to restore power from various possibilities like mobile diesel generators and connections to the coal fired plant;
- Increase the robustness of the fire fighting system.

3.3 Peer review conclusions and recommendations specific to this area

The National Report indicates that comprehensive complimentary safety analysis is done by the utility for Borssele NPP, and that measures are proposed to increase the safety capabilities in case of LOOP, SBO, and loss of UHS (without external support). This has been evaluated by the regulatory authority. The assessment of the regulatory authority was adequately independent and robust, although the further assessment is going on.

The country assured that structures, systems and components relevant to LOOP and SBO, loss of UHS (without external support) are under adequate supervision of the utility, and are one of the subjects of regulatory inspections. The “stress tests” results will be further analysed and lead to additional inspections.

The country explained some measures (for example linked to availability of deep wells), decided by the utility immediately after events in Fukushima Daichi NPP.

The capabilities to cope with SBO situations during mid-loop operation should be developed and corresponding procedures should be prepared and validated. Due to the short times available for manual intervention and the worsening accessibility of the containment after the start of water boiling in the open primary circuit, the possibility to use remotely controlled valves allowing for primary system water make-up in case of SBO during mid-loop operation should also be investigated.

The time necessary to get the on-site mobile diesel generator operational will be improved in order to provide in a timely manner a last resort to retrieve AC power under a total SBO scenario.

Possibilities to increase the robustness of back-up power supply from mobile means, as well as from small portable equipment, should be further investigated considering external support.

The country reported about a plan for the implementation of modifications and other measures for further improvement of safety capabilities, which shall be prepared by the utility taking into account results of “stress tests” and peer review. This is going to be discussed and endorsed by the regulatory authority.

4 PLANT(S) ASSESSMENT RELATIVE TO SEVERE ACCIDENT MANAGEMENT

4.1 Description of present situation of plants in Country

4.1.1 Regulatory basis for safety assessment and regulatory oversight (national requirements, international standards, licensing basis already used by another country, ,…)

The Dutch Nuclear Energy Act sets the framework for nuclear safety management. Beneath this, "Decrees" provide for additional regulations, including provisions for licensing and requirements for risk assessments, and specifically those for managing severe accidents.

The regulator can also issue "Nuclear Safety Rules" (NVRs) – the third tier in the regulatory framework. These have allowed the regulator to attach international safety standards to the licence, including the WENRA Reference Levels (RLs) and IAEA Safety Requirements and Guides (47 are attached at present). The safety standards attached include "Severe Accident Management Programmes for NPPs" (NS-G-2.15).

Basic requirements for emergency preparedness are provided for in the operating licence; this includes requirements to conduct emergency exercises.

In principle, the approach adopted in the Netherlands enables regulation in accordance with current international practice, and to be flexible in adopting further requirements if this changes. The regulatory body agrees with this view and states that it considers the totality of the Dutch legal framework gives it adequate powers to require any SAM measures it deems necessary, the main instrument being through the operating licence.

4.1.2 Main requirements applied to this specific area

The Decrees include specific requirements for numerical risk. These are general requirements that apply to all industrial activities in the Netherlands. From this, risks need to be less than: 10^{-6} per year for individual risk (mortality) as a consequence of operating an installation; 10^{-5} per year for societal risks, i.e. risks directly attributable to events leading to 10 or more fatalities. Supplementary criteria are also applied, requiring a hundredfold reduction in this limit for each tenfold increase in the predicted number of fatalities.

As already noted, aspects such as the WENRA RLs and IAEA safety standards are provided for under the licence. This process ensures that the requirements imposed will align with wider international practice. In regard to severe accident management, the content of the national report suggests this coverage is adequate.

4.1.3 Technical background for requirement, safety assessment and regulatory oversight (Deterministic approach, PSA, Operational Experience Feedback)

The licensee has conducted Level 1, 2 and 3 PSAs, which include external hazard initiators. The Level 3 PSA (which utilises the COSYMA computer program) results in estimated risk levels compliant with the regulatory criteria outlined above. These are "living" PSAs, i.e. they are updated yearly.

Early, late, and very late release frequencies over all operational states are calculated in the Netherlands. Large release frequencies are not calculated and so used in the licensing basis. Instead the risk levels mentioned above (including individual and societal risks) are included in the licence process.

The calculated total core damage frequency, over all power states, has been calculated as 2.12×10^{-6}/yr. This includes an early release core damage frequency value of 2.34×10^{-8} /yr (1.1% of total).

Twin strategies are applied to manage a severe accident. Firstly for in-vessel retention and then, if this fails, for corium retention within the containment. The licensee is currently reviewing international research to better underpin these strategies.

SAMGs have been in operation at Borssele since 2000 as an outcome from the PSR at the plant in 1993. Their scope was expanded following the 2003 PSR to include shutdown conditions. The SAMGs are based on the generic SAMGs produced by the Westinghouse Owners Group and were considered state of the art in 2003. They are intended to address scenarios deriving from severe external hazards, such as earthquakes and floods, where there is the imminent potential for core melt.
The SAMGs include guidance for using the pressure relief valves and various pressuriser spray options to control the Reactor Pressure Vessel (RPV) pressure. For an ex-vessel event the containment (37,100m^3) has filtered venting, a spray system, air coolers, a filtered recirculation system and Passive Autocatalytic Re-combiners (PARs). The containment is designed for overpressures of 3.8bar; however, the design has no core catcher.

4.1.4 Periodic safety reviews (regularly and/or recently reviewed)

Information on the PSRs is contained in the National Report (section 7.1) and is summarised earlier in this report (section 2.1.1.5). All three previous PSRs have led to significant improvements in relation to the management of severe accidents. Notable improvements in this regard were implemented as follows:

1986: Introduction of the Bunker Concept with Station Blackout diesels, backup coolant make up (TW) and backup feed water (RS) systems

1997: Improvements to heat removal systems
New Emergency Diesel Generators (EDGs)
Filtered containment venting
Measures for hydrogen management (PARs) in core melt scenarios
Improved independence in safety systems
Introduction of SAMGs
Autonomy time for external design basis events increased to 24h and autarky time to 10h
Emergency control room and reactor protection systems included in bunker concept
Installation of primary bleed and feed valves (no high pressure core melt scenarios)
Installation of the alternative UHS system (VE)

2006: Increases in the autonomy time for design basis events to 72 hours
Further improvements in cooling and powering arrangements
Improvement in flood margins by moving EDG air intakes
New crash tender capable of dealing with large kerosene fires
Expansion of SAMGs to shutdown conditions

Autonomy time for external design basis events increased to 72h

In the 1990s, the regulatory body requested the licensee (EPZ) to implement an age management programme. This was done in order to prevent severe accidents by the control of physical degradation of safety systems, structures and components. This obligation was added to the licence conditions in 1995. A subsequent IAEA AMAT mission assessed the age management programme. Improvements have been made to the programme on the basis of the suggestions from the mission. Age management is extremely important in life time extension for the evaluation of degradation. As an example: new test coupons of the reactor material are exposed in the reactor to simulate neutron embrittlement after 60 years.

4.1.5 Compliance of plants with current requirements (national requirements, WENRA Reference Levels)

As already noted, the Dutch regulator has confirmed Borssele's ongoing compliance with its national licensing basis and other legal criteria. In addition and noted above, IAEA safety standards and the WENRA RLs are incorporated into the licensing basis as NVRs.
Specific compliance with WENRA has been confirmed in recent years as part of the WENRA Reactor Harmonization Working Group (RHWG) initiative by the regulator. However, as compliance to WENRA RLs was not in scope of the stress test, the detail and extent of this compliance was

discussed during the country visit. Nuclear Safety Department KFD confirmed compliance with the 2008 WENRA Reference Levels (RLs) during the review process and these have been incorporated into the NVRs.

During the peer review process KFD stated that upon issue of the license mid 2011 the licensee had to fully comply to all NVRs, except for the Design-series NVRs.For the latter NVRs, the licensee has to comply as much as reasonably possible. The justification for this position of the regulator is that the design of an older generation NPP cannot be considered in the same way as more modern NPPs. The level of compliance between existing NVRs and modern regulations will be identified as part of the 2013 PSR in 2013. Any deviations between the NVRs and the RLs will be identified and, under the PSR programme, a plan to achieve compliance in the period 2013 to 2017 will be developed. However, issues identified with a potential large safety impact will be addressed as soon as reasonably possible.

4.2 Assessment of robustness of plants

4.2.1 Adequacy of present organizations, operational and design provisions

4.2.1.1 Organization and arrangements of the licensee to manage accidents

IAEA GS-G-2.1, '*Arrangements for Preparedness for a Nuclear or Radiological Emergency'*, is attached to the site license as an NVR and is thus applicable for the Borssele NPP.

Borssele has standard arrangements for controlling the plant in the event of a severe accident. The Main Control Room (MCR) has a filtered air supply and, following a SBO event, compressed air and respirators are available. There is also an alternative Emergency Control Room (ECR, which is bunkered and has gas-tight doors, but which does not have a filtered air supply) for managing a controlled shutdown, core cooling and spent fuel pool cooling. Both the MCR and ECR have suitable and robust access to plant measurements needed to control a severe accident. Radiological analyses suggest both would remain habitable, even in an extreme severe event, though further confirmation of this has been requested by the regulator.

There are seven operations shift teams at Borssele, each managed by a shift supervisor and each composed of at least eight operators. It is the shift supervisor's responsibility to decide on the extent of the licensee's Emergency Response Organisation (ERO) that needs to be activated. Once the ERO is operational, the site emergency director takes over responsibility for the emergency. Based on data from exercises, the ERO will be set up within 45 mins (even outside normal working hours) and then requires a further 30 mins to become operational.

The ERO has a very similar structure to those in place in other nations participating in the stress tests exercise. The ERO supports plant operation in accident and severe accident conditions and combines an industrial safety and nuclear emergency organisation. The responsibilities of the ERO cover all the areas to be expected in the management of severe accidents. The ERO is a scalable organisation: the number of staff called in (by pagers, phone calls) will depend upon the scale of the emergency being addressed. The regulator is however concerned that there may not always be sufficient staff for the ERO in all circumstances, e.g. in long events, or where site access may be difficult, and so suggests two further shift teams may be needed. This is to be analysed further by the licensee.

The ERO will be located in the plant's Alarm Coordination Centre (ACC). This is a purpose-built facility designed for internal events and emergencies. Though bunkered (like the ECR), it is not designed to withstand severe events such as a major earthquake, flood or aircraft crash. The licensee has therefore proposed a new Emergency Response Centre (ERC) to provide a more robust shelter. In the meantime, the ERO will need to relocate, if the ACC becomes uninhabitable, to a standard meeting room. This will however entail losing much of the functionality (e.g. communications provisions) of the ACC. Interim measures are therefore envisaged to enhance the capability of some of the meeting rooms on site (though not to the same standards as the ERC will have), pending full ERC commissioning.

The licensee has no offsite facilities but other organisations have facilities that could be used to assist in an emergency some of which are mobile. Contractual arrangements are in place to facilitate this.

The ERO is responsible for liaising with the local and national (government) authorities. The arrangements here include provision for a liaison officer to be stationed with the local authorities during an accident to facilitate communications and technical understanding.

The emergency plan includes provision for technical advice in the event of an emergency. This includes access to a ‘think tank’ organised by the regulator and to the plant vendor’s experts (AREVA’s crisis staff based in Germany). Both these groups will have plant measurements available online and access to simulator outputs.

The regulatory inspection programme for Borssele, that encompasses the ERO, is based on IAEA GS-G-1.3 (*Regulatory Inspection of Nuclear Facilities and Enforcement by the Regulatory Body*). Regulatory inspections consider the following: Training of the ERO staff, Accident Management Handbook, Exercises by the ERO staff, Use of procedures of the ERO staff, Communication (internal and external), Procedures for accident management measures, Adequacy of source term estimation, Adequacy of radiological predictions.

Training and emergency exercises are conducted routinely and include change-over of ERO shifts. Scenarios are controlled using the plant’s full scope simulator (located in Essen, Germany), though it is noted that this cannot simulate severe accidents. Emergency exercises can be very large scale, e.g. a recent national exercise involved 1000 people. The licensee produces an annual summary report of its exercises which is assessed by the regulator. The KFD participates in six emergency exercises annually. One or two KFD-inspectors are based at the ERO location to observe the exercise and to check if the correct measures are taken to restore safety functions.

Training for Technical Support Centre (TSC) staff requires them to be qualified to address seven specific scenarios and then complete refresher training in at least two of these in each subsequent year. Nevertheless, the regulator believes there is still scope for improvements in training, and specifically is seeking improved training in the SAMGs, focusing on circumstances of reduced accessibility to the site, reduced numbers of ERO staff, reduced availability of instrumentation, harsh conditions and long duration accidents.

4.2.1.2 Procedures and guidelines for accident management (Full power states, Low power and shutdown states)

The use and history of SAMGs at Borssele have been described in previous sections. As per the WENRA RLs, the SAMGs are entered if the EOPs have not been successful in protecting against the imminent possibility of, or an actual core melt; The SAMGs then provide guidance on the mitigation of consequences and on how to bring the plant back to a stable state. The EOPs are based on event- and symptom-based approaches developed by the Westinghouse Owners Group (WOG). The SAMGs are also derived from the generic WOG approach; no particular difficulties have been encountered however from applying a Westinghouse-based approach to a KWU-designed plant.

The EOPs and SAMGs are wide-ranging and include coverage of shutdown states. The regulator is confident that their coverage is adequate and that the sets of EOPs and SAMGs complement one another. Sample SAMGs and records (and reports) of exercises using SAMGs were discussed during the review process.

The procedures are based on dose limits specific to severe accident management scenarios (500 mSv to save human life; 100 mSv to save important material interests; 100 mSv for other activities necessary for SAM). Human factors aspects have also been considered explicitly. The EOPs are reviewed every four years and on design changes; SAMGs are reviewed on design changes. The SAMGs and EOPs were verified and validated following an emergency exercise in 2000. KFD approved their validation in August 2001.

The licensee is currently in the process of developing a set of Extensive Damage Mitigation Guidelines (EDMGs) to augment the SAMGs. This is an approach developed in the USA following the events of 11th September 2001. They address gross infrastructure problems deriving from a major incident, e.g. blocked roads, or doors no longer amenable for access. The EDMGs will be a 'living' collection of specific guidelines (~ 15 guidelines). Addition measures that may be identified in the stress tests and/or the 2013 PSR may require additional or updated guidelines. In 2012, the licensee will perform analyses of international examples and develop a Quality Assurance procedure for EDMGs. It is planned to draft the EDMGs in the period 2012-2013.

As noted above however, the regulator is seeking better training for applying the SAMGs. In addition, because the SAMGs were developed relatively early compared to other nations (in 1990s), they are based on the then-practice of making best use of existing equipment. The modern approach however is to utilise specific equipment designed for addressing severe accidents (e.g. PARs, filtered venting, bleed & feed strategies, extensive use of mobile pumps, additional power supplies) for SAM. The regulator is thus seeking improvements in the SAMGs so that Borssele's overall approach aligns with wider international good practice.
The Regulator wants the Licensee to study the world-wide post-Fukushima developments regarding SAMGs and improve on those in use where necessary.

4.2.1.3 Hardware provisions for severe accident management

Reactor hardware provisions at Borssele have been outlined briefly above. These include a steam-driven pump available to supply emergency feed during the first hours of a SBO event, measures for decreasing RPV pressures following a core melt using standard non-dedicated means (i.e. pressure relief valves and various pressuriser spray options) and measures for depressurising containment (filtered venting, the spray system, air coolers, a filtered recirculation system, PARs). The PARs have been designed for severe accident conditions.
The SAMGs assume a core melt-through will occur, so the strategy is based around RPV depressurization aimed at preventing high pressure melt ejection. This is needed since an analysis of the forces on the RPV showed these would be too high. Several power supply options are available to supply the systems needed for depressurising the RPV. In case of site flooding, batteries are installed at elevations safe from the floodwater to ensure these have adequate power supplies.
No explicit means of core vessel cooling is provided. The licensee has looked at the possibility of flooding the ex-vessel cavity in both 2000 and 2004. However, these analyses failed to identify any practical solutions. A key problem here is the narrowness of the cavity, which would mean high steam or hydrogen pressures. This position is to be reviewed at the next PSR. It is noted that such a measure has however not been installed anywhere yet on a KWU-designed Pressurised Water Reactor (PWR), although it has been installed on other reactors of comparable power.
As noted above, the design has no core catcher. So the severe accident strategies, supported by calculations, rely on adequate corium cooling to ensure retention within the containment. Studies here are ongoing. In the analyses used for the SAMG strategies it is conservatively assumed that molten corium has a non-coolable configuration and will ultimately penetrate the basemat. Consequently containment pressure shall be reduced to prevent a high pressure melt-through the basemat. General opinion is, however, that the corium will spread and become coolable if not come to a stand-still, provided the basemat is thick enough. The SAMG strategies maintain efforts to submerge the corium.
In an extreme scenario, filtered venting could be used as a last resort to control containment pressures. The SAMGs envisage venting being carried before a 6.3bar over-pressure is reached (c.f. a design over-pressure of 3.8 bar). Manual operation of the filtered venting system is possible. Seismic qualification of the system is currently ongoing.
The containment venting system is kept inerted with nitrogen. The possibility of detonation/deflagration in the stack is currently dismissed because of the PARs.
The case of sub-atmospheric pressures in the containment has also been considered. A system that acts as a one-way pressure valve is installed that opens automatically on a measured high negative pressure difference. This valve can also be operated manually. The system consists of two trains of two motor operated valves. These valves are all controlled by signals from the engineered safety features activation system (ESFAS).The valves will open if a sub-atmospheric pressure of < 30 mbar is detected. They will then close if a sub-atmospheric pressure of < 10 mbar is detected. In this way they act like one-way valves. The valves are electrically feed by batteries. Two parallel trains cover the single failure criterion in the open direction. They are isolatable because there are two valves in sequence (safe against single failure in the closing direction).
In addition to venting, containment spraying can be used as an additional measure, though the system is primarily designed to wash-out radioactive products. The spray system contains boron; besides, the system allows the addition of other chemicals.

Following upgrades, the installed SAM instrumentation is designed to cope with LOCA conditions. This should be bounding in all respects except in regard to the radiation levels expected in an ex-vessel core melt scenario. Furthermore, a containment pressure sensor has been replaced by a type that can handle pressures above the containment design pressure, in order to allow the containment to be vented as per the SAMGs. All radiation and radioactive release instrumentation has been designed with high radiation scenarios in mind.
In the National Report it is stated that the regulator recognizes that in the Licensee Report, for the assessment of ENSREG-postulated scenarios, the licensee has given credit to SSCs that are not designed, classified or tested for their purpose in severe accident management. This is a common and acceptable approach for accident management past the design basis and for the purpose of the stress tests this is acceptable too. This conclusion was based on an evaluation performed in the process of implementing the Westinghouse Owners' Group generic SAMGs (*WENX 99-02 "Borssele Nuclear Power Plant Severe Accident Management Guidelines instrumentation report" rev. 2, December 1999).* Consistent with the SAMG philosophy, all available instrumentation may be used to obtain process information. The main instrumentation consists of the qualified post-accident instrumentation, which include some instrumentation installed for coremelt accidents. Nevertheless, validation of the data is mandatory in the SAMG decision process.
During the peer review country visit, the licensee reported that, containment instrumentation is required to function correctly in radiation fields of up to 10^3 Gy during normal operation and to ~ 10^5 Gy during accident conditions.
The regulator has recommended further studies to establish the validity of the assumptions made regarding the associated SSCs. The regulator has stated that further assurance is needed to provide adequate confidence that the SSCs in place to handle severe accidents will deliver their intended safety functions reliably. Improvements to SSC functional testing and operator training have therefore been requested.
A mobile diesel generator is available on-site and further mobile generators can be brought onto the site if there is the need. In addition there is potential to use the emergency diesels located at the coal-fired power station on the site. This will not be a conflict as the two plants have a common owner and the NPP will be given priority. The location of the on-site mobile generator is to be moved to reduce its vulnerability to flood events. In addition, further improvements are proposed to the engineered connection points and new connection points are envisaged, but further study is required.
There appears to be reasonable diversity in the means of supplying cooling capability, including several tenders (fire trucks) operated by the site's fire brigade (one of which is an aircraft crash tender).
The national report notes that providing storage facilities for portable equipment, tools and materials needed in an emergency that are accessible after all foreseeable hazards would increase the potential effectiveness of the emergency response organisation. These storage facilities are under investigation but as a temporary measure, it is planned to use existing locations in the reactor and ancillary buildings as they have seismic and flood protection. This may require expansion of the auxiliary building to create space. Additional offsite or mobile locations may be identified later.
The arrangements through which the operator ensures that the plant and equipment it has in place to address severe accidents remains in an appropriate working condition (e.g. routine inspections, maintenance and testing) were discussed during the peer review exercise. Similarly, regulatory inspection of these items and the regulator's approach to the underlying safety assessments that prove these provisions are adequate. In general, equipment used for SAM is subject to routine maintenance and inspection. However, the licensee has noted that not all SAMG equipment is inspected. In this case, equipment/component faults identified during an exercise are corrected (non-routine maintenance). The licensee will review this situation.
Post accident instrumentation is identified as such and qualifications are preserved through surveillance and maintenance instructions. In general (with a similar exception as above to certain equipment), surveillance and maintenance by the plant is under regulator supervision.
The regulator uses IAEA GS-G-1.3 as the basis for its inspection program. GS-G-1.3 states that all safety relevant SSC's should be inspected. The regulator has stated that all equipment which can be used in severe accident management has to be inspected and that the inspection program will be improved on this specific subject.

4.2.1.4 Accident management for events in the spent fuel pools

The Dutch report gives extensive coverage to the management of severe accidents affecting the Spent Fuel Pool (SFP). The SFP is adjacent to the reactor inside the containment building. Fuel stored in the SFP is kept to a minimum; once Technical Specifications allow, it is shipped for reprocessing. The overall strategy is to ensure adequate cooling by preventing the uncovering of the fuel.
There are no specific SAMGs for the SFP, but some SAMGs in effect cater for accidents involving the SFP because of its in-containment location, e.g. strategies for entering containment, controlling containment conditions, controlling hydrogen levels etc. The underpinning logic is that the pressure containment is designed for LOCA events, so accidents affecting the SFP will either make a small contribution to the total accident or will be appropriately bounded.
As a result of the stress tests review, further means of providing emergency make-up to the SFP will be provided. The make-up options will include using water from the Safety Injection (SI) tanks; use of flexible hoses to connect to the demineralised water system or to other sources, and using the containment sprays. Some of these are new proposals and have yet to be implemented.
Two diverse, independent and multiply-redundant systems are provided for ensuring ongoing SFP cooling. Each of these systems can be supplied in an emergency from fire tenders drawing water from the nearby river. However, operating some of these systems would require entry into containment and so the licensee is exploring the installation of a dedicated cooler submerged in the SFP which can be supplied and operated from outside.

There are two PARs installed above SFP for control of hydrogen. However, as these were not located with SFP faults in mind, further studies are to be carried out, e.g. on the inerting effects of ongoing steam production.

In addition, studies are to be provided looking at radiation levels as a function of reducing SFP water levels.

4.2.1.5 Evaluation of factors that may impede accident management and capability to severe accident management in multiple units case

Borssele has looked closely at the likely effectiveness of its severe accident management arrangements during extreme events. The review has concluded that accessibility and habitability of vital areas is ensured, except in the case of prolonged external flooding. It should be noted that as it is a single unit site, multiple unit effects are not relevant.
In regard to flooding, the site can be reached from three sides, so there is some redundancy in potential routes for supplying the site with additional resources or personnel if needed. However, as a result of this review, the licensee is looking at the possibility of using helicopters to bring in reinforcements.
As already noted, the Emergency Response Center (ERC) is vulnerable to very extreme events so the ERO may need to relocate, e.g. to an alternative meeting room on the site. Recognising the shortcomings in these arrangements, the licensee is proposing to build a purpose-built ERC.
The ability to restore / maintain power supplies in an extreme event has been looked at in detail. The regulatory body has however asked for this to be analysed in more depth for extreme flooding scenarios.
Contaminated water storage provisions are extensive on the site, and include access to further large tanks at the coal fired plant if needed. However the regulator considers further analysis would be of benefit here in light of the problems experienced at Fukushima in this regard (though noting that the volumes generated will likely be less at a PWR than for a Boiling Water Reactor (BWR)).

4.2.2 Margins, cliff edge effects and areas for improvements

4.2.2.1 Strong points, good practices

- Explicit incorporation of international standards (e.g. those of IAEA, WENRA) into the licence via the Nuclear Safety Rules (NVRs) approach.

- Borssele has SAMGs for all operational states (including shutdown). The licensee has been very proactive in this regard, implementing them far faster than in many nations reviewed. Its SAMGs were considered state of the art in 2003
- Borssele has used a full scope Level 3 PSA for deriving its severe accident management strategies (many nations reviewed are still developing Level 2 PSAs) and has been subject to IAEA IPSART missions.
- The scale of emergency exercises at Borssele is unusually large by international standards – one recent national exercise involved 1000 people.
- PARs are already installed that are designed for severe accident conditions (in many other nations, PARs are either in the process of being installed or are only designed for design basis events).

4.2.2.2 Weak points, deficiencies (areas for improvements)

- Specific SAMGs need to be developed for the SFP.
- There are question marks over whether all the SSCs installed for severe accident management are capable of delivering their intended safety functions reliably.
- Ambiguous tagging of keys of rooms (e.g. emergency control room) in the bunkered building.
- Not all SAM equipment is subjected to routine maintenance/inspection.

4.2.3 Possible measures to increase robustness

4.2.3.1 Upgrading of the plants since the original design

There have been a significant number of major improvements to the Borssele plant since it was commissioned in 1973. The major improvements have been implemented through the plant's three PSRs, as summarised above in section 4.1.4.

4.2.3.2 Ongoing upgrading programmes in the area of accident management

Other than the work to introduce EDMGs (see above), no significant improvements appear to have been ongoing at Borssele prior to Fukushima. This is perhaps not surprising given the point in the plant's PSR cycle at which the stress tests have been performed (the result of the next PSR is due in 2013 with implementation of improvements before the end of 2017).

A possible exception to this statement is the ongoing work to seismically qualify the containment venting system, which may have been initiated before Fukushima.

Work to complete the remaining recommendations from IAEA's 2010 IPSART mission (where concerns were expressed in regard to MAAP calculations and the validity of what these had assumed) is ongoing. The Regulator receives regular progress reports on this work and it will be completed before the 2013 follow-up IPSART mission. In addition, it was confirmed during the stress tests review that future analysis is to use the MELCOR program.

4.2.4 New initiatives from operators and others, and requirements or follow up actions (including further studies) from Regulatory Authorities: modifications, further studies, decisions regarding operation of plants

4.2.4.1 Upgrading programmes initiated/accelerated after Fukushima

Improvements relevant to severe accident management initiated or accelerated since the Fukushima accident are listed in the preceding sections. A more complete list of measures is provided in the Dutch national report. Highlights from this list relevant to severe accident management include:

- Provision of a new Emergency Response Centre (ERC)
- Improved storage facilities for equipment, tools and materials needed in an emergency
- Means to refill the SFP without needing to enter containment

- Improvements in the diversity of means for ensuring SFP cooling
- Improvements in arrangements for using mobile diesel generators
- Better communication systems
- Seismic upgrades to fire-fighting and containment ventilation systems
- Improvements to the flooding withstand of the ECR
- Develop and implement EDMGs

The regulator has welcomed these proposals, but reserves the right to look in more detail at their effectiveness when more detail becomes available. In addition, the regulator has identified a number of areas where further work is needed to build on the licensee's proposals. Most of these are requests for further analysis (see next section). However, the regulator has also requested the following, relevant to severe accident management:

- Seismic qualification of additional parts of the fire-fighting system not identified by the licensee
- Improvements to EOPs, SAMGs and training to cater, for example, for longer term events.

4.2.4.2 Further studies envisaged

A significant number of topics have been proposed for further study as a result of the stress tests process. Lists are provided in the national report and, during the peer review discussions, several further topics were stated as having been requested for review / analysis. Key areas being addressed directly relevant to severe accident management include:

- Establishing the validity of assumptions in regard to the SSCs needed to manage severe accidents and in particular whether there is a need for upgrades to equipment and/or instrumentation to address severe accident scenarios;
- Performing either a seismic margins assessment or a seismic PSA;
- Strategies for corium stabilisation within containment;
- More extensive use of steam for powering the emergency feed water pump;
- Revisiting previous analyses of ex-vessel RPV cooling;
- The possibility of detonation / deflagrations in the containment filtered venting stack
- Better arrangements for emergency diesel generators, including improved means for recharging batteries and strategies to conserve battery power
- Updated and extended analysis of hydrogen management within containment, including for the SFP;
- Potential improvements to SFP cooling arrangements so that this does not require a containment entry;
- Improvements to SAMGs and EOPs, e.g. focusing on longer term accidents and including better training provisions;
- Analysis of potential doses to workers during severe accident management activities, including assessments of how dose levels increase with reducing SFP level and habitability of the MCR and ECR;
- Reassessments of ERO staffing, including how the ERO would cope if not up to full complement;
- The handling of large volumes of contaminated water generated by accident management strategies;

4.2.4.3 Decisions regarding future operation of plants

The Fukushima accident and subsequent analyses of the robustness of severe accident management provisions (e.g. the stress tests) have not led to any issues that necessitate changes to the plans for future operation of the Borssele plant.

4.3 Peer review conclusions and recommendations specific to this area

The national report and the subsequent ENSREG peer review exercise suggest a good approach has been adopted in the Netherlands for the management of potential severe accidents. This approach goes back many years – the improvements that Borssele has put in place, e.g. from past PSRs, are only now starting to be implemented in some other nations.

A key area however, identified by the Dutch regulator in the National Report, and supported here by the peer reviewers, is the need for further assessment work to establish the validity of assumptions made in regard to the SSCs needed to manage severe accidents. Though it is agreed that such qualification / substantiation need not necessarily be to the conservative standards expected for normal Design Basis provisions, analysis, testing etc to underwrite the performance of these SSCs in their potential operating environments and to ensure they will function after a severe initiating event, are key aspects for gaining confidence that suitable and sufficient SAM measures are in place and will function acceptably on demand. Moreover, it is important that these assessments are systematic, i.e. addressing all the SSCs mentioned in the EOPs and SAMGs, and carried out reasonably early in the overall process to suitably inform other activities, e.g. the need for further plant and equipment enhancements.

The approach of including international standards, guidance and practices within the licensing approach via NVRs has been noted above as a good practice.

The extent and nature of the proposals put forward for improvements in safety in light of Fukushima appear broadly sound, the peer reviewers have examined the licensee's initial proposals for proposed timescales. Part of the work will be done in the PSR (mainly the studies), the remaining work will be done with a more stringent timescale. It is in the intent of the Regulator that the implementation schedule will be kept as short as possible with a view for completion by 2016-2017.

The overall approach to improving severe accident management arrangements in the Netherlands is judged to be soundly-based and appears to be being appropriately managed and regulated.

Recommendations from the ENSREG peer review of severe accident management are therefore as follows:

- The Dutch regulator's suggestion for further analysis to establish the validity of the assumptions made regarding the SSCs needed for SAM is supported and should be pursued as a matter of priority.
- The maintenance schedule for equipment related to accident management should be reviewed by licensee
- Unambiguous tagging of keys of rooms (e.g. emergency control room) in the bunkered building should be implemented.
- The licensee should consider placing the SAM execution procedures at the location where they are to be used.

List of acronyms

AC	Alternating Current
ACC	Alarm Coördinatie Centrum (Alarm Coordination Centre)
DBE	Design Basis Earthquake
DBF	Design Basis Flood
DC	Direct Current
ECR	Emergency Control Room
EDG	Emergency Diesel Generator
EDMG	Extensive Damage Mitigation Guidelines
EL&I	'Ministerie van Economische zaken, Landbouw & Innovatie'; ministry of economic affairs, agriculture & innovation
ENSREG	European Nuclear Safety Regulator Group
EOP	Emergency Operating Procedure
EPZ N.V.	Elektriciteits-Produktiemaatschappij Zuid-Nederland EPZ
ERO	Emergency Response Organisation
ERC	Emergency Response Center
I&M	'Ministerie van Infrastructuur & Milieu'; Ministry of infrastructure & the environment
IAEA	International Atomic Energy Agency
IPSART	International Probabilistic Safety Assessment Review Team
HCLPF	High Confidence Low Probability of Failure
I & C	Instrumentation and Control
KFD	Kernfysische Dienst (Nuclear Safety Department)
KTA	Kerntechnische Ausschuss
KWU	Kraftwerk Union
LOCA	Loss-Of-Coolant Accident
LOOP	Loss Of Offsite Power
MCR	Main Control Room
NAP	Normaal Amsterdams Peil
NPP	Nuclear Power Plant
NVR	Nuclear Safety Rules
NS 1	Nood Stroom net 1 (Emergency Grid 1)
NS 2	Nood Stroom net 2 (Emergency Grid 2)
PAR	Passive Autocatalytic Recombiner
PGA	Peak Ground Acceleration
PRA	Probabilistic Risk Analysis
PSA	Probabilistic safety Analysis
PSR	Periodic Safety Review
PWR	Pressurised Water Reactor
RHWG	Reactor Harmonization Working Group
RL	Reference Level, WENRA
RPV	Reactor Pressure Vessel
RWS	Rijkswaterstaat
SAMG	Severe Accident Management Guidelines
SBO	Station Blackout
SRA	Safety Assessment Report
SFP	Spent Fuel Pool
SHA	Seismic Hazard Assessment
SMA	Seismic Margin Assessment
SSCs	Structures, Systems and Components
TSC	Technical Support Centre
UHS	Ultimate Heat Sink
UJ	Low Pressure Fire System
WANO	World Association of Nuclear Operators

WENRA	Western European Regulators’ Association
WOG	Westinghouse Owner's Group

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